Spatial Distribution of Government-Owned Primary Healthcare Facilities in Michika Local Government Area, Adamawa State, Nigeria: A Geospatial Assessment

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Abstract
Equitable access to primary healthcare depends as much on where facilities are placed as on how many exist. This paper assesses the distribution of government-owned healthcare facilities in Michika Local Government Area (LGA), Adamawa State, using Global Positioning System (GPS) data collection and Geographic Information System (GIS) analysis. Facility locations were captured in the field, linked to attribute data gathered through questionnaires administered to facility managers, and mapped against the sixteen political wards of the LGA. Thirty questionnaires were administered and all were returned. Set against the 2006 census population of 155,302 and a projected 2013 population of about 209,900, the surveyed facilities translate to roughly one facility for every 5,200 people in 2006 and one for every 7,000 by 2013. These ratios mask the more important issue of location, since access in a mountainous, largely rural LGA is governed by distance and terrain rather than by headcount alone. The paper discusses the findings in light of Nigerian and international literature and closes with recommendations on siting new facilities, staffing, data management and community participation.

Keywords: *Healthcare facilities, spatial distribution, GIS, Accessibility, Michika, Adamawa State*

1. Introduction

Health is a precondition for productive life and a central element of the sustainable development agenda. Healthier people work more effectively, earn more and place less strain on household and public resources, which is why health provision has attracted sustained attention from planners and researchers (Asuzu, 2004; Bhatt & Joshi, 2013). In Nigeria, responsibility for health care is shared across three tiers of government. The Federal Government oversees tertiary institutions, states manage general hospitals, and local governments run primary-level clinics, dispensaries and maternity centres. Primary facilities are therefore the first and often the only point of contact between rural communities and the formal health system. A recurring finding in the Nigerian literature is that the main weakness of the system lies less in the quality of individual services than in the uneven placement of facilities, which leaves many of the people who need care far from it (Atser & Akpan, 2009). Onokerhoraye (1984) made the point that facilities provided from fixed locations must be sited so that people in different localities can reach them, and that where facilities do not follow the distribution of population, some groups are effectively deprived. Awoyemi et al. (2011) later showed for Kogi State that long distances caused by poor facility location were a major barrier

to use. Geographic Information Systems offer a practical way to examine this problem. A GIS combines hardware, software and geographic data for capturing, storing, analysing and displaying spatially referenced information (Galati, 2006), and it has become a standard tool for understanding how health services are organised in space (McLafferty, 2003). Studies in Enugu (Ejiagha et al., 2012), Vadodara (Bhatt & Joshi, 2013) and Malaysia (Hazrin et al., 2013) have used it to describe facility patterns and measure accessibility. Michika LGA has received little of this kind of analysis. Health services there are provided at primary, secondary and tertiary levels, yet no systematic account of where public facilities are, what categories they fall into, and how they relate to the population they serve was available to the researcher. This paper addresses that gap. Its objective is to examine the distribution of public healthcare facilities in the LGA,

2. Study Area

Michika LGA lies in the northern part of Adamawa State at about latitude 10.62°N and longitude 13.39°E. It shares boundaries with Madagali LGA to the north-east, with Mubi and Hong LGAs to the south, and with Askira/Uba LGA of Borno State to the west. The LGA covers about 901 km² and had a population of 155,302 at the 2006 census, of whom 74,428 were male and 80,874 female (National Population Commission, 2006). It is divided into sixteen political wards, including Bazza Margi, Futudou/Futules, Garta/Ghunchi, Jigalambu, Madzi, Michika I and II, Tumbara/Ngabili and Wamblimi/Tilli.

The physical setting matters for health planning. The LGA includes mountainous terrain along the Nigeria–Cameroon border, with plains and valleys to the east. The climate is semi-arid, with a hot dry season from October to April and a rainy season from April to October, peaking in August and September. Vegetation is mainly short-grass savanna with patches of woodland. About 80% of resident's farm, and others trade, rear animals, or work in leather and wood. Because most residents are rural farmers dependent on footpaths and unpaved roads, the distance to a clinic is a practical constraint, and seasonal rains can lengthen it further.

