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SPATIAL ANALYSIS OF PHYSICAL ACCESSIBILITY TO PUBLIC PRIMARY HEALTHCARE CENTERS IN KADUNA STATE, NIGERIA

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ABSTRACT

The rising call for spatial justice in the distribution and access to public facilities especially health necessitated this study. The study sets out to assess the spatial patterns of physical accessibility to PPHCs in Kaduna State. Four physical accessibility parameters were used in this study: travel time, travel distance to the nearest Public Primary Healthcare Centers (PPHCs), mean distances between and within PPHCs, and effective geographic catchment area coverage of PPHCs. Both travel time and distance to the nearest PPHC were evaluated using a questionnaire. The mean distance between and within PPHCs for LGAs was estimated from the Nearest Neighbor Analysis. The effective geographic catchment area of a PPHC was determined using the geospatial Thiessen polygon method. Findings showed that 42% of the respondents, live close (< 2 km) to a PPHC facility. The proximity of the respondents from Igabi (52%), Zaria (49%), and Zangon-Kataf (51%) is closer than the other LGAs. Thiessen catchment area showed a wide range of variations with some PPHCs with very large areas (426 -615 km^2) mostly found in the central senatorial zone, especially in Birnin Gwari and Chikun LGAs. The most widespread are PPHCs with relatively moderate catchment sizes of (187–339 km^2) found across parts of northern, central, and southern senatorial and LGAs. The study concludes that areal and topographic factors as revealed by the polygon-derived catchment areas should also guide the decision for the siting of PPHCs in the state. Hence, additional PPHCs are recommended especially LGAs with extensive land masses.

Keywords: Accessibility, healthcare centers, travel time, mean distance, catchment area

INTRODUCTION

Primary health care was declared the model for global health policy in 1978 (World Health Organization, 1978). Primary health care requires a change in socioeconomic status, distribution of health resources, a focus on health system development, and an emphasis on basic health services (Magnussen et al., 2004). WHO and UNICEF elaborated the strategy of primary health care as the means to achieve *Health for All by the Year 2000*. The concept of PHC had strong socio-political implications. It explicitly outlined a strategy that would respond more equitably, appropriately, and effectively to basic health-care needs. The main goal of most public healthcare systems is to improve or achieve a healthier population. Physical Access to health services is one of the first steps in maintaining and improving population health. However, adequate attention has not been paid to equity in the planning and distribution of healthcare facilities over the years in the country (Onokerhoraye, 1999). Furthermore, Yang *et al.*, (2006) remarked that equitable distribution of healthcare resources is one of the main goals of health facility planning. Thus, systematic variations in healthcare accessibility as matters of social justice need holistic planning to improve accessibility for public PHCs in Nigeria.

Efficient and equitable accessibility to healthcare services is one of the vital elements in the 17th global target set by the United Nations for promoting sustainable development goals (UNDESA., 2015). According to WHO (2017) under the human rights concept, accessibility is described as the availability of health services within a safe and reasonable physical reach to all sections of the population especially vulnerable and marginal groups likely ethnic minorities and indigenous people, women, children, aged groups and persons with disabilities including in rural areas. The history of development of Primary Health Care (PHC) has come a long way. Lambo (2015) summarised the implementation of PHC in Nigeria into six phases, in which the second phase (evolution of the BHSS to PHC, 1980-1985), coincides with the period of the Fourth National Development Plan (1981-1985) that addressed the issue of preventive health services for the first time. The policy statement contained in this plan called for the implementation of the Basic Health Services Scheme (BHSS), which provides for the establishment of three levels of healthcare facilities, namely Comprehensive Health Centres (CHC) to serve communities of more than 20, 000 people; Primary Health Centres (PHC) to serve communities of 5000 to 20, 000 persons; and Health Clinics (HC) to serve 2000 to 5000 persons. Thus, a CHC would have at least one PHC in its catchment area (ideally 4) and a PHC would have at least one HC in its catchment area. These institutions were to be built and operated by state and local governments with financial aid from the federal government.

Accessibility has physical (spatial), time, economic and social dimensions (Ibrahim and Abdulhamed, 2012). Accessibility is a variable quality of location. In an operational sense, it is a variable quality of centrality or nearness of other functional locations clearly; the notion of accessibility is closely related to movement minimization especially when this is measured by the costs involved in overcoming distance. Accessibility by the user population is an important prerequisite for the patronage of any medical facility. Therefore, the need for primary healthcare facilities and access for residents cannot be over-emphasized. It is an important component of the overall health system, which has an impact on the well-being of the populace.

