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Accessibility to Emergency Health Care in Cape Coast Ghana

[1]Lincoln Tei Nyade and [2]Emmanuel Abeashi Mensah

[1]*Department of Geography and Resource Development, University of Ghana, Ghana*
[2]*Department of Geography and Regional Planning, University of Cape Coast, Ghana*

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Corresponding Author:
Lincoln Tei Nyade
Department of Geography and Resource Development,
University of Ghana, Ghana
Email: kwesiktn@gmail.com

Abstract: Globally one in every 10 dies from their inability to access emergency health care. For developing countries where the number of trauma cases resulting from motor accidents, conflicts, and industrial accidents is steadily rising, access to emergency health becomes even more important. The study examined the level of access to emergency health care using the Three-delay model. Dimensions of access examined included physical accessibility, delays in health care decisions, and the quality of care. The study employed a cross-sectional descriptive survey design where self-administered questionnaires were used to collect data from 122 exit clients from the four existing emergency units in the study area. Physical accessibility of 31 suburbs in Cape Coast was also conducted using ArcGIS 10.1 Network Analyst. Service area analysis of emergency units showed most of the areas out of the 31 suburbs was within 5 and 10 min of the emergency facility but, there were delays in the decision to seek health care mostly because of poor knowledge of the risk of complications and the cost involved. Actual reported levels of physical access differed significantly with 37.7% having 10 min delays and 26.3% having 20 min delays. Health care was generally perceived as good although the most accessible of the emergency units was the least resourced.

Keywords: Accessibility, Emergency Health Care, Cape Coast, Ghana, GIS

Introduction

Emergencies can happen anywhere and at any time. Timely access to emergency healthcare can reduce mortalities. People in such conditions potentially face life-threatening symptoms and mostly access health facilities without an appointment (Ministry of Health, 2011). Situations like this present a series of choices to the patient (Morgan *et al*., 2012; Flottemesch *et al*., 2012; Uscher-Pines *et al*., 2013). Globally physical accessibility remains an important factor in obtaining quality health care. However, the absence of physical access can result in delays in treatment (Rahimi *et al*., 2017). To date, variations in geographical accessibility to health are topical in many countries (Al-Taiar *et al*., 2010; Minutha *et al*., 2014; Freyssenge *et al*., 2018; Calovi and Seghieri, 2018; Banke-Thomas *et al*., 2019; Parvin *et al*., 2021; Silalahi *et al*., 2020). While numerous factors contribute to reaching emergency health care, the interval between the time of emergency and its associated outcome is non-negligible (Kelly *et al*., 2016, Ouma *et al*., 2018). Consequently, a positive or negative outcome of emergencies may be affected by delayed treatment. Thaddeus and Maine (1994) outlined three phases of delays in accessing quality maternal care based on the decision-making, arrival time at a health facility, and the provision of adequate health care. This model guided the conceptualization of this study.

Ghana continues to reform its healthcare system with a commitment to improve accessibility and maximize spatial proximity of emergency healthcare (Norman *et al*., 2012, Azaare *et al*., 2020; Acheampong *et al*., 2021). Unfortunately, few studies regarding timely access to the health care system in developing countries have dealt with short distances to the nearest provider (Noor *et al*., 2003. Ouma *et al*., (2018) have estimated that 29% of the African population is geographically marginalized from emergency healthcare. Furthermore, this indicates that most healthcare planners seldom incorporate appropriate spatial planning policy in the distribution of healthcare resources.

Improvement in the healthcare delivery system cannot be achieved without having effective measures to judge its progress. Ghana typifies such a measure of progress in its emergency service delivery (Osei-Ampofo *et al*., 2013). This includes timely access. Hence the use of a quantitative metric to enhance existing health policies is adopted. Although measuring access to healthcare does little to improve the health system, the metric helps us understand whether health policies are effective. The measurement of physical accessibility requires a multi-dimensional approach. We focused on designing a study relating to the nature of emergency healthcare delivery in general in the Cape Coast Metropolis. These questions were asked; (1) What is the level of physical access within Cape Coast to emergency health care? (2) What factors delay the decision to seek emergency health care? (3) What is the perception of patients on emergency health care delivery in the metropolis.?

Using GIS to Measure Physical Accessibility to Healthcare

Geographical accessibility studies are diverse. This body of work specifically covers some components of emergency care like hospital location, travel time, and quality of emergency care (Abbott, 2008; Carr *et al*., 2009). Considering travel time from locations to emergency health departments, (Carr *et al*., 2009) measured accessing emergency health care by estimating the interval of ambulance response times. They found that most of the U.S. population (94%) reach emergency facilities, not beyond 45 min. Similarly, about 98% of the population reaches emergency care in 60 min. Another U.S. study found that only 69.2% of the population have access to a trauma centre within 45 min and 84.1% have access within 60 min (Branas *et al*., 2005).

Several methods such as spatial-auto correlation, Euclidian distance, travel (distance) time analysis, and raster analysis, have been used to measure geographical accessibility (Al-Taiar *et al*., 2010; Huerta Munoz and Källestål, 2012; Kuupiel *et al*., 2019). All these methods have been classified under cumulative models, gravity models, and utility-based models (LaMondia *et al*., 2010). A cumulative model which considers a specific radius of a place (location) and time (distance) fitted the study. Some studies have argued that accessibility based on the residence is a limitation without factors such as the specific location of patients' emergencies (Branas *et al*., 2005). However, other researchers have considered distance and travel time to measure accessibility effectively (Arcury *et al*., 2005; Al-Taiar *et al*., 2010; Delamater *et al*., 2012). In areas where automobiles are common, travel time is mostly employed (Hare and Barcus, 2007). For example, public transport utilization in calculating travel time is common in developing countries (Pearce *et al*., 2006; Tsoka and Le Sueur, 2004).

