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Research Article

Mapping Health Disparities: Spatial Accessibility to Healthcare Facilities in a Rural District of Ghana Using Geographic Information Systems Techniques

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Abstract

Background: Access to healthcare is crucial for health equity and outcomes, especially in resource-limited rural areas. Despite expansion efforts, access disparities persist, impacting rural well-being. Assessing spatial accessibility to primary and secondary healthcare is essential for identifying underserved areas and guiding effective resource allocation and intervention strategies. *Objective:* This study aims to evaluate the geographic access to healthcare services in a rural district of Ghana using Geographic Information Systems (GIS) and spatial analysis techniques. *Methods:* Utilizing Geographic Information Systems (GIS) 3.28.6, spatial data including health facility locations, settlements, road networks, and population data were analysed. Buffer and distance to the nearest hub analyses were conducted to assess healthcare accessibility to all ten (10) healthcare facilities in the district. Travel time analysis was performed using specified travel speeds for various modes of transportation. Chi-square tests were employed to evaluate the associations between settlement characteristics and access to primary and secondary healthcare services. *Results:* Approximately 40% of the health facilities were located in Akumadan, the district capital. Primary healthcare accessibility within a 3km radius covered 35% of settlements and 59% of the population, while secondary healthcare, within a 5km radius, was accessible to only 11.3% of settlements and 27.2% of the population. The mean distance to health centres was 4.35 ±2.72 km and to hospitals was 10.35 ±5.77 km. Mean walking times were 87 ±54.6 minutes to health centres and 209.2 ±117.0 minutes to hospitals. By motorized transport, travel times were up to 24 minutes to health centres and 55 minutes to hospitals; by

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bicycle, up to 37 minutes to health centres and 190 minutes to hospitals. Chi-Square Tests revealed significant associations between settlement type and both primary ($\chi^2(1, N=80) = 30.77$, $p < .001$) and secondary ($\chi^2(1, N=80) = 15.93$, $p < .001$) healthcare access, as well as between population level and healthcare access. Proximity to health facilities (primary $\chi^2(1, N=80) = 21.26$, $p < .001$; secondary $\chi^2(1, N=80) = 5.48$, $p = .019$) and transportation accessibility (primary $\chi^2(1, N=80) = 9.13$, $p = .003$; secondary $\chi^2(1, N=80) = 12.13$, $p < .001$) were significantly associated with healthcare access. *Conclusion:* This study unveils substantial disparities in healthcare accessibility, characterized by uneven distribution of facilities and remote distances. Challenges include limited infrastructure and geographic isolation. Addressing these requires enhanced infrastructure, transport networks, expanding outreach services, and equitable policy reforms to promote health equity.

Keywords

Healthcare Disparities, Primary Healthcare, Secondary Healthcare, Healthcare Access, Spatial Analysis, Outreach Services

1. Introduction

Access to healthcare facilities is a cornerstone of equitable healthcare delivery and improved health outcomes, particularly in rural areas [1]. This access encompasses various facets, including physical proximity to facilities, transportation availability, affordability of services, and cultural acceptability of care. In rural districts, where geographic isolation and limited infrastructure pose significant challenges, ensuring adequate healthcare access becomes even more imperative, as limited access can lead to delayed diagnosis and treatment, resulting in poorer health outcomes and increased morbidity and mortality rates [2]. Healthcare accessibility, defined as the population's ability to obtain a specified set of healthcare services, involves the intricate interplay between population distribution and the availability of healthcare facilities [3].

Globally, the well-being of populations and spatial accessibility to healthcare facilities are crucial drivers of economic growth and prosperity, prompting governments to ensure equitable and easily accessible healthcare services for all citizens [4]. However, access to reliable healthcare facilities remains a challenge for approximately 1.3 billion people worldwide, particularly in developing countries [5].

In Ghana, Healthcare expenditure represented 3.54% of the Gross Domestic Product (GDP) in 2018, with fluctuations observed over the years but generally declining since 2004, reaching only 3.5% in 2018. In rural Ghana, the condition of roads significantly affects healthcare access, highlighting challenges in reaching medical facilities [6]. To address these challenges, Ghana has implemented a five-tier health delivery system, including Community-based Health Planning and Services (CHPS), health centres, district hospitals, regional hospitals and teaching hospitals aimed at ensuring decentralized, responsive, and accessible medical care nationwide [7].

The Offinso North district in Ghana epitomizes the difficulties faced in healthcare access, with numerous settlements located far from the district capital. Despite recent additions to healthcare infrastructure, such as the introduction of a new health facility, accessibility to healthcare services has not significantly improved, primarily due to its proximity to another town already equipped with healthcare facilities. The district grapples with pressing healthcare challenges, evident from an outpatient department (OPD) per capita of 0.83, a skilled delivery rate of 61%, and notable instances of under-five deaths and maternal mortality. Urgent measures are warranted to enhance healthcare access, foster proactive health-seeking behaviour, and address public health issues through comprehensive assessments of accessibility [8].

Spatial analysis techniques, particularly Geographic Information Systems (GIS), play a pivotal role in identifying and understanding healthcare accessibility disparities by analyzing spatial access and utilization patterns. These techniques enable policymakers to assess the distribution of healthcare facilities relative to population needs and geographical barriers, crucial for effective resource allocation and intervention planning [9].

