SPATIAL ACCESSIBILITY TO PUBLIC MATERNAL HEALTH CARE FACILITIES IN IBADAN, NIGERIA.

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ABSTRACT

This paper assesses the potential accessibility of women aged 15-49 years to public maternal health care services by examining the service areas and distributional pattern of public maternal health care facilities in Ibadan, Nigeria. Information on the locations of facilities was collected from the Oyo state ministry of health. The distributional pattern was assessed using nearest neighbor analysis and Moran’s I statistic. Walking and driving service areas were modeled using the circular buffer method. Results showed that facilities are randomly distributed. There is a need to improve the supply and distribution of facilities to meet present and future needs.

Key Words: Public maternal health care facilities, Geographic distribution, Service area, Potential accessibility, Oyo state, Nigeria.

INTRODUCTION

The adequate supply and optimal allocation of maternal health care services is important for improving maternal health; however an adequate supply is not enough as access to them must also be guaranteed. Spatial accessibility therefore remains one of the most important factors considered in health care studies. The focus of such studies include for instance, the examination of physical and/or structural accessibility to health care, assessment of the variations in the provision and utilization of health care services, analysis of the extent of service areas and identification of gaps in provision, modeling of optimal facility locations, examination of issues of equity and efficiency in health care provision, assessment of health care policies among others. Occasionally, these issues are considered in relation to the incidence of disease and mortality. At the core of most of these studies is therefore the issue of location and its role or impact on the provision of health care. For instance, Ayeni and Rushton (1985) illustrated the problems and effects of poor location planning in the provision of public facilities in Ogun state, Nigeria. They identified some of the ways in which the Nigerian government has misinterpreted issues of efficiency and equity in the distribution of maternity clinics thus resulting in the proliferation of facilities which did not address the needs of many communities. Similarly, Okafor (1991) studied the distributive effects of the location of health care facilities in Ibadan, Nigeria in terms of access to them using Scheiders and Symons access opportunity model. His study revealed that areas of high accessibility lie to the North and areas outside the traditional pre-colonial city. Using both regression and correlation analysis, he found that there was no systematic discrimination against low income disadvantaged groups. However, he pointed out that distribution was not equitable and concluded
that public policy on health care provision in the country does not adequately address the needs of the people. Awoyemi et al (2011) found unequal access to health facilities in the examination of factors influencing access to and the use of health facilities in Kogi state, Nigeria. They found that long distance to health facilities caused by the poor location pattern of health care facilities is a major barrier to their use. Similarly, Arnaldo and Mota (2012) examined the spatial configuration of health care facilities in Brazil and with the aid of location allocation models they proposed optimal solutions for a more efficient and equitable distribution of health facilities.

The review of literature also shows that the approaches and methods of analysis employed in the study of the relationship between location, space and health have varied over time. Methods used are therefore diverse and mostly quantitative ranging from the application of location allocation modeling to statistical analysis and GIS mapping (Daskin et al, 2004). For instance, Bagheri et al (2005) measured accessibility to primary health care services in New Zealand based on World Health Organization acceptable levels of minimum travel time and distance to the closest facility via a road Network. Using the mean centre of population distribution within each unit and road networks, the best route (shortest path) from residential areas to facilities as well as areas poorly covered was obtained. Similarly, Agaja (2012) also carried out extensive GIS mapping and documentation of primary maternal health care centers in Ughelli South and Warri South Local Government Areas of Delta state, Nigeria. This was done to provide geospatial information about the distribution and accessibility of primary health care centers. The distribution was found to be clustered in some areas leaving others underserved. Many similar studies (Black M, 2004; Higgs, 2004; Dussault et al, 2006; Anderson et al, 2009; Abbas, 2012) have also suggested that poor maternal health care is largely due to or aggravated by poor access to health care facilities. Hence, a variety of methodologies and approaches have been adopted to investigate physical accessibility based on distance and/or time. However, one of the best ways to measure accessibility is to examine the distribution of maternal health care facilities as well as their service areas or coverage.