Service areas can be created using straight-line travel distances. For instance, Abbott (2008) suggested 4 and 8 min service areas. By this, he emphasizes strategies to improve ambulance services by analyzing the spatial extent of these service areas. An earlier study compared a network of roads measured from residences to emergency departments in determining service area accessibility (McGregor *et al*., 2005).

For several years, the continuous use of GIS techniques for spatial or physical accessibility has been profound. Areas like transport, retail site analysis, emergency services, and health planning have benefited from its application (McLafferty, 2003; Amer, 2007; Surage *et al*., 2017). Amer maintained that applying geoinformation techniques in health is appropriate. For the last two decades, geoinformation has been widely employed in developing countries (Sarani, 2011; Surage *et al*., 2017). It is challenging to contend with a universally accepted range for physical accessibility. Rooväli and Kiivet (2006) placed a distance beyond 30 min as geographically not acceptable. Additionally, Hare and Barcus (2007), put people beyond a range of 45 min as geographically marginalized to access health care in general.

Measuring physical accessibility is embedded in healthcare planning. Furthermore, healthcare planning and GIS are interlinked by spatial data with associated attributes such as the location of healthcare facilities, distribution, and characteristics of patients. These concepts are considered primary during the planning of small or large-scale healthcare services (Murad, 2004). However, effective policies and planning would lessen marginalized access to emergency healthcare.

Materials and Methods

Study Area

Cape Coast Metropolitan Area (CCMA) is located at longitude 1°17' 30" W and latitude 5°10' 0" N (Fig. 1) Relatively the coastline borders the Gulf of Guinea in the southern part. From the western side, Komenda-Edina-Eguafo/Abirem district shares a boundary with the metropolis. From the east and north, Cape Coast shares borders with the Abura-Asebu-Kwamankese district and the Twifo-Heman-Lower Denkyira district respectively. The spatial extent of the metropolis measures about 124 square kilometres with three classes of road networks. The population of the metropolis is currently 189,925 which represents 6.6% of the region's total population. Proportionally, males constitute 48.9% and females represent 51.1%. Recent data shows the Cape Coast metropolis has moved from both rural and urban settings to a completely urban area with a household size of 2.9 (PHC, 2021).

Design and Sampling

The study employed a cross-sectional descriptive survey. Self-administered questionnaires were used to assess emergency health care accessibility, the delays in the decision to seek health care, and the perception of the quality of health care provided. The Network Analysis model was used to delineate Service areas and generate the nearest facility Origin-Destination Matrix. A multiple-criteria strategy sampling method was used. In the first criterion, four (4) health facilities with designated emergency units were sampled purposively.

In the second criterion, a saturation method was used to sample 122 exit clients. In this technique, a register of emergency clients was collected and a list was created out of the register to allow for a simple random lottery method to select exit clients (between 3-5 clients daily in each of the four hospitals).