Across the world, investments in PHC improve equity and access, health care performance, accountability of health systems, and health outcomes. While some of these factors are directly related to the health system and access to health services, the evidence is clear that a broad range of factors beyond health services play a critical role in shaping health and well-being. These include social protection, food systems, education, and environmental factors, among others (WHO, 2021a).

The United States President's Commission (1983) explained the conceptual problem related to accessibility, that equitable access to healthcare should be in a manner that every single citizen can acquire an adequate level of medical care without excessive burdens. Another Commission came up with a solution that regarded the concept of accessibility as the timely use of healthcare services and the best possible use of health outcomes. In this study, the conceptual framework considers physical accessibility as equitable and timely access to and patronage of a healthcare facility based on travel distance, travel time using geospatially determined mean distance, effective catchment area, and condition of transport route as perceived by respondents. Many studies attempt various techniques to get a clear understanding of the accessibility to PPHCs (Cabrera-Barona et al., 2018). Geospatial techniques are widely used in different fields of studies related to healthcare to maximize geographical accessibility to PPHCs and other health facilities (Higgs, 2004). GIS is a platform that provides a framework for the population for both assessments of the distribution of healthcare centers and evaluation of effective coverage (Delamater et al., 2012). Spatial or geographical accessibility generally refers to the physical access of a user to a healthcare location (McGrail and Humphrey, 2014) or simply reflect the

linkages between the point of medical service demand and the point of medical service delivery taking into consideration of existing transport framework and travel impedance (Wang et al, 2016).

The current model for the location of PPHCs is guided by political wards. The distribution of political wards is largely influenced by political power and has a high tendency to defile the role of physical factors which greatly determine access to public facilities. It is in the background of this that this study aims to assess the physical variables of the existing political ward by ward distribution pattern of PPHCs to identify the implication this may constitute to accessing PPHCs.

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MATERIALS AND METHODS

The study was carried out in Kaduna State of Nigeria. Kaduna State is located between Latitudes 09^{o} 02' N through 11^{o} 32'N and Longitude 0615' E through 08^{o} 38' E. The state was created on May 27, 1967, and occupies part of the central position of the Northern part of Nigeria (with Kaduna as its capital) and the North-West geo-political zone. It shares common borders with Katsina State to the North, Nasarawa State and the Federal Capital Territory, Abuja to the South, Kano, and Bauchi States to the Northeast, Zamfara State to the Northwest, Niger State to the West, Plateau State to the Southeast. The State occupies an area of approximately 45,711.2km2 5% of Nigeria's total landmass) and is the twelfth largest State in Nigeria.