While previous studies have utilized GIS to explore healthcare facility access in Ghana [10, 7, 2], data on geographical accessibility to primary and secondary healthcare considering common transport modes such as walking, cycling, motorcycling, and driving remain limited. Therefore, this study aims to assess spatial accessibility to primary and secondary healthcare facilities in Offinso North, a rural district of Ghana, using prevalent means of transport for travel time estimation from settlements to the nearest health facility. The objectives of this study is to evaluate the geographic access to healthcare services in a rural district of Ghana using Geographic Information Systems (GIS) and spatial analysis techniques.

2. Materials and Methods

2.1. Study Area

The study was carried out in the Offinso North District of Ghana. Established in the latter part of 2007, is among the 43 Administrative Districts within the Ashanti Region, situated

in its extreme North-Western part. Spanning a longitude range of 1˚45w to 1˚65w, it shares borders with Techiman, Sunyani Tano, and Nkroanza Districts in the Brong Ahafo Region to the North and West, while being adjacent to Sekyedumase District in the East and Offinso South Municipality in the South. Encompassing approximately 6300 square kilometres, which accounts for about 2.6% of the Ashanti Region's total surface area, the district is intersected by the Accra-Kumasi trunk road, serving as a crucial gateway from the Northern and Brong Ahafo Regions into the Ashanti Region. Akumadan serves as the district capital, with other significant settlements including Nkwakwaa, Asempanaye, Asuosuo, Nkenkaasu, and Afrancho, located along the Kumasi-Techiman Road. The district is divided into five sub-districts: Akomadan, Amponsakrom, Nkenkaasu, Kobreso, and Mankramso. Presently, the estimated population stands at approximately 86,981, exhibiting a growth rate of 2.7%, with an average household size of 6. Predominantly rural, about 78% of the population resides in rural areas. The healthcare infrastructure includes two hospitals, five health centres, and three Community-based Health Planning and Services (CHPS) Compounds.

2.2. Data Collection

Spatial data were obtained from the District Health Directorate and OpenStreetMap, encompassing geospatial coordinates for 10 health facilities, road networks, and 80 settlements as of 2023. It also covers administrative boundaries (sub-district boundaries of the study area) and population data for all 80 settlements and sub-districts. Field visits were conducted to validate the accuracy of health facility spatial data and gather additional information on health facility attributes.

2.3. Data Analysis

The coordinates (latitude and longitude) of health facilities, including hospitals, health centres, Community-Based Health Planning and Services (CHPS) compounds, and settlements, underwent conversion to compatible formats (e.g., CSV, Shapefile) and were projected into a unified coordinate system. The spatial integrity of these datasets was meticulously verified to ensure accurate georeferencing (Geometry CRS at EPSG:4326-WGS84). The visualization of the datasets was conducted using Google Earth Pro version 7.3.2.5776 to confirm both accuracy and spatial distribution. Validation and quality checks were executed for the results obtained from distance analysis, involving comparisons with ground truth data or field observations. Any anomalies or errors identified during the analysis process were thoroughly scrutinized to ensure that the analysis represents the real-world scenario and yields valuable insights.

2.3.1. Buffer Model

To establish service coverage areas, buffer zones were established surrounding each healthcare facility, utilizing the geometry Coordinate Referencing System of EPSG:32630-WGS84/UTM zone 30 N, with a segment of 5 and a milter limit of 2.0 to define varying buffer distances corresponding to different levels of service provision. Following WHO guidelines [6], a 3km buffer was designated around all health centres and CHPS compounds, while a 5km buffer enveloped all hospitals within the study's catchment boundaries. In this study, settlements situated beyond the 3km buffer were identified as having limited geographic accessibility to primary healthcare, while those outside the 5km buffer were deemed to have constrained access to secondary healthcare [2].

2.3.2. Distance to Nearest Hubs Model

Central locations (hubs) within the settlement were identified based on population density or administrative significance. The distance from each populated area to the nearest hub was computed to determine access to centralized healthcare resources. Symbology and colour ramps were used to represent distance values effectively. Statistical analysis was done to quantify accessibility metrics. Summary statistics such as mean distance, median distance, and standard deviation were computed on the distance matrices. The closest facility analysis technique was employed to evaluate the closeness of health centres to local hubs. This strategy is pivotal for reducing distances, time, and expenses, particularly in situations requiring prompt medical attention. This method pinpointed the nearest health centre for every community [11].

2.3.3. Population Coverage Within Facility Buffers

Population coverage within recommended buffer zones was calculated to assess the accessibility of health facilities using the select by location tool with 3km and 5km buffers as the comparing features. Total population coverage accessing health facilities within the recommended buffer radius was calculated using this formula:

$$(n/N) \times 100$$

Where n = total population of settlements within a 3km or 5km buffer radius, N = total district population.