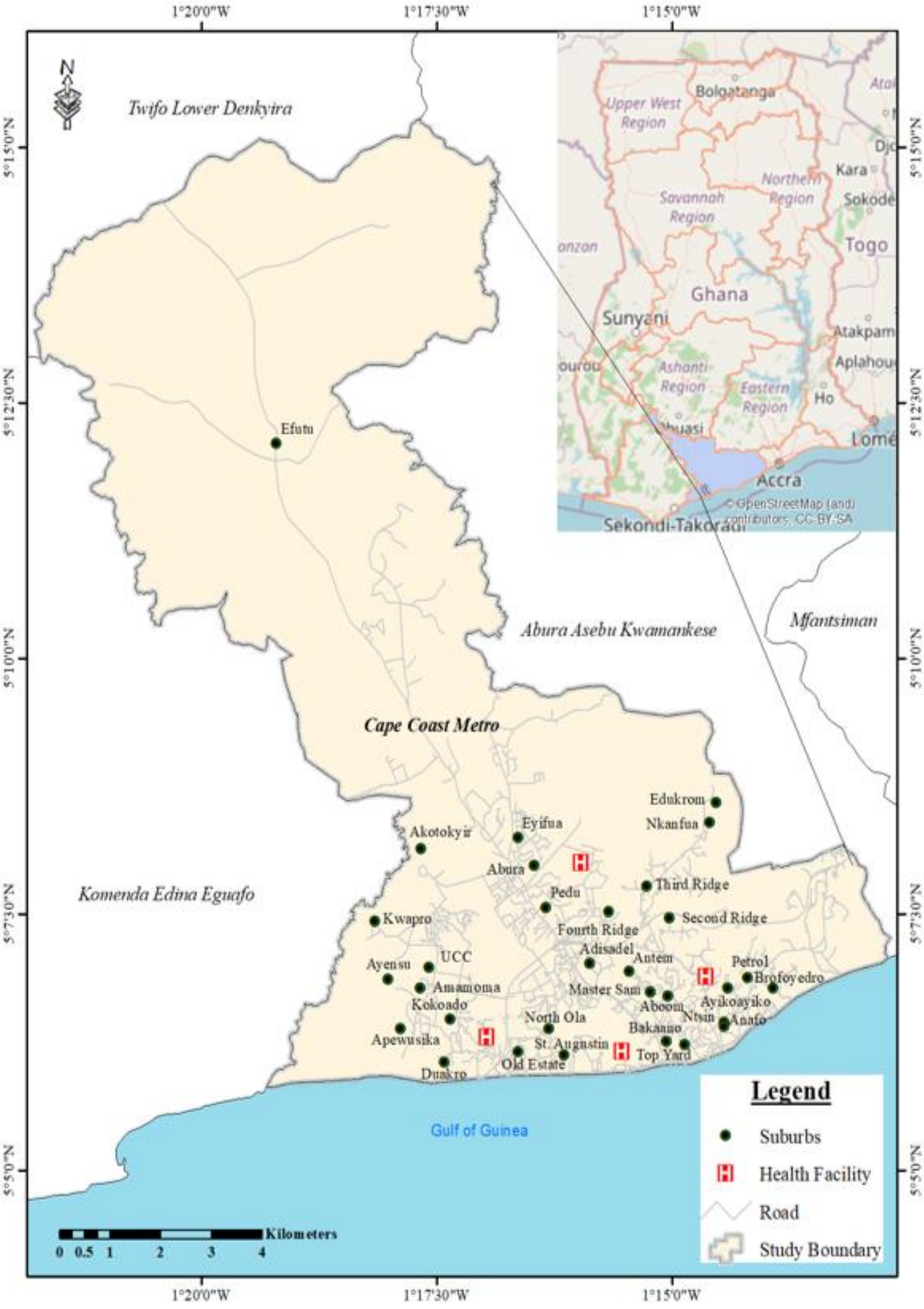

Fig. 1: Map of the study area

Data Sources

This study utilized primary and secondary data. Primary data sources were obtained from administering survey questionnaires to exit clients of hospitals' emergency departments. The structure of the questionnaire examined the quality of care provided by emergency departments, delays in decision-making, and the choice of health facility. Secondary data was gathered from hospital administrative records and the DHIMs database of the Cape Coast Metro Health Directorate. Road networks were digitized in the study area and their corresponding attributes were obtained. Other spatial data, such as the vector layer of the health facility was collected using handheld GPS (Garmin GPSmap 62) which was obtained from the geography department of the University of Cape Coast.

Data Processing and Analysis

Data analysis was based on completed questionnaires and GIS analysis. The spatial data was edited in ArcGIS 10.1. Using the Network Analysis extension, the topology of the road network was built to enforce data integrity (Laaribi and Peters, 2019). A field was created in the attribute table of the road network and named 'Drive Time' (DT). DT was computed by finding the average speed of vehicles within the urban setting which is approximately 50 Km/h (Damsere-Derry *et al*., 2019). This average *DT* was considered with the impedance (time) on each of the road segments. *DT* was then calculated by a field calculator employing the linear drive time formulae of each road segment as:

$$DT = \frac{60}{50000} * [Shape\ Length]$$

Service area polygons for four emergency facilities were ranked in the attribute table of the suburb layer to generate three levels of accessibility from the suburbs to the health facilities. Descriptive statistics consisting of tables and graphs were processed and analyzed with Statistical Package for Social Science (SPSS) version 20.

Results

Reported Emergencies

Figure 2 illustrates emergencies reported from hospital records which range from mild to severe forms. Amongst the reported emergencies stomach related emergencies were the highest followed by respiratory emergencies.

Litman (2003) revealed that accessibility depends on mobility. Here, walking, cycling, public transport, car sharing, taxis, cars, and other transport modes are considered. Empirically, half of the respondents reached emergency facilities through public transport (58.2%). In this study, public transportation includes both taxis and other forms of transportation modes which were not for personal or private use. Additionally considering timely access to emergency health facilities, transportation modes categorized under Non-Motorized Transportation (NMT) were low (walking and cycling which sums up to 7.4%).

Felder and Brinkmann (2002) have stressed that high access to emergency health care is critical for the survival of severely ill-related patients. Hence exploring the time of delay factors in the location of the patient (origin) and their destination (health facility) nexus was important. The actual time of delays to the emergency unit was recorded from the patient's point of view. Table 1 shows that delay times between 1-10 min was 37.7%. Also, 26.3% delayed time to the emergency unit within 11-20 min.

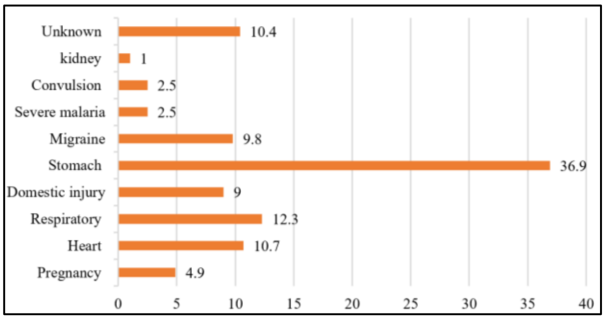

Fig. 2: Reported emergency

Table 1: Modes and travel time

Accessibility modes	Frequencies	Percentages (%)
Walk	8	6.600
Motorbike	4	3.300
Private car	35	28.700
Public transport	71	58.200
Bicycle	1	0.800
Ambulance	2	1.600
Indifferent response	1	0.800
Time of delays (minutes)		
1-10	46	37.700
11-20	32	26.300
21-30	18	14.800
31-40	6	4.900
Above 60	15	12.300
Indifferent response	5	4.100
Total	122	100.000

Service Area Analysis of Four (4) Emergency Health Facilities

For this study, measuring physical access was based on first, determining the spatial extent of the service areas of the four emergency facilities using defined impedance (travel time). Figure 3 shows a three-polygon service area of the study area. Delineation of service areas indicates that the four emergency health facilities can serve multiple areas within 5-10 min. Only, a few suburbs are within 15 min of the service area threshold.

Furthermore, the service area mapping was then used to predict the level of physical access to the four emergency health facilities. Figure 4, accessibility has been classified as low, moderate, and high. Areas with a small symbol (Kwapro, Ayensu, Efutu, Edukrom, etc.,) shows low accessibility to the emergency facilities and the larger symbols symbolize a high level of accessibility. Suburbs such as Adisadel Township, Pedu, Bakaano, and Antem were found to be the suburbs with the highest level of accessibility. These suburbs have high accessibility to emergency facilities because they are located within the 5 min service area polygon of the four emergency hospitals.

The OD-Matrix analysis in this study was based on finding one nearest emergency health facility. It includes the suburbs (location) to the facilities (Destination) but not a hospital-patient threshold analysis. Figure 5 indicated that Cape Coast Metro Hospital serves 3 suburbs and has a staff strength of 15.8% of the total number of staff designated for emergencies. Cape Coast Teaching Hospital serves 7 suburbs and has a staff strength of 53.6%. The University of Cape Coast Hospital serves 9 suburbs and has a staff strength of 22.0% and Ewim Polyclinic serves the highest number of suburbs (12) and has a staff strength of 8.6%.