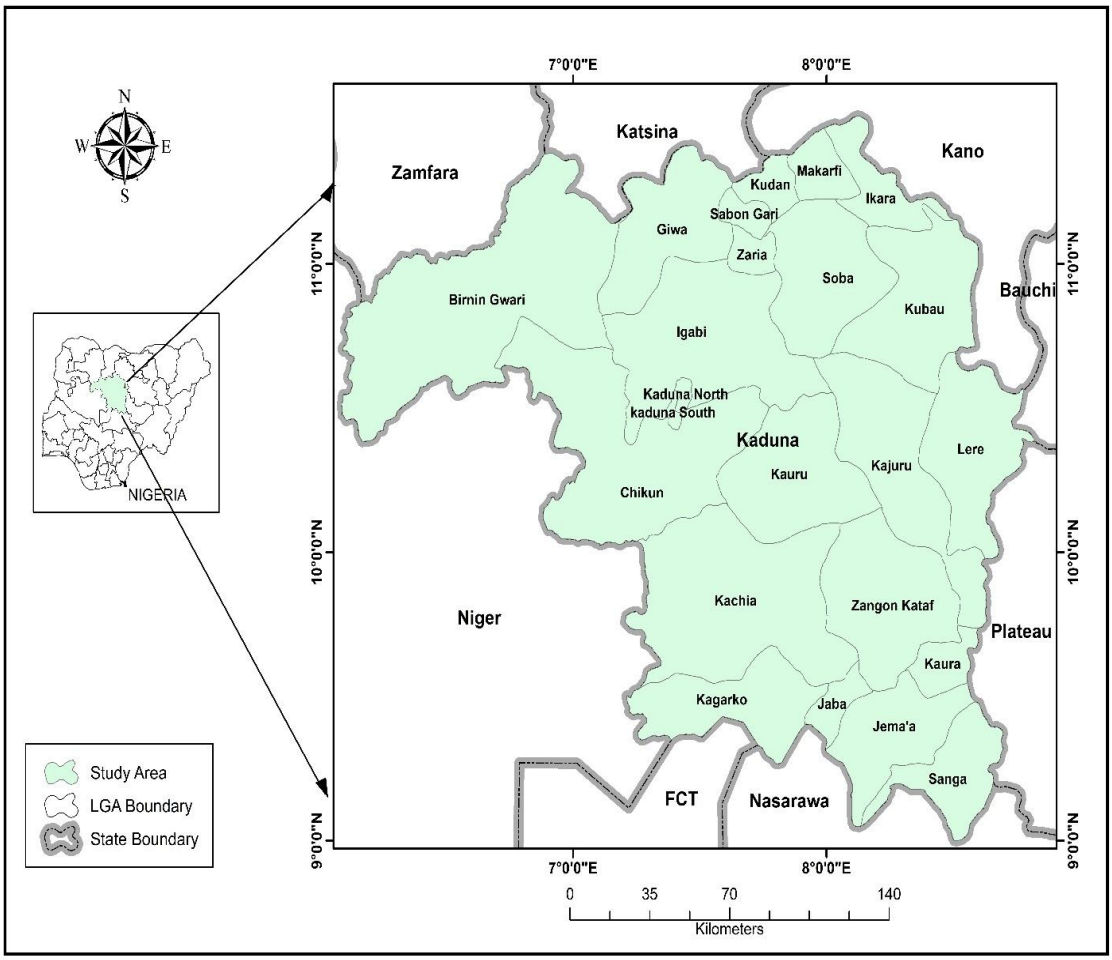

Figure 1: Administrative map Kaduna State showing Local Government Areas of Study
Source: Adapted from the Administrative Map of Kaduna State

The bedrock geology of Kaduna State is predominantly metamorphic rocks of the Nigerian Basement Complex consisting of biotite gneisses and older granites. In the southeastern corner, younger granites and batholiths are evident. The geology is underlain by gneisses, migmatites, and meta-sediments of the Precambrian age which have been intruded by a series of granitic rocks of the late Precambrian to lower Palaeozoic age. Generally, the soils and vegetation are typical red-brown to red-yellow tropical ferruginous soils and savannah grassland with scattered trees and woody shrubs. The climate of Kaduna state is the tropical dry-and-wet type, classified by Koppen as Aw. The Wet season lasts from April through mid-October with a peak in August, while the dry season extends from mid-October of one calendar year to April of the next (Abaje and Giwa, 2010). The annual average rainfall in the state as a whole is about 1323mm. Kaduna State is the third most populous state in the country with a population of 6.06 million (2006 census). The population is culturally very diverse with distinct differences in religion, ethnicity, traditions, and social norms between the predominantly Hausa/Muslim population in the northern part of the State and Christians of a variety of ethnic groups to the south. Over 60 ethnic groups namely, Adara (Kudara), Atyap (Kataf), Bajju (Kaje), Bakulu (Ikulu), Bhazar (Koro), Fantswan, Fulani, Gbagyi (Gwari), Gure, Gwandara, Gwong (Kagoma), Ham (Jaba), Hausa, Kahugu, Mada (Mardan), Ninkyop (Kaninkon), Ninzo, Numana, Nyenkpa (Yeskwa), Oegworok (Kagoro), Sholio (Marwa) Takad (Attakar) and Tsam (Chawai) among others populate the state.

Purposive and systematic random sampling techniques were employed in this study. Kaduna State consists of three Senatorial Zones namely: Kaduna North, Kaduna Central, and Kaduna South Senatorial zones. Three LGAs are purposively selected from each of the Senatorial Zones based on population size because the study is demographically focused. All the LGAs in each of the Senatorial zones are arranged according to their size of population, then, the LGAs with the highest, medium (median), and lowest population are selected. The selected LGAs in Zone A are Zaria, Soba, and Kudan; Zone B are Igabi, Kaduna North, and Kajuru and Zone C are Zangon-Kataf, Kagarko, and Sanga.

The primary data were collected using a closed-ended structured questionnaire as the research tool. Secondary data were sourced from the Kaduna State Ministry of Health, National Population Commission, fieldwork, and relevant public administrative offices. Ratios and percentages were used to analyze the data. Information on the number of health facilities was obtained from the records of the Ministry of Health while population figures were obtained from the National Population Commission (NPC) office. The data were arranged in tables and used to describe trends. Ratios were used to describe the proportion of a variable to another at a given point in time. Population estimates were computed by adopting the 3.1 percent growth rate for the state (NPC, 2006). The purposive sampling technique was used to administer the questionnaires at the household to willing respondents on a daily basis until the required sample size was obtained. Kerlinger (1999) cited by Joshua *et al.*, (2016) describes purposive sampling as being characterized by the use of personal judgment and a deliberate attempt to obtain representative samples by including presumable typical areas or groups in the sample. The sample size was 400 as determined by the Taro Yamane sample size formula.