2.3.4. Travel Time Analysis

Travel times from settlements to health facilities were determined through the application of specified adjusted travel speeds for different transportation modes; Car: 50 km/hr; Motorbike: 30 km/hr [12, 13]; Bicycle: 20 km/hr [14]; Walking: 3 km/hr [15]. Adjustments were made to these speeds to accommodate the varied terrain and road conditions prevalent within the study area. Settlements located along the Techiman-Kumasi major road were assigned a speed of 50 km/hr, while other settlements received a speed assignment of

30 km/hr, reflecting the respective transportation infrastructures. Nonetheless, the speed values for motorbikes, bicycles, and walking remained constant across all settlements in this investigation. Distance measurements from hubs derived through Distance to Nearest Hubs analysis were exported as a CSV file. A supplementary field designated as "speed" was added to the CSV dataset using Microsoft Excel, version 2016. Subsequently, employing the predominant mode of transportation within each settlement, the corresponding speed values were applied to the respective settlements within the CSV file. The time required to travel to the nearest health facility was calculated in minutes using the formula Time = Distance / Speed [16]. In instances where the resulting travel time contained a non-zero decimal value, this value was converted into minutes by multiplying it by 60 and added to the hours obtained, thereby providing an approximation of the total travel time. Descriptive statistics, including mean and standard deviation, were computed for travel times utilizing the basic statistics for field tool available in QGIS version 3.28.6.

2.3.5. Inferential Analysis

Chi-square tests of independence were utilized to analyze the relationships between settlement characteristics and access to primary and secondary healthcare services, with a significance level set at 0.05. Settlements were classified into "large" (populations of 1,500 or more) and "small" (populations under 1,500). Population sizes were categorized as "less than 1,000" and "1,000 or above". Proximity to health facilities was categorized as close (within 3 kilometres) or far (beyond 3 kilometres). Health facility availability was noted as "Yes" (facility present) or "No" (facility absent). Transport accessibility was defined based on whether settlements had continuous access to motorbikes or vehicles, and was categorized as either "Yes" or "No." The outcome variables included "Access to Primary Healthcare Facilities" and "Access to Secondary Healthcare Facilities," with coding of "1" indicating access and "0" indicating lack of access.

2.3.6. Data Presentation

The results of the spatial analysis were presented using a combination of maps and tables. Maps depicted the distribution of health facilities, population density, buffer zones, and travel distance contours to visualize spatial patterns. Tables summarized descriptive statistics and key findings, providing a concise overview of the analysis results of the travel time and distance to the nearest health facilities.

3. Results

3.1. Health Facility and Population Distribution in Offinso North District

The highest health facility-to-population ratio (1:19224 per pop) was recorded in the Nkenkaasu sub-district whereas the lowest ratio was observed in the Kobreso sub-district at 1:6044 per pop. Nearly 40% of the health facilities within the district are situated in its capital, Akumadan. Approximately 38% of the health centres and Community-Based Health Planning and Services (CHPS) Compounds are in the Kobreso sub-district (Figure 2).

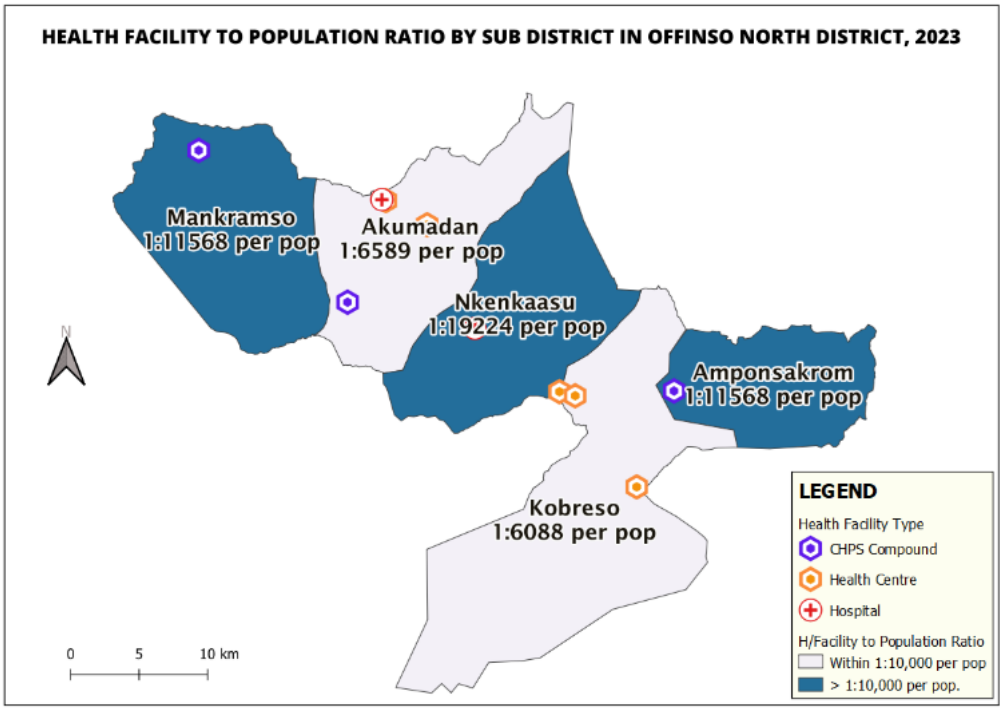

Figure 1. *Health Facility to Population Ratio analysis, Offinso North District, 2023.*

3.2. Health Facility Accessibility Analysis

A total of 28 settlements, constituting 35% of the total settlement in the district, are situated within a 3km radius of health centres and Community-Based Health Planning and Services (CHPS) compounds. Approximately 9 settlements, accounting for 11.3%, are positioned within a 5km radius of hospitals (Figure 2). Settlements within 3km and 5km in Table 1.