This paper therefore assesses the ease with which women of reproductive age can potentially get to public maternal health care services by examining the service areas (sphere of influence) and distributional pattern of available secondary and tertiary public maternal health care facilities in Ibadan metropolis. Service or catchment area analysis is based on the assumption that patients will use the nearest health care facility hence the sphere of influence for services decreases with travel distance or travel time away from the facility. This type of analysis usually involves carrying out some form of buffering and/or overlay analysis; however there are different approaches depending on the desired level of detail and available data. The two best approaches is the circular buffer approach and service area approach using network analysis. The circular buffer approach involves defining the geographical boundaries or sphere of influence based on distance and/or travel time. Although it has been criticized for not taking into account geographical surroundings or barriers such as buildings and rivers, it has been found to be most suitable for large scale analysis. The service area approach is similar to the circular buffer approach with the exception that it utilizes street network datasets thus generating more realistic catchment or service areas. However, for service areas to be as
realistic as possible a very detailed street network is required. This paper however adopts the circular buffer approach not just because detailed street network data could not be obtained but because this approach is best suited to the scale of analysis.

AIM AND OBJECTIVES

The aim of this study was to examine the geographic distribution and service area of major public maternal health care facilities (PMHCF) in Ibadan metropolis thus identifying gaps in the provision of these services in the city.

STUDY AREA

The study was carried out in Ibadan metropolis, the capital city of Oyo State located approximately on Longitude 3° 58’ East of the Greenwich Meridian and Latitude 7° 23’ North of the equator (Fig 1). Ibadan metropolis is the largest indigenous city in Africa and the second largest in Nigeria. The metropolitan area of Ibadan is generally regarded as comprising of eleven local Government areas. Five of these constitute the core area of Ibadan metropolis. These are Ibadan Southwest with headquarters in Ring Road; Ibadan Northwest with headquarters in Onireke; Ibadan North with headquarters at Bodija; Ibadan Northeast with Headquarters along Iwo Road; and Ibadan Southeast with headquarters at Mapo. The other six local government areas covering parts of the city and the surrounding rural areas are Akinyele, Egbeda, Lagelu, Oluyole, Ona Ara, and Ido Local Government Areas. According to the 2006 census, Ibadan has a total population of 2,559,853 made up of 1,295,243 females out of whom 677,142 (52.28%) are of child bearing age. This indicates that there are a large number of potential mothers hence the need to ensure the adequate supply and optimal distribution of maternal health care services in the city.
**Table 1: The Location of Secondary and Tertiary Public Maternal Health Care Facilities in Ibadan.**

<table>
<thead>
<tr>
<th>LGA</th>
<th>HQ</th>
<th>Longitude</th>
<th>Latitude</th>
<th>Name</th>
<th>Location</th>
<th>Maternal Health Workers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ibadan SW</td>
<td>Oluyole Estate</td>
<td>3.866027</td>
<td>7.36255</td>
<td>Ring road State Hospital</td>
<td>Ring road</td>
<td>195</td>
</tr>
<tr>
<td>Ibadan NE</td>
<td>Iwo Road</td>
<td>3.90883</td>
<td>7.38077</td>
<td>St. Peters Maternity Hospital</td>
<td>Aremo</td>
<td>34</td>
</tr>
<tr>
<td>Ibadan N</td>
<td>Bodija</td>
<td>3.901370</td>
<td>7.400403</td>
<td>University College Hospital</td>
<td>Orita Mefa</td>
<td>1,591</td>
</tr>
<tr>
<td>Ibadan N</td>
<td>Bodija</td>
<td>3.8998</td>
<td>7.39991</td>
<td>Adeoyo Teaching Maternity Hospital</td>
<td>Yemetu</td>
<td>242</td>
</tr>
<tr>
<td>Akinyele</td>
<td>Moniya</td>
<td>3.91103</td>
<td>7.53231</td>
<td>General Hospital</td>
<td>Moniya</td>
<td>25</td>
</tr>
<tr>
<td>Lagelu</td>
<td>Iyana Offa</td>
<td>4.08695</td>
<td>7.53781</td>
<td>Lagun General Hospital</td>
<td>Lagun</td>
<td>14</td>
</tr>
</tbody>
</table>
Ibadan has only 240 public health care facilities offering various degrees of maternal or obstetric health care services. These maternal health care facilities range from health clinics to general and teaching hospitals. Out of these, 231 (96%) are primary maternal health care facilities, 7 (2.92%) are secondary and 2 (0.83%) are tertiary maternal health facilities. Only six Local Government Areas (Akinyele, Egbeda, Ibadan North, Ibadan Southwest, Lagelu and Oluyole) have at least one secondary maternal health care facility (with the exception of Lagelu that has two secondary maternal health care facilities) while the only two tertiary health care facilities in Ibadan city, the University College Hospital and Adeoyo state hospital, are located in Ibadan North (Table 1). The former is owned by the Federal Government and the latter by the Oyo state Government. In terms of ownership, 9 (3.75%) are owned by the Federal Government, 23 (9.58%) by the Oyo state Government and 208 (86.67%) by the Local Government. With regards to the supply of skilled maternal health care workers, Ibadan has a total of 2,688 workers consisting of 62 consultants, 528 doctors and 2,098 nurses/midwives. Unfortunately, more than half 460 (87%) of doctors, 1431(68%) of nurses/midwives and 46(74%) of consultants are in Ibadan North. A closer inspection shows that 44 out of the 46 consultants (95.65%), 441 out of the 460 doctors (95.87%) and 1,348 out of the 1,431 nurses/midwives (94.20%) are stationed at the only two tertiary health care facilities in Ibadan city.