Thiessen's polygons were delineated in the entire study location and buffering analysis was carried out at different distances (<2km, 2km-5km, 5km-8km, 8km-10km, >10km). Thiessen polygon analysis was performed to identify catchment areas based on the proximal or nearest PPHC facility. The Thiessen polygon catchment area is very crucial for understanding wards PPHCs that have proximity advantages or disadvantages based on area coverage. The data

collected were subjected to descriptive statistics whereby the frequency and percentages were used for the data analysis. Maps, tables, and graphs were used for data presentation.

RESULTS AND DISCUSSIONS

The Physical/Spatial accessibility to public PHCs in Kaduna State

Travel Time: Travel time is one of the metrics of physical accessibility. The findings are presented in Table 1.

Table 1: Approximate time taken to reach PPHC based on available mode of transportation.

Senatorial Zones	LGA	<30mins	(%)	Greater than 30mins -1hr	(%)	Greater than 1hr - 2hrs	(%)	Greater than 2hrs - 3hrs	(%)	>3hrs	(%)	Total	(%)
Kaduna North	Soba	10	22.22	31	68.89	4	8.89	0	0.00	0	0.00	45	100
	Zaria	26	40.63	26	40.63	5	7.81	5	7.81	2	3.13	64	100
	Kudan	18	85.71	3	14.29	0	0.00	0	0.00	0	0.00	21	100
	Total	**54**	**41.54**	**60**	**46.15**	**9**	**6.92**	**5**	**3.85**	**2**	**1.54**	**130**	**100**
Kaduna Central	Igabi	24	33.33	47	65.28	1	1.39	0	0.00	0	0.00	72	100
	Kajuru	6	42.86	5	35.71	3	21.43	0	0.00	0	0.00	14	100
	Kaduna North	44	83.02	6	11.32	1	1.89	1	1.89	1	1.87	53	100
	Total	**74**	**53.24**	**58**	**41.73**	**5**	**3.60**	**1**	**0.73**	**1**	**0.72**	**139**	**100**
Kaduna South	Kagarko	15	41.67	12	33.33	9	25.00	0	0.00	0	0.00	36	100
	Sanga	16	72.73	5	22.73	0	0.00	1	4.55	0	0.00	22	100
	Zango Kataf	35	63.64	18	32.73	2	3.64	0	0.00	0	0.00	*55*	100
	Total	***66***	**58.41**	***35***	**30.97**	***11***	**9.73**	***1***	**0.88**	***0***	**0.00**	***113***	**100**

The results in Table 1 revealed that about 50% of the respondents spent less than 30 minutes at the PHC facilities. This is likely to comprise majorly of those that traveled not more than 5km or travel on foot/animal to the health facilities. In addition, other results in the table show that 40% spent 30 minutes per hour, 7% between 1-2 hours, 2% between 2-3 hours, and 1% fall in the category of 3 hours and above on a trip to health facilities. These results fall short of the stipulation of WHO, that 95% of the population should be able to access healthcare facilities within 30 30-minute drive during a business day or 30 30-minute' walk within 5 km. However, only about 50% of the respondents access the PHC facilities within 30 minutes. Most of the residents in the categories of 1 hour to 3 hours traveled more than 5km to utilize the health facilities; the long travel time may be because to patronize their choice of health center. The remaining 1% that spent three or more hours is possibly those that traveled out of the study area to utilize health facilities. In a study of locational and population factors in healthcare-seeking behavior in Savannah, Georgia, Gesler and Meade (1988), observed that people who had lived in an area for a short time might have preferred to visit a doctor or clinic closer to their previous residence.