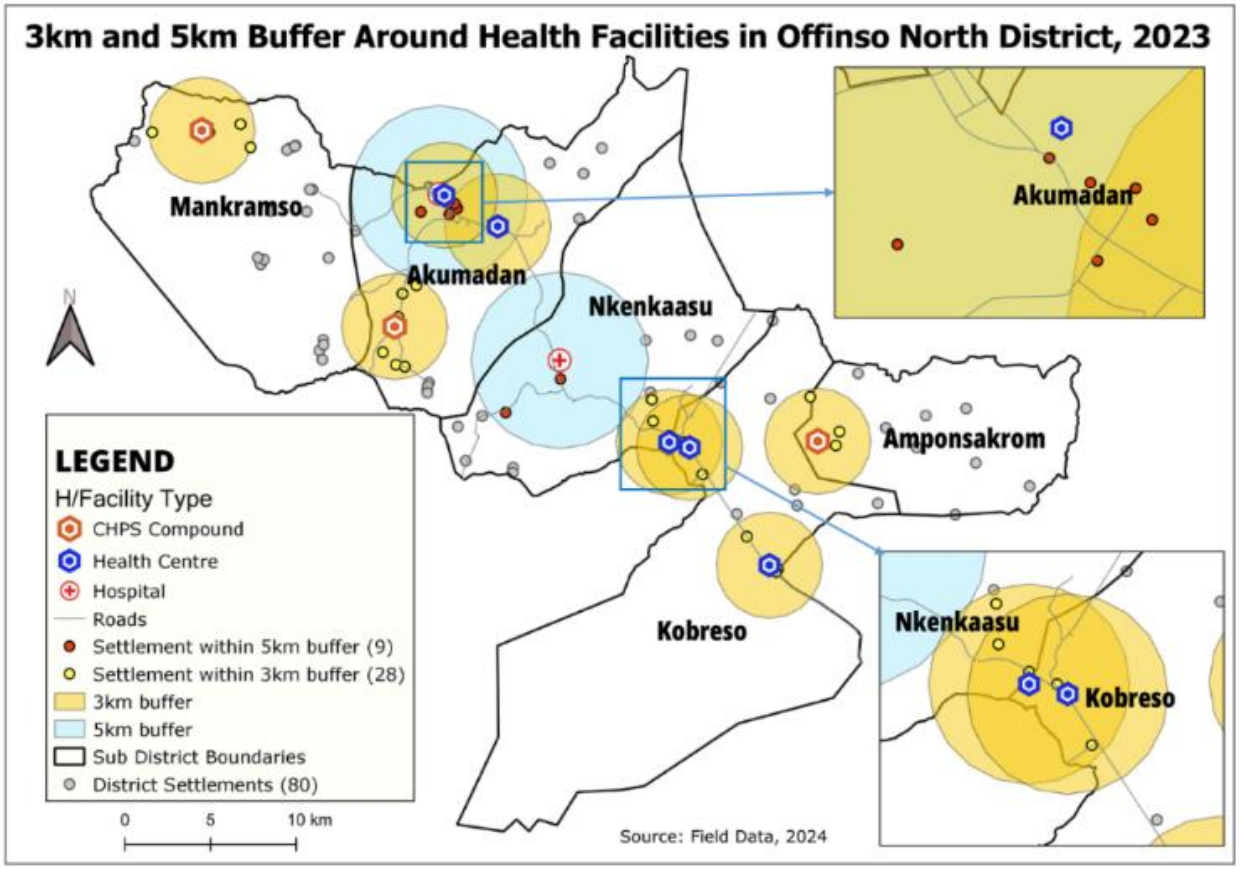

Figure 2. *Spatial analysis of health facility spatial accessibility using 3km and 5km buffer, Offinso North District, 2023.*

Table 1. *Settlements within 3km and 5km buffer in Offinso North District.*

List of settlements within 3km buffer zone	List of settlements within 5km buffer zone
Akumadan, Akumadan-Zongo, Amponsakrom, Asempanaye, Asuoso, Bredane, Caanan, Afrancho, Darso, Dwenedabi, Fante, Gyidi, Kobreso, Kobreso-Zongo, Kwaekesiem, Kwaaware, New Atwene, Bosomponso, Nkwaankwaa No. 2, Ampenkrom, Nkwankwaa No. 1, Nsenoafie, Old Atwene, Sraneso-Zongo, Sraneso No.2, Sraneso No.1, Srentiatia, Tadieso, Tanokwaem	Akumadan, Akumadan-Zongo, Bontenten, Caanan Afrancho, Gyidi, New Atwene, Nkenkaasu, Old Atwene

3.3. Health Facility Distance Analysis

Approximately 65% of settlements are located at distances exceeding 3 kilometres from the nearest health centre or Community-based Health Planning and Services (CHPS) Compound, with only 35% falling within this 3-kilometre threshold (*Figure 3*).