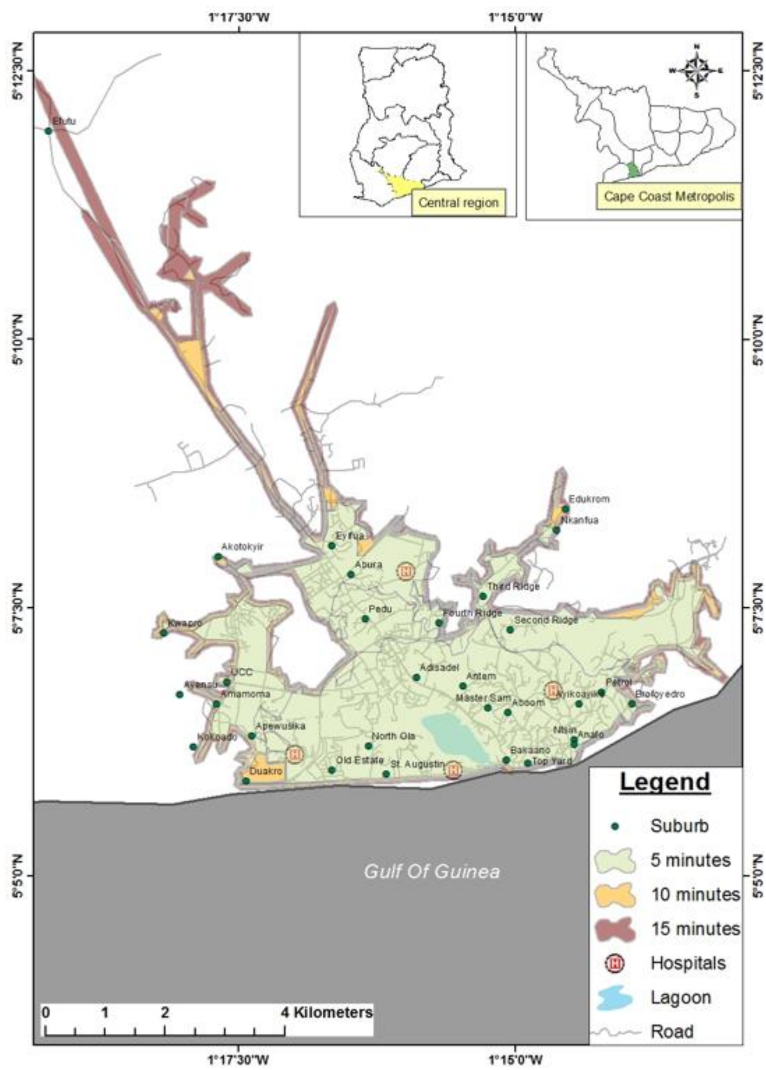

Fig. 3: Service analysis for UCCH, CCTH, CCMH, and Ewim polyclinic

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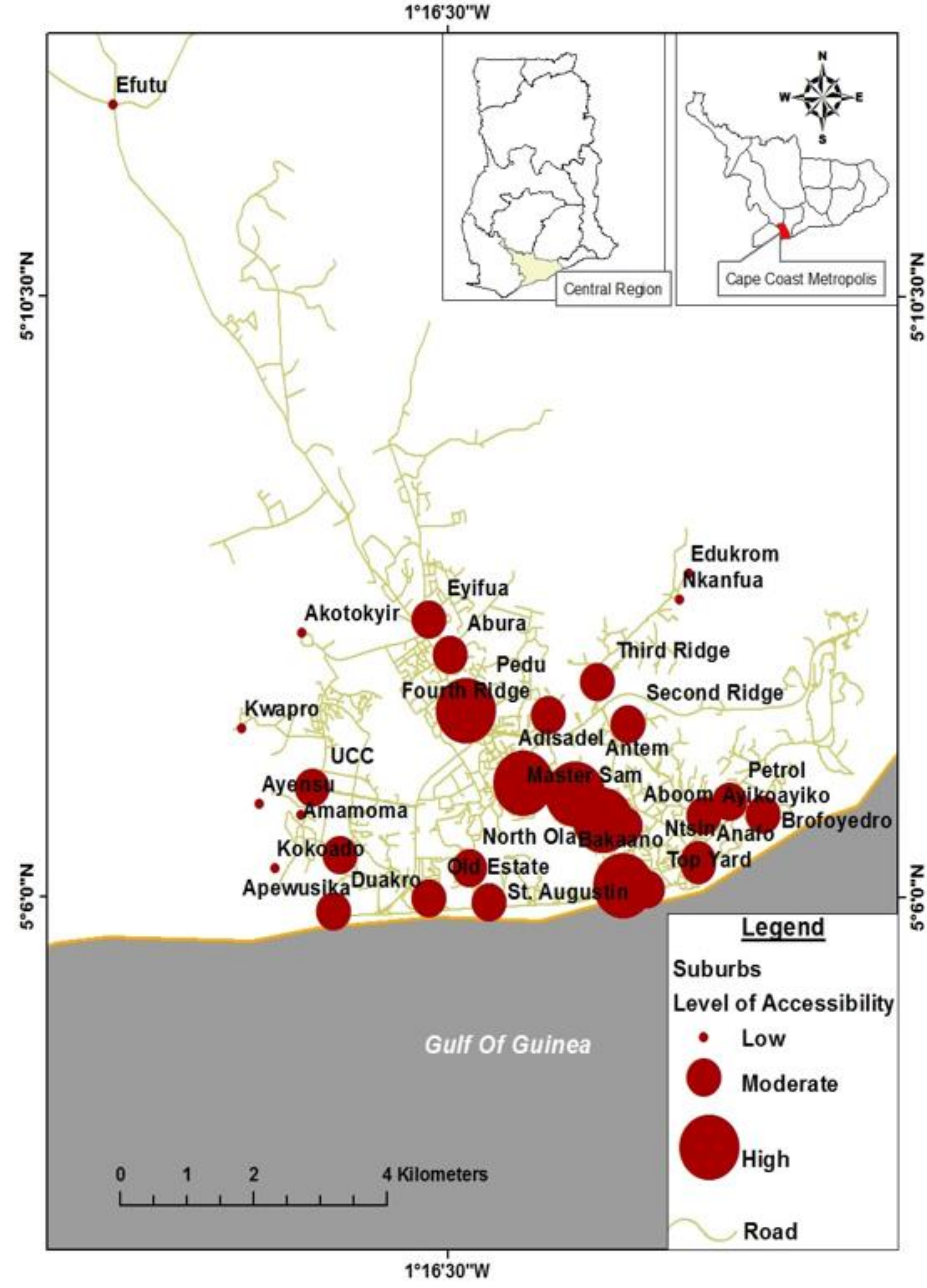