Travel Distance: Findings of investigation of travel distance to PPHCs in Kaduna State are shown in Table 2. The table 2 shows that 161 (42%) of the respondents, live close (< 2 km) to a PPHC facility. The proximity of respondents from Igabi (52%), Zaria (49%), and Zangon-Kataf (51%) live closer than the other LGAs as tabulated. While 39% of the respondents traveled within the range of 2-5 km. This result indicates that the remaining 19% of the respondents are

living within a radius of five to above ten kilometers. This shows that about 19% of respondents are living far away from their PPHCs if compared with the World Health Organization (WHO) which recommended that a health care facility shall be within 0-5 kilometers. The results however, appreciate that the majority (81%) live within the recommended 0-5Km by WHO. This by extension implies that the respondents in the study area traveled a relatively short distance from their homes to a PPHC facility, and this may reduce their cost of transportation and rigors of accessibility to distant modern healthcare services. The accessibility to the public PHC will improve because of the relatively short distance. A study of the effect of distance from home on attendance at a small rural health center in Papua New Guinea revealed that attendance decreased markedly with distance. Most people will not travel further than 5 kilometers for basic preventive and curative care (Muller *et al*., 1998). The report reveals that one of the barriers to quality health care services is the distance traveled to reach the health care.

Table 2: Approximate Distance to PPHC

Senatorial Zones	*LGA*	*< 2km*	*(%)*	*2km - 5km*	*(%)*	*5km-8km*	*(%)*	*8km-10km*	*(%)*	*>10km*	*(%)*	Total	(%)
Kaduna North	Soba	28	62.22	17	37.78	0	0.00	0	0.00	0	0.00	45	100
	Zaria	16	25.00	24	37.50	15	23.44	8	12.50	1	1.56	64	100
	Kudan	18	87.71	2	9.52	1	4.76	0	0.00	0	0.00	21	100
	Total	***62***	**47.69**	***43***	**33.08**	***16***	**1.23**	***8***	**6.15**	***1***	**0.77**	**130**	**100**
Kaduna Central	Igabi	26	36.11	40	55.56	3	4.17	1	1.39	2	2.78	72	100
	Kajuru	6	40.00	7	46.67	2	13.33	0	0.00	0	0.00	15	100
	Kaduna North	8	15.38	39	75.00	2	3.85	2	3.85	1	1.92	52	100
	Total	***40***	**28.78**	***86***	**61.87**	***7***	**5.04**	***3***	**2.16**	***3***	**2.16**	**139**	**100**
Kaduna South	Kagarko	17	50.00	3	8.82	7	20.59	4	11.47	3	8.82	34	100
	Sanga	12	57.14	6	28.57	2	9.52	0	0.00	1	4.76	21	100
	Zango-Kataf	30	51.72	10	17.24	13	22.41	5	8.62	0	0.00	*58*	100
	Total	***59***	**52.21**	***19***	**16.81**	***22***	**19.47**	***9***	**7.96**	***4***	**3.54**	***113***	**100**

Nature of Route to PPHC: The nature of the route has both time and monetary cost implications and hence a vital metric for measuring spatial or physical accessibility to PPHCs. Results from this study are presented in Table 3. The respondents in Zaria (92%), Kaduna North (50%), and Zangon-Kataf (61%) LGAs in each of the senatorial zones enjoy Tarred and good routes, while, the respondents in Kudan (46%), Igabi (79%), and Kagarko (71%) said that their routes are not tarred and are bad. The table further shows that the majority of the respondents 138 people representing 34% claimed that the nature of their routes is Tarred and good, tarred but bad (30%), not tarred but good (20%), or tarred and bad (14%), and 2% bush track. The 2% are likely those who trek or use animals to commute to the health facilities. The poor route conditions can make it extremely difficult for patients to reach even relatively nearby health facilities on time. Further analysis shows that the fairness of the route condition justifies why the majority of the respondents to health facilities spend less time on the road and pay less, no more than N400 as an average cost of transportation in a trip to the health facilities.

Table 3: Physical accessibility based on the nature of the route to PPHC

Senatorial Zones	*LGA*	Tarred but Bad	(%)	Tarred and Good	(%)	Not Tarred and Bad	(%)	Not Tarred but Good	(%)	Bush Track	(%)	Total	(%)
Kaduna North	Soba	10	22.22	0	0.00	4	8.89	31	68.89	0	0.00	45	100
	Zaria	17	26.56	24	37.50	10	15.63	9	14.04	4	6.25	64	100
	Kudan	0	0.00	2	9.52	12	57.14	7	33.33	0	0.00	21	100
	Total	***27***	**20.77**	***26***	**20.00**	***26***	**20.00**	***47***	**36.15**	***4***	**3.08**	**130**	**100**
Kaduna Central	Igabi	37	51.39	19	26.39	11	15.28	4	5.56	1	1.39	72	100
	Kajuru	6	42.86	5	35.71	3	21.43	0	0.00	0	0.00	14	100
	Kaduna North	25	47.17	24	45.28	0	0.00	2	3.77	2	3.77	53	100
	Total	**68**	**48.92**	**48**	**34.53**	**14**	**10.07**	**6**	**4.32**	**3**	**2.16**	**139**	**100**
Kaduna South	Kagarko	0	0.00	9	25.71	10	28.57	16	45.71	0	0.00	35	100
	Sanga	1	4.76	12	57.14	3	14.29	3	14.29	2	9.52	21	100
	Zango Kataf	20	35.09	33	57.89	1	1.75	3	5.26	0	0.00	57	100
	Total	***21***	**18.58**	***54***	**47.79**	***14***	***12.39***	***22***	**19.47**	***2***	**1.77**	***113***	**100**