**MATERIALS AND METHODS**

For this study, a scanned administrative map of Ibadan was digitized and geo-referenced with a geographic coordinate system defined by the Minna datum in ArcGis to obtain a shapefile of the study area. Information on the locations of public maternal health care facilities in Ibadan was collected from the Oyo state ministry of health while geographic coordinates were obtained from the field with the aid of a hand held GPS device. Using ArcGIS 9.3 and Micosoft Excel as data processing tools, the mapping and analytical procedure designed for this study is schematically shown in Fig 2.
The distributional pattern of facilities was assessed using both Moran’s I and nearest neighbor statistic. Global Moran’s I measures spatial autocorrelation based on feature locations and attribute values. Moran’s I tool in ArcGIS calculates a z score (measure of standard deviation) and p-value to indicate whether or not facilities are randomly distributed across the study area. In other words, it evaluates whether the distributional pattern is clustered, dispersed or random. A positive Moran’s I index value indicates a tendency towards clustering while a negative Moran’s I index value indicates a tendency towards dispersion. Similarly, nearest neighbor analysis involves a comparison between the observed spacing of a set of points and the spacing which would be expected in a random pattern. The observed spacing is the distances between any point and all other points determined by straight line measurement or
Euclidean distance. The distribution of public maternal health care facilities was measured using the average nearest neighbor tool in ArcGIS which calculates a nearest neighbour index based on the average distance from each public maternal health care facility to its nearest neighbouring facility.

In addition, the standard distance spatial statistics tool in ArcGIS was used to determine the degree to which they are concentrated or dispersed. If the spatial pattern is concentrated in the center with fewer features towards the periphery (i.e. a spatial normal distribution) a circle polygon of one standard deviation will cover approximately 68% of the features. On the other hand, the directional distribution was assessed using the standard devitional ellipse tool which measures whether a distribution exhibits a directional trend by creating an elliptical polygon. Again, a one standard deviation ellipse polygon will cover approximately 68% if the spatial distribution is normal. Finally, the Service area for each facility was determined using classifications based on literature and WHO standards (Table 2) as the limitation for determining the extension of catchment areas.

<table>
<thead>
<tr>
<th>Classes</th>
<th>Range of values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very good</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>Good</td>
<td>1 - 3</td>
</tr>
<tr>
<td>Moderate</td>
<td>4 – 5</td>
</tr>
<tr>
<td>Poor</td>
<td>&gt;5</td>
</tr>
</tbody>
</table>

Initially Thiessen polygons were used. This method creates polygon features also known as proximal polygons by triangulating all points into a triangulated irregular network (TIN). The perpendicular bisectors for each triangle edge are generated forming the edges of the Thiessen polygon. In other words, this method divides the surrounding space and allocates it to the nearest point feature such that the area inside a given polygon is closer to that polygons point than any other. Hence each polygon represents the sphere of influence of each secondary and tertiary public maternal health care facility in Ibadan. However, for a more refined measure of accessibility and to assess how spatial accessibility varies with impedance multiple buffer rings were generated around each public maternal health care facility.