Fig. 4: Level of accessibility derived from service area analysis

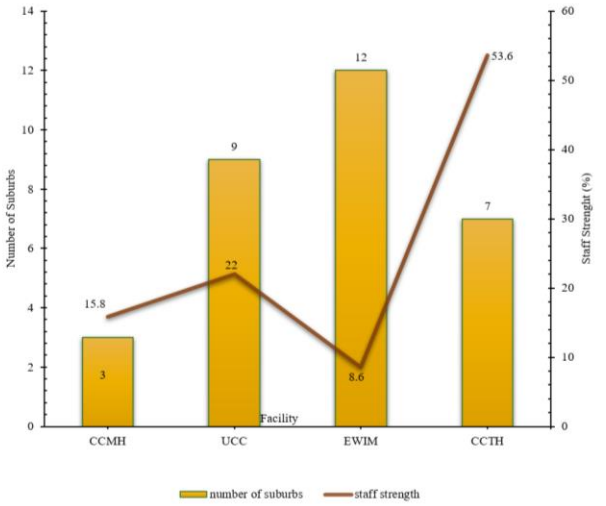

Fig. 5: Level of access to an emergency facility and its staff strength

Table 2: Quality of care

Quality of care	Frequencies	Percentages (%)
Excellent	18	14.8
Very good	47	38.5
Good	30	24.6
Average	20	16.4
Poor	6	4.9
No response	1	0.8
Total	122	100.0

Table 3: Factors influencing perception

Factors	Frequency	Percentages (%)
The facility	35	28.7
The attitude of staff	73	59.8
Less waiting time	74	60.7
Free medication	21	17.2

Phase one of the three-delay model explains that a poor understanding of the complications and risk factors in emergency health situations delays patients to seek timely emergency health care. Individuals faced with health emergencies may experience multiple decisions to access emergency health facilities. Most of the respondents could not properly understand their risk of complication (84.4%).

Poor Healthcare Experiences

Another factor that delayed the decision to seek timely emergency health care is attributed to the patient's previous poor experience with healthcare. Uscher-Pines *et al*. (2013) believed that previous health experience affects patients' health choices. More than half (52.0%) of respondents were faced with delays in the decisions to seek medical attention at hospitals based on their previous poor health experience.

Cost as a Barrier

A patient's decision to seek specific healthcare may be influenced by both causal and associated factors (Devries *et al*. 2013). Cost as an associated factor is noted as the key factor that delays decisions to seek emergency health. Our survey indicated that 62% of the total respondent attributed the cost of transportation and treatment as one of the factors that delay a decision to seek emergency health.

Perception of Quality of Emergency Healthcare

The perceived quality of emergency health care may be subjective. However, in phase three of the delay model, the quality of health influences a patient's decision. Crow *et al*. (2002) further discuss this phase on how patients perceive standards in hospital emergency departments and clarify how patients understand quality (Sofaer and Firminger, 2005; Mohamed *et al*., 2015). Table 2 indicates only 4.9% of the respondents perceived poor quality of emergency healthcare.

Factors Patients Consider Perceiving Health Care as Quality

Different factors influence people's perception of the quality of care. Schmidt (2003) framed patients' experience of actual healthcare to their preferences, rather than expectations. To determine these factors, respondents answered multiple-choice questions. Table 3 shows that less waiting times at the emergency wards was a strong factor that influenced the perception of quality (60.7%) followed by the attitude of health workers (59.8%).

Discussion

An important portion of the study discussed the service areas of four health facilities with the emergency unit and their level of physical access. Scrimgeour and Scrimgeour (2008) describe accessibility to include physical accessibility, affordability, appropriateness, and acceptability. Also, phase two of the three-delay model explained the identification and reaching of health facilities. In this study, patients reached the emergency units of hospitals in diverse ways (Table 1). The analysis drawn corroborates (Kuupiel *et al*., 2019) assertion that the geographical distribution of district health facilities is moderate in Ghana. The level of physical accessibility in the Cape Coast metropolis is very high and significant to the general well-being of the people. Whilst the facilities could serve most areas within 5-10 min, public transport modes were frequently used for accessing health facilities. Although ambulance response times may be better (Mahama *et al*., 2018), it was underutilized in emergencies in the study.

Ambulance operations were insufficient at the time and the few private ones were expensive. Fortunately, ambulance utilization has seen a phase lift since 2016 (Tansley *et al*., 2016) and has an average time of 17 min in the cities (Mahama *et al*., 2018). Aside from using GIS to determine the level of physical accessibility, the actual reported level of travel time was learned. Most of the respondents reached the emergency units within 1-20 min. In the context of the level of physical access and the actual travel time reported, the difference in measurement proves that the level of accessibility in the district is good. In a specific look at accessibility to emergency health facilities, location, and staff strength were considered. Per the sampled suburbs, Cape Coast Teaching Hospital (CCTH) has the highest staff strength but is not optimally accessible by location. However, Ewim Polyclinic can optimally serve most of the suburbs, yet it had the least staff strength and emergency healthcare resources.