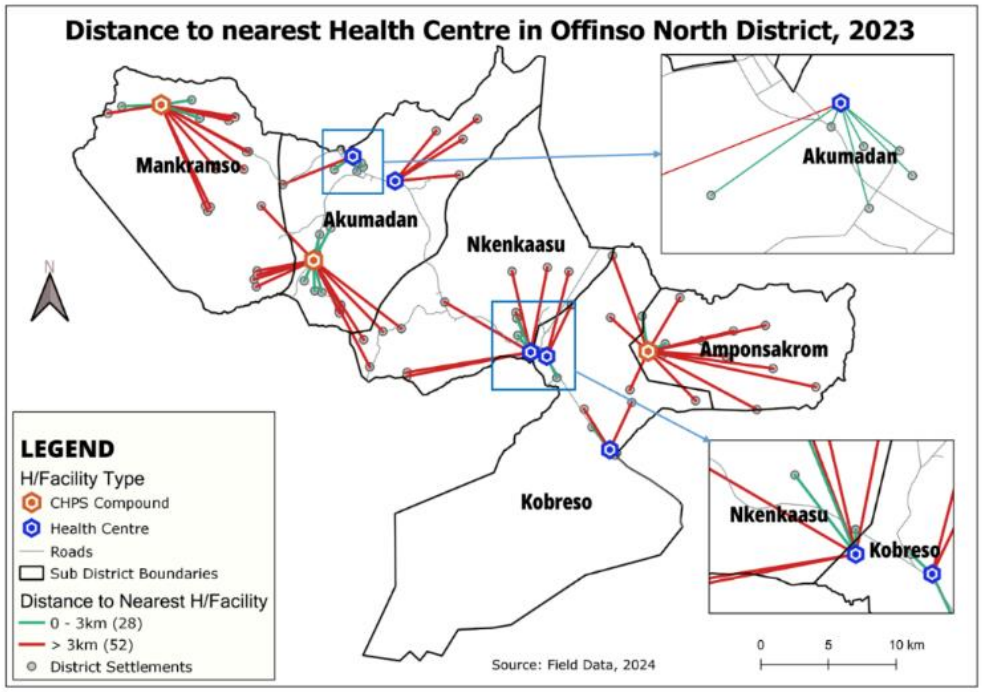

Figure 3. *Spatial Analysis of Distance to Nearest Health Centre, Offinso North District, 2023.*

Approximately 89% of settlements are situated beyond a distance of 5 kilometres from the nearest hospital, with only 11% falling within this 5-kilometre radius (Figure 4).

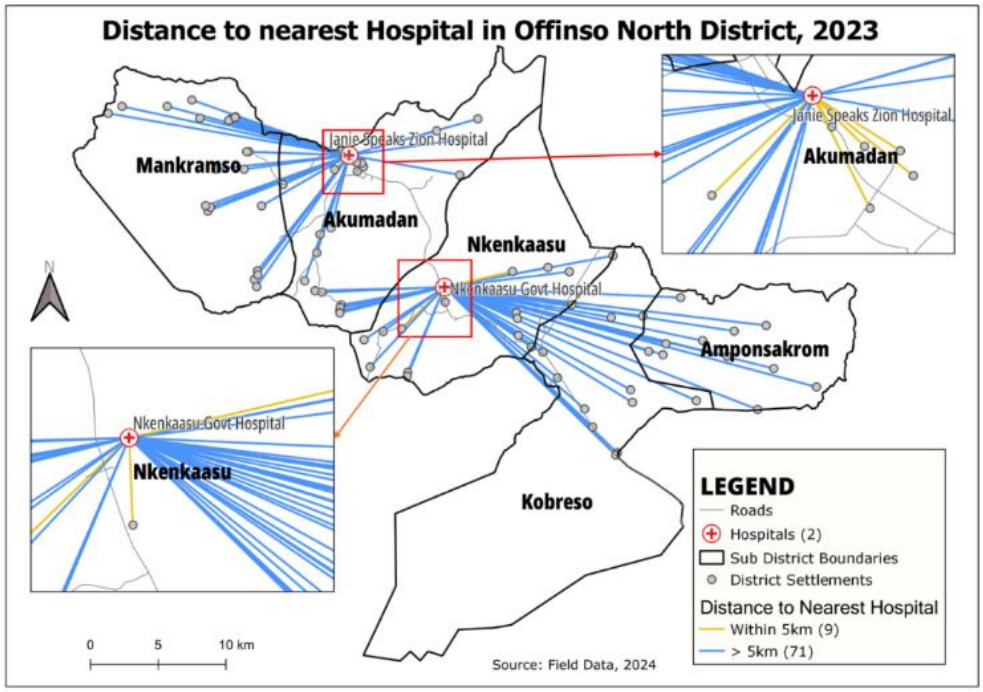

Figure 4. *Spatial Analysis of Distance to Nearest Hospital, Offinso North District, 2023.*

The furthest distance recorded from a settlement to the nearest health centre was approximately 12 kilometres, with a mean distance of 4.35 (2.72) kilometres. The shortest distance measured was 0.3 kilometres. Regarding the proximity to the nearest hospital, the maximum distance from a settlement was noted as roughly 28 kilometres, while the minimum distance

was 0.4 kilometres. the mean distance from settlements to the nearest hospital was 10.35 (5.77) kilometres (*Table 2*).

Table 2. *Descriptive Analysis of Distances to Health Facilities in Offinso North District, 2023.*

Variable	Health Centres/CHPS Compound (km)	Hospital (km)
Distance to nearest health facility		
Minimum	0.26	0.4
Maximum	12.23	27.5
M (SD)	4.35 (2.72)	10.35 (5.77)

3.4. Travel Time Estimate by Commonest Means of Transport

The maximum time required to travel to the nearest health centre and hospital by foot was recorded as 4 hours 5 minutes and 9 hours 10 minutes, respectively. The mean time for walking to the nearest health centre and hospital was 87.0 (54.6) minutes and 209.2 (117.0) minutes, respectively. When utilizing a car or motorbike, the maximum travel time to the nearest health centre or hospital was observed to be 24 minutes and 55 minutes, respectively. Reaching the nearest health center would require up to 37 minutes, while reaching the nearest hospital would take up to 90 minutes by bicycle. (*Table 3*).