The coverage of primary maternal health care facilities is however not examined for various reasons in spite of being important to the delivery of maternal health care. First of all, access to secondary and tertiary maternal health care facilities is important for having an efficient referral maternal health care delivery system. Primary maternal health care facilities offer basic maternal health care such as recovery/rehabilitation and counseling services. More complex pregnancy and post pregnancy health issues which are more common are better
handled by secondary and tertiary facilities. Although these facilities don’t have to be as numerous and ubiquitous as primary maternal health care facilities they still need to be as spatially accessible as possible. When poorly located and distributed they cripple or impair the maternal health care delivery system thus preventing the system from functioning effectively. Secondly, primary maternal health care facilities by their very design tend to be located in every neighbourhood i.e. in close proximity except where seriously inadequate hence they are far more easily accessed than higher order facilities even in most rural communities. Thirdly, due to the macro scale of analysis, primary maternal health care facilities in the study area are numerous. This makes it difficult to both display their geographic coordinates on the study map and depict their coverage because of extremely overlapping service areas particularly in the Local Government Areas that make up the city core.

RESULTS

The spatial distribution and pattern of public maternal health care facilities.

In examining the geographic distribution of secondary and tertiary public maternal health care facilities in Ibadan, the standard distance spatial statistics tool in ArcGIS generated a polygon feature class with a circle size of one standard deviation with a center x value of 3.946885 and center y value of 7.421063. Since the polygon generated covers only 66% of public maternal health care facilities the distribution can be said to be close to a normal or regular distribution. Similarly, the directional distribution was assessed using the standard deviational ellipse tool. The elliptical polygon generated covered only 66% of public maternal health care facilities. The distribution therefore has some tendency towards a regular pattern with a northeast directional distribution.

In analyzing the pattern of secondary and tertiary public maternal health care facilities nearest neighbour analysis was carried out. As shown in Fig 3, the nearest neighbour ratio of 0.72 is less than one which indicates that the distributional pattern of facilities is fairly clustered though with emerging signs of a tendency towards a regular distribution. The z score of -1.59 falls between -1.96 to +1.96 as a result the p value of 0.11 (i.e. +0.11 standard deviations away from the mean) is larger than the 0.05 critical level, hence the pattern could be some sort of a random pattern.
Similarly, Global Morans I spatial statistics was also used to analyze the pattern of facilities. Although best when dealing with larger sample sizes, Fig 4 shows that the Morans I index is 0.18 indicating that the distributional pattern is somewhat clustered. However, since the z score of 1.28 falls between -1.96 to +1.96 as a result the p value of 0.20 (i.e. +0.20 standard deviations away from the mean) is larger than 0.05 i.e. a 95% confidence level. Since both p values are larger than 0.05 (p>0.05) this means that facilities are randomly distributed. This suggests that the location of secondary and tertiary public maternal health care facilities was not planned or provided particularly to meet demand for them. In other words, facilities could have been established as such areas grew in economic importance which explains why most are located near the Local Government Area headquarters.

Fig 3: Screenshot of Nearest Neighbour Analysis Result
Walking Service Areas and its implications

Walking remains a major way of travelling in developing countries like Nigeria particularly in rural areas hence having facilities within walking distance could help improve the referral system and encourage the use of secondary facilities when serious pregnancy related complications arise. Walking service areas were thus created at a distance of 1, 3 and 5kms away from all secondary and tertiary public maternal health care facilities in Ibadan (Fig 5). Since the average walking speed is 5km/hr, this implies that women living within the buffered zones will spend between 15-60minutes to get to public maternal health care facilities (with the exception of the effects of barriers such as the terrain). It was also discovered that walking service areas for the two secondary maternal health care services in Lagelu Local Government Area extend slightly beyond Lagelu’s administrative boundary to Iwo and Aiyedire Local Government Areas of Osun state. This implies that women aged 15-49 years living outside Oyo state might potentially benefit from the presence of these facilities. The best coverage is however at the city core especially in Ibadan North, Northeast and Southeast which are all completely within the buffered zones hence women aged 15-49 years in these areas potentially have spatial access to available facilities. On the other hand, Ido Local Government Areas is not served at all while some Local Government Areas such as Ona-Ara are only slightly covered. The service areas that fell only within Ibadan and its region and the

Fig 4: Screenshot of Global Moran’s I Result
percentage area served was determined while Service areas were reclassified based on a non-numeric scale of very good, good, moderate and poor spatial accessibility. It was therefore discovered that only 0.79%, 5.25% and 8.55% of the land area is within a 1, 3 and 5km walking distance of public maternal health care facilities. Overall, only a small area (14.59%) is within walking distance of both secondary and tertiary maternal health care facilities. This suggests that most women of child bearing age will have to travel by other means of transport. With the lack of efficient rapid transit systems, high transport costs and high levels of poverty women living in areas outside the buffered zones are more likely to use more accessible alternative sources of maternal health care such as traditional health care centres.