3. Review of Related Literature

3.1 Health facility provision and distribution in Nigeria

Health care facilities are the physical structures and supporting equipment through which services are delivered, and in Nigeria they are owned by federal, state and local governments, by private operators and by voluntary and faith-based bodies. Under the constitution, health is a concurrent responsibility, so all three tiers of government may plan, provide and manage facilities. In practice, the lack of coordination between tiers has repeatedly weakened national plans, and distribution has remained uneven. Facilities tend to be concentrated in commercial and urban areas, while rural dwellers, who are the majority in many northern LGAs, depend on a thin network of dispensaries and clinics. Private providers, whose motive is profit, also cluster in towns, which widens the urban-rural gap further.

Studies from different regions of Nigeria reach similar conclusions. Atser and Akpan (2009) documented uneven distribution and accessibility of facilities in Akwa Ibom State. Ejiagha et al. (2012) applied GIS to the healthcare delivery system of Enugu urban area and showed that accessibility varied sharply between parts of the same city. Onokerhoraye (1984) demonstrated that persons per hospital differed enormously across the Nigerian states of his time, which meant that national averages hid concentration in some places and deprivation in others. Outside Nigeria, Bhatt and Joshi (2013) modelled the accessibility of primary health centres in tribal talukas of the Vadodara district in India, and Hazrin et al. (2013) mapped spatial patterns of health clinics in Malaysia. Together these studies show that the problem is widespread and that GIS is a suitable method for diagnosing it.

3.2 Accessibility, equity and the role of distance

Access to health care is shaped by availability, affordability, quality and distance. Among these, distance carries particular weight in rural Nigeria, where roads are poor and transport is limited. Awoyemi et al. (2011) found that distance reduced the use of health services in Kogi State, and Beedasy (2010) found that rural location limited geographic access to specialised care in Idaho. The concept of equity adds a further layer. Horizontal equity means equal resources for equal need, while vertical equity means different resources for different levels of need. A uniform allocation of one clinic per ward may satisfy the first idea but not the second, because a sparsely populated upland ward may need more outreach than a compact town ward. Amer (2007) argued for spatial justice in health services planning, meaning that location decisions should be judged by who gains and who is left out.

3.3 GIS in health facility planning

A GIS brings together location data and attribute data so that the two can be analysed together (Galati, 2006). McLafferty (2003) described how GIS supports the description of health service supply, the measurement of access, and the planning of new services. Typical operations include mapping facility locations, buffering to create catchment areas, overlaying facility maps on population or settlement layers, and measuring distances to the nearest facility. Dobrica et al. (2010) stressed the importance of well-managed spatial data, since the usefulness of any analysis depends on the accuracy and currency of the underlying database. These capabilities explain why GIS was chosen for this study.

4. Materials and Methods

4.1 Data sources

Both primary and secondary data were used. Primary data comprised the geographic coordinates of facilities, recorded with a handheld GPS receiver during a reconnaissance survey and detailed fieldwork, together with questionnaire responses and interviews with facility managers. An updated list of registered facilities was obtained from the Michika LGA Health Department, and facilities found to be operating at the time of the visit were added. A Federal Ministry of Health record dating from 2000 listed about 39 facilities in the LGA. Secondary data included a reference map of Michika LGA, a topographic map used to delineate roads, drainage and settlements, and ward-level population figures from the National Population Commission. The 2006 census figures were projected to 2013 using a growth rate of 4.4% per year.

4.2 Questionnaire and database design

The questionnaire covered three groups of variables: service inputs and outputs (location, ward, facility type and grade), manpower (doctors, nurses, midwives, pharmacists, laboratory staff and other cadres) and facilities (beds, wards, laboratory, water and electricity supply, ambulances, immunisation and family-planning units, among others), as well as problems the facility faced. Thirty copies were distributed and all thirty were retrieved. Attribute data were first entered in Microsoft Excel and then linked to the GPS points in a geodatabase. Feature classes were created for facilities (points), roads and drainage (lines) and settlements and ward boundaries (polygons).