Areal Coverage of a PPHC: this study adopted an approach that measured both areal coverage and topographic constraints to determine the catchment area of a PPHC using the Thiessen Polygon. Findings are presented in the Fig 2 below. Map of Thiessen polygons with 5km buffer and public PHC facilities distribution at two levels, state and the three Senatorial zones (Kaduna North, Kaduna Central, and Kaduna South). At the state level, the map of the Thiessen catchment area shows PPHCs with very large areas (426 -615 km^2) found in the central senatorial zone, especially in Birnin Gwari and Chikun LGAs. The most widespread are PPHCs with relatively moderate catchment size of (187–339 km^2) found across parts of northern, central, and southern senatorial and LGAs. The last 2 categories of (01–81 km^2) and (82–186 km^2) are mostly found in the Northern and Southern Senatorial zones/LGAs except for Kaduna South and Kaduna North LGAs and parts of Chikun and Igabi LGAs that make up the Kaduna metropolis. This analysis was observed at a larger scale of senatorial zones. This allowed a larger scale classification and view of PPHC area catchment sizes. Analysis of PPHC catchment areas at the senatorial zone level shows the central zone has the largest total catchment area for all PPHCs 19, 227 $km^{2,}$ and the largest average catchment area per PPHC at 203 km^2.

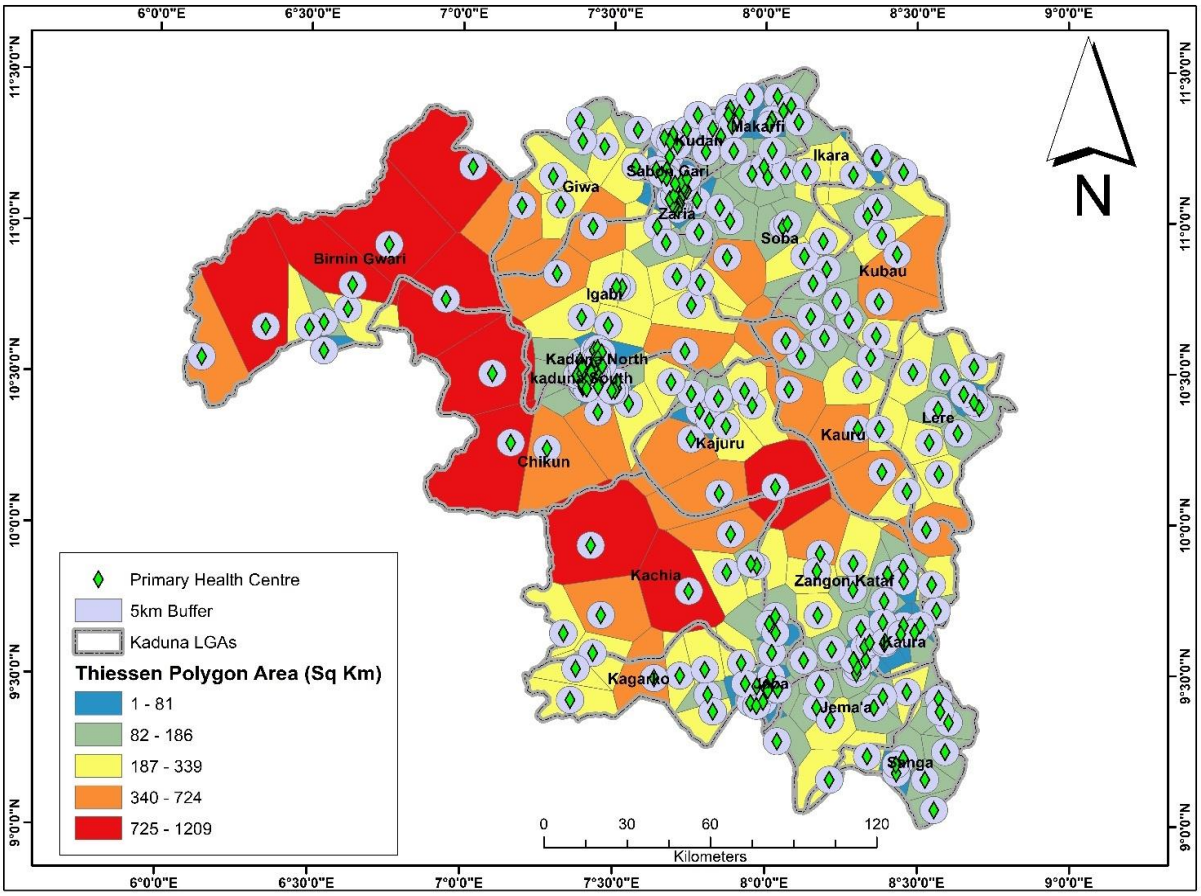

Figure 2: Map of Kaduna State showing Thiessen polygon and Buffer of 5Km

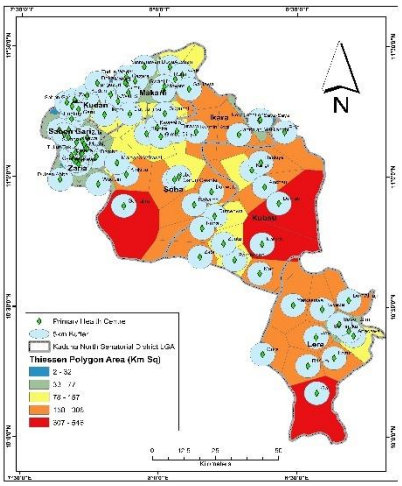

Figure 3

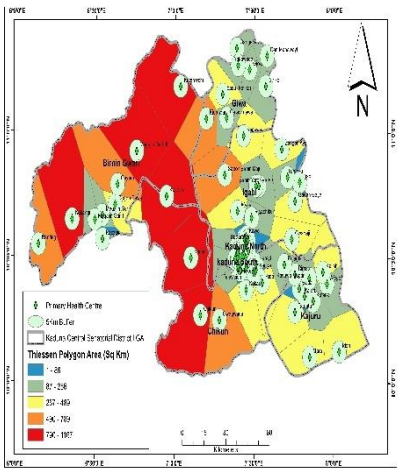

Figure 4

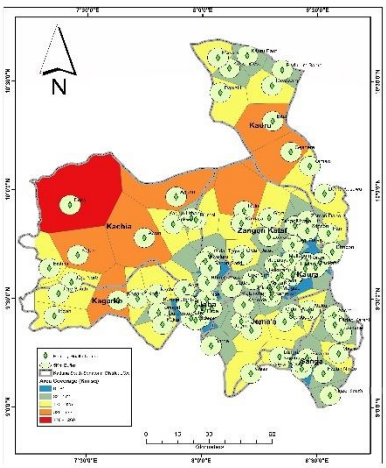

Figure 5

Figure 3: Map of Kaduna North Senatorial Zone showing Thiessen polygon and Buffer of 5Km