Our finding shows that patients' delays to the emergency unit beyond 20 min were less than half of the respondents (Table 1). Some factors that caused the delays conformed to Thaddeus and Maine (1994) conceptual model. The first factor in the delays for patients to seek emergency health care was their poor understanding of the risk of complications of the type of emergency. Secondly, phase one of the delay model revealed that decisions based on past healthcare experience may cause delays in seeking timely healthcare. Patients' previous healthcare experience was the third cause of the delay (Badu *et al*., 2016). Many patients experienced delays in seeking emergency health care because of financial incapacity (Devries *et al*. 2013). An aggregate of three variables (excellent, very good, and good) of quality represents about 77.9% of the total response. We aggregated these variables patients perceived the quality of emergency healthcare delivery as generally good (Afari *et al*., 2014; Aaronson *et al*., 2017).

Conclusion

Improvement in emergency healthcare in developed and developing nations is a function of strategic and effective planning. However, the commitment is dependent on need identification. Therefore, this study investigated physical accessibility, causes of delays in early access to healthcare, and the perceived quality of care. The study found that the causal factors that prolong the decision to access emergency healthcare are poor understanding of risk and complications, previous experience in healthcare, and the cost of transportation and medical cost. The physical accessibility and coverage are generally good (under 15 min) in the south except for fringe communities. The quality of healthcare is perceived as very good. Also, it is important to note that using GIS models for analyzing accessibility can depict physical access for planning purposes. Unfortunately, the most accessible facility was the least resourced. Ewim Polyclinic optimally serves most of the suburbs within the metropolis, yet it has the least staff strength and equipment among the four major emergency facilities. This finding is useful in health planning, especially in emergency health delivery.

The study recommends that:

- Ewim Polyclinic should be expanded because its location is good and can optimally serve many suburbs within the metropolis
- Ambulance services are still inadequate which should be beefed up to enhance effective commuting in emergency cases
- Additionally, there is a need to capture network impedance accurately to generate realistic accessibility results using GIS

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Author’s Contributions

Lincoln Tei Nyade: Reviewed literature, collected the data and drafted the research.

Emmanuel Abeashi Mensah: Supervised the research and helped with the conceptualization of the methodology and analysis of data.

Ethics

This study is extracted from a student thesis. At the time, permission was granted by the Cape Coast metropolitan health directorate to access the emergency units of four health facilities. The principles of ethical research such as informed consent, participation without coercion, confidentiality, anonymity, and respect for research participants were adhered to.

Conflict of Interest

The authors declare therefore no conflict of interest.

References

Aaronson, E., Mort, E., & Soghoian, S. (2017, December). Mapping the process of emergency care at a teaching hospital in Ghana. In *Healthcare* (Vol. *5*, No. 4, pp. 214-220). Elsevier. https://doi.org/10.1016/j.hjdsi.2016.12.001

Abbott, R. M. (2008). Geographic analysis of ambulance availability in Arkansas. *Family & Community Health*, *31*(1), 35-43. https://doi.org/10.1097/01.FCH.0000304066.48195.a4

Acheampong, A. K., Ohene, L. A., Asante, I. N. A., Kyei, J., Dzansi, G., Adjei, C. A., ... & Aziato, L. (2021). Nurses' and midwives' perspectives on participation in national policy development, review and reforms in Ghana: A qualitative study. *BMC Nursing*, *20*, 1-10. https://doi.org/10.1186/s12912-021-00545-y

Afari, H., Hirschhorn, L. R., Michaelis, A., Barker, P., & Sodzi-Tettey, S. (2014). Quality improvement in emergency obstetric referrals: Qualitative study of provider perspectives in Assin North district, Ghana. *BMJ Open*, *4*(5), e005052.

Amer, S. (2007). *Towards spatial justice in urban health services planning: a spatial-analytic GIS-based approach using Dar es Salaam, Tanzania as a case study* (Vol. *140*). Utrecht University. https://dspace.library.uu.nl/handle/1874/19334

Al-Taiar, A., Clark, A., Longenecker, J. C., & Whitty, C. J. (2010). Physical accessibility and utilization of health services in Yemen. *International Journal of Health Geographics*, *9*, 1-8.

Arcury, T. A., Gesler, W. M., Preisser, J. S., Sherman, J., Spencer, J., & Perin, J. (2005). The effects of geography and spatial behavior on health care utilization among the residents of a rural region. *Health Services Research*, *40*(1), 135-156. https://doi.org/10.1111/j.1475-6773.2005.00346.x

Azaare, J., Akweongo, P., Aryeetey, G. C., & Dwomoh, D. (2020). Impact of free maternal health care policy on maternal health care utilization and perinatal mortality in Ghana: Protocol design for historical cohort study. *Reproductive Health*, *17*, 1-17. https://doi.org/10.1186/s12978-020-01011-9

Badu, E., Opoku, M. P., & Appiah, S. C. (2016). Attitudes of health service providers: The perspective of people with disabilities in the Kumasi Metropolis of Ghana. *African Journal of Disability*, *5*(1), 1-8. https://hdl.handle.net/10520/EJC195447

Banke-Thomas, A., Wright, K., & Collins, L. (2019). Assessing geographical distribution and accessibility of emergency obstetric care in sub-Saharan Africa: A systematic review. *Journal of Global Health*, *9*(1). https://doi.org/10.7189/jogh.09.010414

Branas, C. C., MacKenzie, E. J., Williams, J. C., Schwab, C. W., Teter, H. M., Flanigan, M. C., ... & ReVelle, C. S. (2005). Access to trauma centers in the United States. *Jama*, *293*(21), 2626-2633. https://doi.org/10.1001/jama.293.21.2626

Calovi, M., & Seghieri, C. (2018). Using a GIS to support the spatial reorganization of outpatient care services delivery in Italy. *BMC Health Services Research*, *18*, 1-16. https://doi.org/10.1186/s12913-018-3642-4