4.3 Analysis

Facilities were plotted as point features on the ward map in ArcGIS, and their attributes were joined to the spatial data to show category and capacity. The distribution pattern was examined visually and through descriptive statistics, using bar and pie charts, in line with Esri's (2016) guidance on understanding spatial relationships and patterns. The ratio of facilities to

population was computed from census figures. Interviews with managers explored why facilities were established where they are and what constraints, such as land or rented premises, shaped those choices.

5. Findings and Discussion

5.1 Coverage and facility-to-population ratios

The field survey reached 30 facilities, each of which returned its questionnaire, so the dataset reflects every facility the researcher was able to identify as operating. This is fewer than the 39 facilities on the Federal Ministry of Health record of 2000, a difference that may reflect closures, reclassification, or facilities that were listed but not functioning. Table 1 sets the facility counts against the population figures.

Table 1. Facility-to-population ratios in Michika LGA

Indicator	Value
Population, 2006 census	155,302
Projected population, 2013 (4.4% annual growth)	about 209,900
Facilities surveyed in this study	30
Facilities in Federal Ministry of Health record (2000)	about 39
People per surveyed facility, 2006	about 5,180
People per surveyed facility, 2013 projection	about 7,000
People per facility using the 39-facility record, 2006	about 3,980
Average population per ward, 2006 (16 wards)	about 9,700

Source: Author's computation from National Population Commission (2006) and field survey data.

Three points emerge. First, on population growth alone, the burden on each facility rose by about a third between 2006 and 2013 without any new facility being added. Second, the ratio is sensitive to which facility count is used, which underlines the value of a verified, GPS-based inventory. Third, the average masks variation. Sixteen wards of roughly 9,700 people each will not have equal numbers of facilities, and the ward-level mapping is what shows which wards carry the shortfall. Onokerhoraye (1984) found that national averages concealed large state-level differences in persons per hospital, and the same logic applies within a single LGA.

5.2 Spatial distribution

Mapping the facilities as points on the ward layer made it possible to see where services cluster and where they are absent. The reviewed literature gives a clear expectation. Facilities tend to concentrate in and around administrative centres and the main roads, while remote wards, particularly those in the hills, are served thinly or not at all (Atser & Akpan, 2009; Ejiagha et al., 2012). In Michika, the Michika I and II wards contain the LGA headquarters and the main market, so they would be expected to attract the larger share of services, while wards along the mountainous border are those most exposed to long travel. Evidence of this kind, where it appears in the ward maps, points to a distribution shaped by settlement size and road access rather than by population need. This matters because of how people actually reach care. Distance is a significant determinant of use, and in a setting with poor roads and limited transport the effective distance is greater than the straight-line figure suggests (Awoyemi et al., 2011). Beedasy (2010) reached a similar conclusion for rural Idaho, showing that rural

residents face disproportionate barriers to geographic access even in a wealthy country. For Michika, the implication is that a facility count that looks adequate on paper can still leave sizeable populations beyond reasonable reach.

5.3 Categories of facilities

The facilities surveyed fall into the categories of hospital, clinic, maternity center and dispensary, with the larger share at the primary level. This is the expected profile for a local government area, since Nigerian policy assigns primary care to local government and refers complicated cases upward. It also means that the quality of the referral chain matters. Primary centers act as filtering units, and specialized services such as surgery and orthopedics are not available at that level. Where referral points are distant or hard to reach, patients with severe conditions bear the cost of the gap. Mapping facility category alongside roads and settlements therefore shows not only where care is available but at what level.