Figure 4: Map of Kaduna Central Senatorial Zone showing Thiessen polygon and Buffer of 5Km
Figure 5: Map of Kaduna South Senatorial Zone showing Thiessen polygon and Buffer of 5Km

Respondents' Perception of Physical/Spatial Accessibility to PPHCs Facility

Presentation from questionnaire analysis of respondents' perception of the nature of routes, the most applied means of transportation, average distance, transport cost, and time taken to reach PPHCs. The majority of the respondents, 138 people representing 34% claimed that the nature of their routes is tarred and good, tarred but bad (30%), not tarred but good (20%), not tarred and bad (14%), and 2% bush track. The 2% are likely those who trek or use animals to commute to the health facilities. The most applied means of transportation is Motorcycle/Tricycle (52%) and a few of them (11%) use private cars. The average cost of transportation to the PPHCs paid by the majority (92%) is not more than ₦400 per trip to a PPHC center. The majority (81%) of the respondents in the study area traveled a relatively short distance (0-5km) from their homes to a PPHC facility, while 19% of the respondents were living within a radius of five to above ten kilometers. The average time taken to reach PPHC based on means of transportation reveals that about 50% of the respondents spent less than 30 minutes at the PHC facilities. Most of the residents in the categories of 1 hour to 3 hours traveled more than 5km to utilize the health facilities; the long travel time may be because to patronize their choice of health center. The remaining 1% that spent three or more hours is possibly those that traveled out of the study area to utilize health facilities.