Carr, B. G., Branas, C. C., Metlay, J. P., Sullivan, A. F., & Camargo Jr, C. A. (2009). Access to emergency care in the United States. *Annals of Emergency Medicine*, *54*(2), 261-269. https://doi.org/10.1016/j.annemergmed.2008.11.016

Crow, H., Gage, H., Hampson, S., Hart, J., Kimber, A., Storey, L., & Thomas, H. (2002). Measurement of satisfaction with health care: Implications for practice from a systematic review of the literature. *Health Technology Assessment*. https://uhra.herts.ac.uk/bitstream/handle/2299/1073/102382.pdf

Damsere-Derry, J., Ebel, B. E., Mock, C. N., Afukaar, F., Donkor, P., & Kalowole, T. O. (2019). Evaluation of the effectiveness of traffic calming measures on vehicle speeds and pedestrian injury severity in Ghana. *Traffic Injury Prevention*, *20*(3), 336-342. https://doi.org/10.1080/15389588.2019.1581925

Delamater, P. L., Messina, J. P., Shortridge, A. M., & Grady, S. C. (2012). Measuring geographic access to health care: Raster and network-based methods. *International Journal of Health Geographics*, *11*(1), 1-18. https://doi.org/10.1186/1476-072X-11-15

DeVries, A., Li, C. H., & Oza, M. (2013). Strategies to reduce nonurgent emergency department use: Experience of a Northern Virginia Employer Group. *Medical Care*, 224-230. https://doi.org/10.1097/mlr.0b013e3182726b83

Felder, S., & Brinkmann, H. (2002). Spatial allocation of emergency medical services: Minimising the death rate or providing equal access?. *Regional Science and Urban Economics*, *32*(1), 27-45. https://doi.org/10.1016/S0166-0462(01)00074-6

Flottemesch, T. J. anderson, L. H., Solberg, L. I., Fontaine, P., & Asche, S. E. (2012). Patient-centered medical home cost reductions limited to complex patients. *The American Journal of Managed Care*, *18*(11), 677-686. https://europepmc.org/article/med/23198711

Freyssenge, J., Renard, F., Schott, A. M., Derex, L., Nighoghossian, N., Tazarourte, K., & El Khoury, C. (2018). Measurement of the potential geographic accessibility from call to definitive care for patient with acute stroke. *International Journal of Health Geographics*, *17*(1), 1-14. https://doi.org/10.1186/s12942-018-0121-4

Hare, T. S., & Barcus, H. R. (2007). Geographical accessibility and Kentucky's heart-related hospital services. *Applied Geography*, *27*(3-4), 181-205. https://doi.org/10.1016/j.apgeog.2007.07.004

Huerta Munoz, U., & Källestål, C. (2012). Geographical accessibility and spatial coverage modeling of the primary health care network in the Western Province of Rwanda. *International Journal of Health Geographics*, *11*, 1-11. https://doi.org/10.1186/1476-072X-11-40

Kelly, C., Hulme, C., Farragher, T., & Clarke, G. (2016). Are differences in travel time or distance to healthcare for adults in global north countries associated with an impact on health outcomes? A systematic review. *BMJ Open*, *6*(11), e013059. https://doi.org/10.1136/bmjopen-2016-013059

Kuupiel, D., Adu, K. M., Bawontuo, V., & Mashamba-Thompson, T. P. (2019). Geographical accessibility to district hospitals/medical laboratories for comprehensive antenatal point-of-care diagnostic services in the Upper East Region, Ghana. *EClinical Medicine*, *13*, 74-80. https://doi.org/10.1016/j.eclinm.2019.06.015

Laaribi, A., & Peters, L. (2019). *GIS and the 2020 Census: Modernizing Official Statistics*. Redlands, CA: Esri Press.

LaMondia, J. J., Blackmar, C. E., & Bhat, C. R. (2010, August). Comparing transit accessibility measures: A case study of access to healthcare facilities. In *Transport Research Board 2011 Annual Meeting, Washington, DC*. https://www.caee.utexas.edu/prof/Bhat/ABSTRACTS/ComparingAccessibility.pdf

Litman, T. (2003). Measuring transportation. *Traffic, mobility and accessibility. ITE Journal*, *73*(10), 28-32.

Mahama, M. N., Kenu, E., Bandoh, D. A., & Zakariah, A. N. (2018). Emergency response time and pre-hospital trauma survival rate of the national ambulance service, Greater Accra (January-December 2014). *BMC Emergency Medicine*, *18*, 1-7. https://doi.org/10.1186/s12873-018-0184-3

McGregor, J., Hanlon, N., Emmons, S., Voaklander, D., & Kelly, K. (2005). If all ambulances could fly: Putting provincial standards of emergency care access to the test in Northern British Columbia. *Canadian Journal of Rural Medicine*, *10*(3), 163.

McLafferty, S. L. (2003). GIS and health care. *Annual Review of Public Health*, *24*(1), 25-42. https://doi.org/10.1146/annurev.publhealth.24.012902.141012

Ministry of Health. (2011). Policy and guidelines for hospital accident and emergency services in Ghana. https://www.moh.gov.gh/wp-content/uploads/2016/02/Guidelines-for-Strengthening-AE-Services-in-Hospitals.pdf

Minutha, V., Subash, S. S., Tali, J. A., & Divya, S. (2014). Measuring spatial accessibility to primary health center in Mysore difstrict. *International Journal of Physical and Social Sciences*, *4*(12), 30-41. https://www.indianjournals.com/ijor.aspx?target=ijor:ijpss&volume=4&issue=12&article=003

Mohamed, E. Y., Sami, W., Alotaibi, A., Alfarag, A., Almutairi, A., & Alanzi, F. (2015). Patients' satisfaction with primary health care centers' services, Majmaah, Kingdom of Saudi of Saudi Arabia. *International Journal of Health Sciences*, *9*(2), 163. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4538893/