5.4 Manpower, equipment and operating constraints

Facility location is only half of access. The quality of services is closely tied to the manpower available, and a facility without trained staff, drugs, water or power does little for the people living near it. The questionnaire was therefore designed to capture staffing, beds, laboratory and pharmacy services, and utilities. The wider literature suggests the constraints that facilities of this type commonly report: shortage and uneven deployment of nurses, midwives and doctors, irregular drug supply, inadequate equipment and, in rural areas, poor water and electricity supply (Asuzu, 2004; Amer, 2007). Managers' interviews also point to the practical limits on siting, such as the availability of land or affordable rented premises, which tend to pull facilities toward larger settlements.

5.5 Implications for planning

Taken together, the findings support three conclusions. The facility stock, measured against the 2006 census and especially against the projected 2013 population, is stretched. The distribution is likely to favour the central wards and leave peripheral and upland wards under-served. And the strength of the current stock cannot be judged on numbers alone, because staffing and infrastructure determine whether a facility function. These conclusions are consistent with the situation reported for other Nigerian settings and with the Alma-Ata principle that primary care should be brought as close as possible to where people live and work (World Health Organization, 1978).

6. Recommendations

The following recommendations follow from the findings above. They are directed at the Michika LGA Health Department, the Adamawa State Primary Health Care Development Agency and partners working in the area.

1. **Site new facilities by need, using the GIS evidence.** Priority for new health centers should Go towards where the GIS maps show the greatest distance to the nearest facility and the highest population per facility. Candidate sites should be tested with buffer analysis, using a catchment radius that reflects local terrain and road conditions rather than a single national figure, and should be placed on or near existing roads and larger settlements so that they are usable in the rainy season.

2. **Extend reach through outreach in the interim.** Where a new building is not immediately Affordable, mobile clinics and scheduled outreach should be organized for upland and border wards, and community health extension workers should be deployed to bridge the gap.

3. **Apply a ward-based minimum and plan on projected population.** At least one primary Health center should serve each ward, and additional facilities should be added in wards whose population per facility exceeds the LGA average. Plans should use projected rather than census-year population, since the 4.4% annual growth rate used here implies that the 2006 figures understate present demand.

4. **Staff and equip the facilities already in place.** Existing centres should be equipped with trained midwives, nurses and community health workers, a dependable drug supply, clean water and power (including solar where grid supply is unreliable). Incentives such as rural postings allowances and housing for staff would help retain personnel in remote wards, which is where migration of health workers and absenteeism hurt most.

5. **Strengthen the referral chain.** Referral routes between dispensaries, health centres and the general hospital should be mapped, and ambulance or motorcycle transport arranged for emergencies, particularly for maternal and child cases.

6. **Maintain a living facility register.** The geodatabase built for this study should be adopted by the LGA Health Department and updated at least annually, so that closures, new openings and staffing changes are recorded. The discrepancy between the 30 facilities surveyed and the 39 on the 2000 record illustrates the cost of working without a verified register (Dobrica et al., 2010). Staff should be trained in basic GPS and GIS use.

7. **Involve communities in decisions.** Ward and village development committees should be Involved in choosing sites, monitoring service quality and supporting facilities, in the spirit of the Alma-Ata Declaration. Communities are well placed to identify practical obstacles and to hold facilities accountable (World Health Organization, 1978).

8. **Deepen the evidence base.** Future work should add road-network travel time and seasonal access to the analysis, test the pattern with nearest-neighbour and similar spatial statistics, and extend the study to private and faith-based facilities so that the full supply of care in Michika is understood.

7. Conclusion

This paper has assessed the distribution of government-owned healthcare facilities in Michika LGA using GPS and GIS. Thirty facilities were surveyed with full questionnaire return, giving about one facility for every 5,200 people at the 2006 census and one for every 7,000 on the 2013 projection. The central finding is that access in Michika is a question of location, terrain and staffing as much as of numbers. The GIS database developed here gives local planners a basis for placing new health centers where they are most needed, for targeting outreach, and for monitoring change over time. If the recommendations above are adopted, the LGA would be better placed to meet the objective of the national health policy of bringing basic care within reach of every community.

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