It can be concluded that most of the residents in the categories of 1 hour to 3 hours traveled more than 5km to utilize the health facilities; the long travel time may be because to patronize their choice of health center. The visit to the PPHC is not frequent for the majority of the study location. It is therefore recommended that more healthcare facilities are expected to be established at shorter distances to the residents of the study area.

Table 4: Summary of Spatial Pattern of Observed Mean Distances between PPHCs derived from Near Neighbor Analysis of LGAs in Kaduna North Senatorial Zone

S/No	LGA	NNA	EMD (Meters)	OMD (Meters)	WHO's 5Km Recommendation
1	Ikara	1.320652	4867.6339	6428.4511	Exceeded
2	Kubau	1.120258	7545.1688	8452.5382	Exceeded
3	Kudan	1.387313	3161.6655	4386.2211	Not Exceeded
4	Lere	1.365194	7002.0219	9559.1201	Exceeded
5	Makarfi	1.119391	3676.2367	4115.1445	Not Exceeded
6	Sabon Gari	0.741291	2566.5768	1902.5807	Not Exceeded
7	Soba	0.856683	7124.8858	6103.7710	Exceeded
8	Zaria	1.200324	2353.3936	2824.8352	Not Exceeded

Source: **Authors' Fieldwork, 2022.**

Table 5: Summary of Spatial Pattern of Observed Mean Distances between PPHCs derived from Near Neighbor Analysis of LGAs in Kaduna Central Senatorial Zone

S/No	LGA	NNA	EMD (Meters)	OMD (Meters)	WHO's 5Km Recommendation
1	Birnin Gwari	1.372924	12437.7346	17076.0585	Exceeded
2	Chikun	0.79956	9838.7326	7866.7163	Exceeded
3	Giwa	1.332850	8035.6011	10710.2549	Exceeded
4	Igabi	1.290995	8812.2582	11376.5794	Exceeded
5	Kaduna North	0.323911	3884.2823	1258.1608	Not Exceeded
6	Kaduna South	0.115970	9824.2735	1139.3253	Not Exceeded
7	Kajuru	1.195593	7849.1951	9384.4458	Exceeded

Source: **Author's Fieldwork, 2022.**

Table 6: Summary of Spatial Pattern of Observed Mean Distances between PPHCs derived from Near Neighbor Analysis of LGAs in Kaduna South Senatorial Zone

S/No	LGA	NNA	EMD (Meters)	OMD (Meters)	WHO's 5Km Recommendation
1	Jaba	1.131 885	3034.4804	3434.6837	Not Exceeded
2	Jema'a	0.989941	5882.7484	5823.5756	Exceeded
3	Kachia	0.991762	9824.2735	9743.3373	Exceeded
4	Kagarko	1.240297	6862.1498	8466.4540	Exceeded
5	Kaura	0.993020	3481.8370	3457.5351	Not Exceeded
6	Kauru	0.1534758	7991.7337	12265.3784	Exceeded
7	Sanga	1.436827	5341.7440	7675.1618	Exceeded
8	Zangon Kataf	1.148779	7785.9726	8944.3651	Exceeded

Source: **Author's Fieldwork, 2022.**

CONCLUSION AND RECOMMENDATIONS

The use of political wards as a basis for the allocation and location of PPHCs has been observed in this study to fall short of the need to meet physical accessibility to PPHCs. For instance, observed mean distances between PPHCs in most of the LGAs far exceeded the 5km specification by WHO. Although this finding is variant with results obtained from the questionnaire were 80.77%, 90.65% and 69.02% of respondents from Kaduna north, central, and south senatorial districts respectively claim to live in the vicinity of <2km – 5km. This may

be due to the coincidence of PPHCs located in heavy-density areas or poor perception of distances when placed on actual distance. This also points to the fact that most rural communities away from the centers of these PPHCs are at the receiving end. The challenge of these long distances between PPHCs is further confirmed by the results of travel time and cost to PPHCs. Other parameters of physical accessibility such as the nature and condition of transport used by respondents also add their influences on longer travel time. The findings based on linear parameters were further corroborated with results of effective catchment areas of PPHCs where most of the extensive rural community LGAs recorded very large area extents. This is projected to imply longer distances away from PPHC centers and hence probably longer travel time.

Recommendations from these findings suggest that these geographic parameters should also form part of the decision to allocate and locate PPHCs. There is also the need to improve rural transport systems to facilitate easy and fast access to PPHCs. Also, PPHCs should not be sited in observed high-density population areas only, with some consideration for low-population and poor topographic areas which may be far away from the PPHCs especially as obtained from Thiessen polygon-derived catchment areas. For such additional PPHCs are recommended especially LGAs with extensive land masses.

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