Table 3. *Time travel to nearest health facility analysis, Offinso North District, 2023.*

Variable	Health Centre/CHPS Compound			Hospital		
	Travel time to nearest health facility in minutes					
Means of travel	Min	Max	Mean (SD)	Min	Max	Mean (SD)
Walking	5	245	87.0 (54.6)	8	550	209.2 (117.0)
Car	0	24	8.34 (5.46)	0	55	19.87 (11.79)
Motorbike	1	24	8.69 (5.43)	1	55	20.69 (11.52)
Bicycle	1	37	13.05 (8.15)	1	90	34.4 (17.1)

3.5. Determinants of Healthcare Access

A Chi-Square Test of Independence was conducted to evaluate the association between settlement characteristics and access to primary and secondary healthcare services. The results indicated that settlement type was significantly associated with both primary (χ^2 (1, N=80) = 30.77, p <.001) and secondary (χ^2 (1, N=80) = 15.93, p <.001) healthcare accessibility. Population-level also showed a significant association with primary (χ^2 (1, N=80) = 23.66, p <.001) and secondary (χ^2 (1, N=80) = 13.49, p <.001) healthcare accessibility. Proximity to health facilities was significantly related to primary (χ^2 (1, N=80) = 21.26, p <.001) and secondary (χ^2 (1, N=80) = 5.48, p =.019) healthcare accessibility. Furthermore, transportation accessibility was significantly associated with primary (χ^2 (1, N=80) = 9.13, p =.003) and secondary (χ^2 (1, N=80) = 12.13, p <.001) healthcare accessibility (*Table 4 and Table 5*).

Table 4. *Determinants of primary healthcare accessibility in Offinso North District, 2023.*

Variables/Categories	Access to Primary Healthcare Facilities		χ2	p-value
Settlement Type	No	Yes		
Small	4 (56.2%)	9 (11.2%)	30.77	P<.001**
Large	5 (6.2%)	21 (26.2%)		
Population Type				

Variables/Categories	Access to Primary Healthcare Facilities		χ2	p-value
Settlement Type	**No**	**Yes**		
Population ≤1,000	42 (52.5%)	9 (11.2%)	23.66	P<.001**
Population of 1,000 or more	8 (10.0%)	21 (26.2%)		
Proximity to Health Facility				
Far	50 (62.5%)	0 (0.0%)	80.00	P<.001**
Closed	0 (0.0%)	30 (37.5%)		
Availability of Health Facility				
No	50 (62.5%)	19 (23.8%)	21.26	P<.001**
Yes	0 (0.0%)	11 (13.8%)		
Transportation Accessibility				
No	37 (46.2%)	12 (15.0%)	9.13	0.003*
Yes	13 (16.2%)	18 (22.5%)		

Statistically significant at p-value <0.05*; p-value <0.001**, χ2 = Chi-square value, n=number of respondents

Table 5. *Determinants of secondary healthcare access in Offinso North District, 2023.*

Variables/Categories	Access to Secondary Healthcare Facilities		χ2	p-value
Settlement Type	**No**	**Yes**		
Small	54 (67.5%)	0 (0.0%)	15.93	P<.001**
Large	19 (23.8%)	7 (8.8%)		
Population Type				
Population ≤1,000	51 (63.7%)	0 (0.0%)	13.49	P<.001**
Population of >1,000 or more	22 (27.5%)	7 (8.8%)		
Proximity to Health Facility				
Far	50 (62.5%)	0 (0.0%)	12.79	P<.001**
Closed	23 (28.7%)	7 (8.8%)		
Availability of Health Facility				
No	65 (81.2%)	4 (5.0%)	5.48	0.019*
Yes	8 (10.0%)	3 (3.8%)		
Transportation Accessibility				
No	49 (61.3%)	0 (0.0%)	12.13	P<.001**
Yes	24 (30.0%%)	7 (8.8%)		

Statistically significant at p-value <0.05*; p-value <0.001**, χ2 = Chi-square value, n=number of respondents