Morgan, S. R., Smith, M. A., Pitts, S. R., Shesser, R., Uscher-Pines, L., Ward, M. J., & Pines, J. M. (2012). Measuring value for low-acuity care across settings. *The American Journal of Managed Care*, *18*(9), e356-63. https://europepmc.org/article/med/23009334

Murad, A. A. (2004). Creating a GIS application for local health care planning in Saudi Arabia. *International Journal of Environmental Health Research*, *14*(3), 185-199. https://www.tandfonline.com/doi/abs/10.1080/0960312042000218606

Noor, A. M., Zurovac, D., Hay, S. I., Ochola, S. A., & Snow, R. W. (2003). Defining equity in physical access to clinical services using geographical information systems as part of malaria planning and monitoring in Kenya. *Tropical Medicine & International Health*, *8*(10), 917-926. https://doi.org/10.1046/j.1365-3156.2003.01112.x

Norman, I. D., Aikins, M., Binka, F. N., & Nyarko, K. M. (2012). Hospital all-risk emergency preparedness in Ghana. *Ghana medical journal*, *46*(1). https://www.ajol.info/index.php/gmj/article/view/77621

Osei-Ampofo, M., Oduro, G., Oteng, R., Zakariah, A., Jacquet, G., & Donkor, P. (2013). The evolution and current state of emergency care in Ghana. *African Journal of Emergency Medicine*, *3*(2), 52-58. https://doi.org/10.1016/j.afjem.2012.11.006

Ouma, P. O., Maina, J., Thuranira, P. N., Macharia, P. M., Alegana, V. A., English, M., ... & Snow, R. W. (2018). Access to emergency hospital care provided by the public sector in sub-Saharan Africa in 2015: A geocoded inventory and spatial analysis. *The Lancet Global Health*, *6*(3), e342-e350. https://doi.org/10.1016/S2214-109X(17)30488-6

Parvin, F., Ali, S. A., Hashmi, S. N. I., & Khatoon, A. (2021). Accessibility and site suitability for healthcare services using GIS-based hybrid decision-making approach: A study in Murshidabad, India. *Spatial Information Research*, *29*, 1-18. https://doi.org/10.1007/s41324-020-00330-0

Pearce, J., Witten, K., & Bartie, P. (2006). Neighbourhoods and health: A GIS approach to measuring community resource accessibility. *Journal of Epidemiology & Community Health*, *60*(5), 389-395. https://doi.org/10.1136/jech.2005.043281

PHC. (2021). General Report form 3A. *Population and Housing Census*. https://statsghana.gov.gh/gssmain/fileUpload/pressrelease/2021%20PHC%20General%20Report%20Vol%203A_Population%20of%20Regions%20and%20Districts_181121.pdf

Rahimi, F., Goli, A., & Rezaee, R. (2017). Hospital location-allocation in Shiraz using Geographical Information System (GIS). *Shiraz E-Medical Journal*, *18*(8). https://doi.org/10.5812/semj.57572

Rooväli, L., & Kiivet, R. A. (2006). Geographical variations in hospital use in Estonia. *Health & Place*, *12*(2), 195-202. https://doi.org/10.1016/j.healthplace.2004.12.001

Schmidt, L. A. (2003). Patients' perceptions of nursing care in the hospital setting. *Journal of Advanced Nursing*, *44*(4), 393-399. https://doi.org/10.1046/j.0309-2402.2003.02818.x

Sofaer, S., & Firminger, K. (2005). Patient perceptions of the quality of health services. *Annu. Rev. Public Health*, *26*, 513-559. https://doi.org/10.1146/annurev.publhealth.25.050503.153958

Silalahi, F. E. S., Hidayat, F., Dewi, R. S., Purwono, N., & Oktaviani, N. (2020). GIS-based approaches on the accessibility of referral hospital using network analysis and the spatial distribution model of the spreading case of COVID-19 in Jakarta, Indonesia. *BMC Health Services Research*, *20*(1), 1-20. https://doi.org/10.1186/s12913-020-05896-x

Surage, J., Tawiah, R., & Twumasi-Mensah, T. (2017). Geographical perspective of modeling primary healthcare accessibility. *International Journal of Human Rights in Healthcare*, *10*(1), 56-67. https://doi.org/10.1108/IJHRH-08-2016-0013

Sarani, S. (2011). Measuring physical accessibility to health facilities-a case study on Khulna City. *World Health Popul*.

Scrimgeour, M., & Scrimgeour, D. (2008). *Health care access for Aboriginal and Torres Strait Islander people living in urban areas, and related research issues: A review of the literature*. Cooperative Research Centre for Aboriginal Health. https://www.researchgate.net/publication/281361287_Health_Care_Access_for_Aboriginal_and_Torres_Strait_Islander_People_Living_in_Urban_Areas_and_Related_Research_Issues_A_Review_of_the_Literature

Tansley, G., Stewart, B., Zakariah, A., Boateng, E., Achena, C., Lewis, D., & Mock, C. (2016). Population-level spatial access to prehospital care by the national ambulance service in Ghana. *Prehospital Emergency Care*, *20*(6), 768-775. https://doi.org/10.3109/10903127.2016.1164775

Thaddeus, S., & Maine, D. (1994). Too far to walk: Maternal mortality in context. *Social Science & Medicine*, *38*(8), 1091-1110. https://doi.org/10.1016/0277-9536(94)90226- 7

Tsoka, J. M., & Le Sueur, D. (2004). Using GIS to measure geographical accessibility to primary health care in rural South Africa: Research in action. *South African Journal of Science*, *100*(7), 329-330. https://hdl.handle.net/10520/EJC96284

Uscher-Pines, L., Pines, J., Kellermann, A., Gillen, E., & Mehrotra, A. (2013). Emergency department visits for nonurgent conditions: Systematic literature review. *The American Journal of Managed Care*, *19*(1), 47-59. https://europepmc.org/article/med/23379744