Fig 5: Locations within Walking distance of 5km away from Public Maternal Health Care Facilities in Ibadan
Driving Service Areas and its implications

Service areas based on recommended driving distance was generated at a distance of 10, 15 and 20km away from both secondary and tertiary facilities (Fig 6). At a radius of 10km, service areas completely cover the city core i.e. Ibadan North, Northwest, Northeast, Southwest and Southeast as well as most parts of Akinyele, Lagelu and Oluyole Local Government Area. At 10-15km, Service areas or coverage extends to Ona-Ara and Ido Local Government Area and completely covers Lagelu and Egbeda Local Government Area. Their sphere of influence also surprisingly extends albeit slightly to Afijio Local Government Area in Oyo state located to the North of Akinyele Local Government Area as well as to the Local Government Areas of neighbouring states i.e. Odeda, Obafemi-Owode and Remo North Local Government Areas of Ogun state and Irewole, Iwo, Ola-Oluwa, Aiyedire and Isokan Local Government Areas of Osun state. At a buffer distance of 20km, all Local Government Areas in Ibadan are covered with the exception of Ido, Oluyole and Ona-Ara Local Government Areas and coverage extends a bit more into surrounding Local Government Areas. It was discovered that at a maximum threshold of 20km, catchment areas of all secondary and tertiary maternal health care facilities covered a large part (74%) of Ibadan city. This suggests that many women aged 15-49 years have at least potential access to available facilities. Service area maps were also reclassified based on a non-numeric scale of very good, good, moderate and poor spatial accessibility. However, service areas measured based on driving distance could be misleading especially in less developed countries where many women don’t have vehicles and have no access to efficient and affordable transport systems. All the same, it remains a good benchmark for assessing coverage and determining potential access to facilities. The fact that service areas cut across state boundaries suggests that these facilities might induce some residents of Ogun and Osun state living at the border to travel across state borders for maternal health care. This could put unnecessary pressure on available facilities and skilled health care workers thus jeopardizing the quality of care being offered.
The overlay of both walking and driving service area maps identifies areas that are potentially accessible to available public maternal health care facilities and areas completely underserved (Fig 7). It shows that there is a need to locate maternal health care facilities in areas with moderate to poor spatial access to facilities such as Ido Local Government Area so as to improve accessibility and ease the burden not just on available maternal health care facilities and skilled health care workers but also on women of reproductive age. It is also implied that many women aged 15-49 years resident within walking and driving distance of these facilities should have access to them. The number of women aged 15-49 years using these facilities will likely fall with increasing distance from these facilities. However, it is important to note that there are other factors especially non spatial factors that could determine whether or not realized or actual accessibility is eventually achieved.
Fig 7: Areas with Potential Spatial Access to Public Maternal Health Care Facilities in Ibadan
CONCLUSION

This study has shown that most women aged 15-49 years in Ibadan metropolis are at least within 20km of available facilities hence they have a reasonable amount of physical access to them. However, this does not imply that all of them can afford to travel to these facilities especially on a regular basis or pay for the services offered by these facilities. Similarly, women with physical access to facilities may choose not to use them for psychological, cultural, religious or political reasons. However, ensuring physical accessibility and coverage is a major step in encouraging women of child bearing ages to use public maternal health care facilities. It is therefore important for the Government to realize that the choice of location matters in the provision of maternal health care facilities as well located maternal health care services can encourage their use. In other words, where maternal health care facilities and skilled health care workers are located is a primary factor in determining whether or not they are accessible and have adequate catchment areas.

ACKNOWLEDGEMENTS

I acknowledge with gratitude the suggestions generously given by my supervisor – Dr. G.O Ikwuyatum. I also thank the staff of the Oyo State Ministry of Health for their help in the collection of data.

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