4. Discussion

The spatial analysis in this study highlights major disparities in healthcare accessibility within the Offinso North district of Ghana. The Nkenkaasu sub-district exhibited a significantly higher ratio of health facilities to population compared to other sub-districts, indicating an uneven distribution of healthcare resources. The concentration of health facilities, with 40% located in the district capital of Akumadan [17, 18], highlights potential challenges for residents in remote areas who may face difficulties accessing essential healthcare services [19-21]. Moreover, the findings reveal trends concerning the proximity of settlements to healthcare facilities. A notable proportion (35%) of settlements are within the recommended distances of health centres and CHPS compounds for primary healthcare. However, a considerable majority (89%) of settlements are beyond the recommended 5-kilometre threshold, particularly for access to hospitals providing specialized care. This finding in the current study is lower compared to a study in a similar setting in Jordan [11] and Ghana [6] which documented that 69% and 50.5% of settlements lie within the recommended radius of health facilities respectively. However, the findings in the current study are higher compared to studies conducted in Saudi Arabia [22] and Bhutan [23]. In the Offinso North District, a total of 51,278 individuals (59%) out of the district's population of 86,981 have access to primary healthcare within the recommended radius of 3km. In accessing secondary health care in the district, only 23,625 (27.2%) of the district's population have access to the recommended radius to seek secondary healthcare in the three available hospitals. The current finding is lower compared with 81.4% and 61.4% reported in the Ashanti Region of Ghana for primary and secondary healthcare accessibility respectively [2]. However, in this study, the coverage for the population accessing primary health care is higher compared with 26.6% documented in Rwanda [9]. The findings in this current study highlight the prevalence of healthcare deserts within the district, where a reasonable number of residents face significant barriers to reaching both primary and secondary care services [24]. The identified disparities in healthcare accessibility within the Offinso North District of Ghana are likely influenced by several interconnected challenges. One prominent challenge is the historical and systemic underinvestment in healthcare infrastructure and services in rural areas compared to urban areas. Insufficient financial resources for rural healthcare often result in fewer facilities, thus worsening disparities in access to essential services [25]. The inequitable allocation of financial resources could stem from political factors. In Ghana, it is common for ruling governments to strategically locate healthcare facilities in areas of political support to secure votes, often at the expense of equitable distribution. This pattern is evident in the Offinso North District as well.

This study further highlighted the challenges in healthcare accessibility encountered by residents in hard-to-reach areas of the Offinso North District. Several settlements are located up to 5 kilometres from the nearest health center, with Nyamebekyere No.2 being situated at a maximum distance of 12 kilometres. The mean distances to health centres (4.35±2.72 km) and hospitals (10.35±5.77 km) and their standard deviations underscore the variability and uneven distribution of healthcare access within the district. Notably, the maximum distance for accessing primary healthcare in this study is substantially lower than the 197 kilometres reported in a similar study in Kpandi [6]. The maximum distance to access secondary healthcare in this study was 27.5 kilometres. In a rural district where most residents lack basic transportation options [26], this distance presents a significant challenge for accessing specialized services at the two available hospitals [2]. To tackle the healthcare accessibility challenges revealed by the spatial distribution analysis, several strategies should be implemented. This include fostering partnerships between local governments, non-governmental organizations, and community stakeholders can optimize resource allocation and ensure a more equitable distribution of healthcare services throughout the district. This approach may also decrease the reliance on local healers in rural areas. Local healers in remote areas frequently experience high workloads as many individuals seek their services due to limited access to modern healthcare. This substantial burden hinders their ability to pursue additional training, resulting in challenges in updating and improving the care they provide. Consequently, this can adversely affect the quality of healthcare available to rural inhabitants [27]. Additionally, increasing outreach points for mobile health services can further improve access to primary and secondary care for remote communities.

This study reveals significant disparities in healthcare access due to travel time. For many individuals, particularly those in hard-to-reach areas, bicycles and motorbikes are the most common modes of transport. Notably, the study found that walking to the nearest health facility could take up to 245 minutes. Many residents in these underserved areas lack personal bicycles or motorbikes due to poverty. Consequently, high costs charged by commercial motorbike riders force many to walk. This situation delays access to essential primary and secondary healthcare and increases health risks. Although this travel time is shorter compared to findings from a similar study in Côte d'Ivoire [28] and Kenya [29], it still underscores the considerable burden placed on residents seeking essential medical services. However, this travel time is longer compared to findings from a study conducted in India [18]. The disparities in travel times highlight the necessity for specific measures to improve transportation infrastructure and facilitate access to healthcare for marginalized communities. The geographical locations of most settlements play a significant role in shaping healthcare accessibility challenges. The rural vast and diverse terrain, characterized by rugged landscapes, poor road networks, and geographic isolation of some settlements, presents formidable challenges in establishing and maintaining healthcare facilities [24].

Difficult terrain and lack of reliable transportation infrastructure contribute to increased travel times and reduced accessibility, particularly for residents in these remote areas. Moreover, socio-economic factors, including poverty, limited education, and inadequate health literacy, are likely to exacerbate challenges in accessing healthcare services. The rural district under study is primarily an agricultural area, where residents often encounter irregular and limited success in selling farm produce due to the prevailing economic crisis in Ghana [10]. Consequently, many of these inhabitants face financial constraints and find it challenging to prioritize healthcare-seeking behaviour amidst competing needs. To address travel time disparities and enhance healthcare access in underserved areas, local authorities should focus on improving transportation infrastructure. This includes upgrading road networks and introducing reliable transportation options, such as community shuttles or subsidized transport services. Additionally, establishing more local healthcare facilities within reachable distances can reduce travel burdens. Addressing socio-economic factors by improving economic opportunities and education can help mitigate financial barriers to healthcare. Finally, targeted community outreach and health literacy programs can empower residents to prioritize and navigate their healthcare needs more effectively.

This study shows the associations between settlement characteristics and healthcare access. Urban areas typically offer better access because they have more healthcare facilities and specialized services. This might be due to the economies of scale in cities, which support more comprehensive healthcare infrastructure. In contrast, rural areas face challenges such as fewer facilities and greater distances to services, worsening accessibility issues. This limited access in rural regions often results from historical underinvestment and systemic neglect. A similar finding was documented in a systematic review study conducted in high-income countries (United States of America, Canada) and lower-income countries (Ethiopia, South Africa) [30] and in China [31]. To address these gaps, it is crucial to implement special public health efforts, like providing community-based healthcare services, to improve access in underserved areas. [32, 33].

This study found that population size significantly affects healthcare accessibility. Larger populations, typically associated with commercially developed areas, benefit from improved infrastructure and services due to economies of scale. This is evident in Akumadan, the district capital, and Nkenkaasu, the second-largest settlement in the Offinso North District. However, rapid population growth can strain existing healthcare facilities, leading to overcrowding and reduced service quality, as seen with the two hospitals in the district. This problem often stems from inadequate planning and underinvestment in healthcare infrastructure. To address these issues, governing authorities need to invest in scalable infrastructure that can expand with population growth. Strategic planning is also crucial to ensure equitable distribution of resources. Proactive measures, such as designing adaptable healthcare facilities and expanding capacity in anticipation of growth, are essential for maintaining service quality and accessibility. These steps are vital for preventing future declines in service quality in areas like Nkenkaasu and Akumadan.

This current study further elucidates the significant impact of proximity to healthcare facilities on accessibility. The current study found that shorter distances to these facilities are generally associated with higher utilization rates. In contrast, in rural areas, long travel distances to healthcare facilities create barriers that exacerbate accessibility issues. This finding aligns with a study conducted in low- and middle-income countries [30]. These challenges may stem from the uneven distribution of healthcare facilities and inadequate infrastructure. Additional contributing factors could include historical neglect of rural healthcare needs and insufficient investment in local healthcare infrastructure. To address these issues, health authorities must collaborate with the district assembly to increase the number of local healthcare facilities in underserved areas and enhance existing infrastructure. Furthermore, policy measures should aim to improve facility density and invest in transportation options. This will help reduce travel distances and better serve rural populations, such as Nyamebekyere, Konkon, and other settlements far from healthcare facilities in the Offinso North District.

This study highlights the critical role of transportation accessibility in healthcare access. Limited transportation options can significantly restrict residents' ability to reach healthcare services, particularly in areas with inadequate public transport [34]. This gap is particularly severe in rural settlements such as Nyamebekyere and Konkon, where poorly developed road networks and limited transportation resources are common. In the Offinso North District, Akumadan serves as the primary commercial hub. The district capital hosts a major weekly market every Tuesday, attracting significant patronage from surrounding settlements, particularly those in remote areas. On market days, residents from these hard-to-reach communities rely on the sole vehicle service available on Tuesdays to travel to Akumadan. This trip enables them to both trade and access healthcare services in the district capital. Missing this vehicle results in losing access to secondary healthcare, as the two main hospitals and the biggest health centre are located only a few kilometres apart from each other. This dependency on the vehicle poses a significant challenge for residents in remote areas, limiting their access to essential primary and secondary healthcare services. The underlying causes of this challenge may be a lack of coordinated planning to address transportation needs in hard-to-reach areas [35]. To mitigate these challenges, health authorities should adopt a multidimensional approach. This includes expanding public transport systems or offering transportation assistance programs [36]. Enhancing transportation infrastructure will help bridge the gap between urban and rural healthcare accessibility. This improvement is expected to reduce disparities in healthcare access between urban and rural areas.

A key limitation of this study was its dependence on spatial

analysis and secondary data, which did not capture all local healthcare issues. It lacked real-time updates on transportation and policy changes and may have overlooked socio-economic and cultural factors such as health literacy and financial constraints. Data accuracy and availability also limited the findings. Future research should include qualitative studies on barriers, longitudinal studies to assess intervention impacts, detailed GIS analyses, socio-economic evaluations, and reviews of mobile health units' effectiveness.

5. Conclusions

The spatial analysis of healthcare accessibility in Offinso North District revealed significant disparities stemming from the uneven distribution of healthcare facilities, which were predominantly concentrated in the district capital. To address these disparities effectively, it is crucial to implement strategies such as expanding healthcare facilities in underserved areas, enhancing mobile health services by establishing additional outreach points and improving transportation and socio-economic conditions in remote regions. These measures are essential for bridging the gaps in healthcare accessibility and ensuring more equitable access across the district.

Abbreviations

CRS	Coordinate Reference System
CSV	Comma-Separated Values
EPSG	European Petroleum Survey Group
KM	Kilometres
UTM	Universal Transverse Mercator
WGS	World Geodetic System

Supplementary Material

The supplementary material can be accessed at https://doi.org/10.11648/j.ajhr.20241205.11

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Ethics Approval

Permission was obtained from the Offinso North District Health Directorate.

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Data Availability Statement

The data is available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest.

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Biography

Richmond Bediako Nsiah is a key member of the Public Health Department at the Asokore Mampong Municipal Health Directorate. He holds a Master of Public Health (Health Information) and has accumulated valuable experience as a consultant for JSI on the USAID MRITE and Global Vax projects over the past two years. Richmond has further enhanced his expertise with professional certificates in Monitoring and Evaluation, Project Management, and Leadership and Management, all obtained through the University of Washington's distance learning program. In his current role, he mentors healthcare professionals on Geo-enabled digital micro-planning to improve healthcare delivery and oversees health information systems and data management practices. Richmond also leads a group of young health practitioners dedicated to improving health service delivery through research.

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