International Research Journal of Multidisciplinary Scope (IRJMS), 2025; 6(2): 1350-1364

Original Article | ISSN (O): 2582-631X DOI: 10.47857/irjms.2025.v06i02.02257

Spatial Patterns of Health Facilities and Disease in Calabar

Felicia Agbor-Obun Dan[1], Egba Ebagu Tangban[2], Nnana Okoi Ofem[2], Emeka Josephat Owan[3], Edem Ebong[4], Queen Olubukola Ayeni[5], Ejukwa Osam[2], Akaninyene Umo Udeme[6], Francis Abul Uyang[3], Cletus Ekok Omono[3], Agnes Awoli Ewuru[7], Daniel Daniel James[8], Eja Iwara Eja[9]*,Ojiho Isaac Honey[2], Runyi Daniel James[9]

[1]Department of Human Kinetics and Health Education, University of Calabar, Calabar, Nigeria, [2]Department of Social Work, University of Calabar, Calabar, Nigeria, [3]Department of Sociology, University of Calabar, Calabar, Nigeria, [4]Institute of Public Policy and Administration, University of Calabar, Calabar, Nigeria, [5]Department of Modern Languages and Translation Studies, University of Calabar, Calabar, Nigeria, [6]Department of Educational Foundations, University of Calabar, Calabar, Nigeria, [7]Department of Vocational Education, University of Calabar, Calabar, Nigeria, [8]Department of Special Education, University of Calabar, Nigeria, [9]Department of Tourism Studies, University of Calabar, Calabar, Nigeria. *Corresponding Author's Email: ejaiwara43@gmail.com

Abstract

The research delved into the spatial distribution of health facilities and the prevalence of infectious diseases in Calabar, Nigeria. Data collection predominantly relied on questionnaires, the utilization of the Global Positioning System (GPS), and a Geographic Information System (GIS). The gathered data underwent analysis employing inferential statistics, specifically utilizing nearest neighbor analysis. A formulated hypothesis underwent testing, yielding a calculated value of 0.004. This value revealed a concentration of health facilities in clusters around the metropolis of the study center, with fewer points dispersed towards the outskirts of the study area. Notably, 34 percent of respondents did not reside within the World Health Organization's recommended distance from health facilities. Furthermore, 40.2 percent were close to primary health facilities, 29.9 percent to secondary health facilities, and 14.9 percent visited tertiary health facilities. Additionally, 5.1 percent sought healthcare from herbal homes. The findings indicated that typhoid disease accounted for 27.1 percent of total cases over a decade, while sexually transmitted diseases (STDs) constituted 13.1 percent. The study advocates for the equitable distribution of healthcare facilities by healthcare agencies to effectively control infectious diseases in the studied area.

Keywords: Exploring Spatial, Health Facilities, Infectious Diseases, Location Pattern.

Introduction

The global configuration of health facilities plays a significant role in shaping the overall landscape of public health. A thorough understanding of the geographical patterns defining healthcare infrastructure is crucial for assessing and addressing the prevalence of infectious diseases on a global scale. The strategic placement of health facilities becomes a decisive factor in determining the accessibility of healthcare services, thereby exerting a profound impact on the timely identification, treatment, and prevention of infectious diseases worldwide. A study investigating the spatial arrangement of healthcare facilities underscored the imperative to address regional disparities, aiming to improve access to primary healthcare (1). The presence of readily available and evenly distributed healthcare services has been associated with enhanced health results and diminished health inequalities. This connection has been substantiated by studies investigating the correlation between healthcare facility density and health metrics across European regions (2, 3). Additionally, there is a consensus suggesting that regions with greater concentrations of healthcare facilities often demonstrate superior health outcomes, characterized by lower mortality rates and increased life expectancy (4). Understanding the spatial locational patterns of health facilities necessitates consideration of social determinants of health. Health disparities are frequently associated with socioeconomic factors such as income, education, and race/ethnicity, as highlighted by (5-7). Across many countries world-wide, especially in swiftly urbanizing areas such as numerous Asian nations, healthcare

(Received 01st September 2024; Accepted 12th January 2025; Published 30th April 2025)

resources often concentrate within urban zones. This emphasizes the vital significance of healthcare accessibility, illustrating how the proximity to healthcare facilities markedly influences healthcare usage (8, 9). Spatial analyses conducted in the Asian context have unveiled geographical discrepancies in the distribution of health facilities, often leaving rural areas with limited access compared to urban centers (10). These studies have underscored the significant influence of socioeconomic factors, cultural dynamics, and urbanization on healthcare disparities across Asia (11). For instance, research conducted in Indonesia has investigated the correlation between socio-economic factors and healthcare accessibility, revealing disparities that demand attention to ensure equitable health outcomes (12, 13). Similarly, studies in India have highlighted the pivotal role of spatial analysis in comprehending the distribution of health infrastructure concerning population density and demographics (14, 15). Moreover, enhanced accessibility to primary care facilities, as evidenced in Taiwan, has been associated with reduced mortality rates (16). Meanwhile, research in Southeast Asia has emphasized the influence of health facility distribution on maternal and child health outcomes (17, 18). The health outcomes of residents in West Africa are directly impacted by the geographical distribution of health facilities, as highlighted in the past study (19). Unfavorable health results have been correlated with insufficient access to healthcare services, as demonstrated in the study (20). In this region, healthcare disparities are frequently associated with social determinants, including income, education, and infrastructure development. Once again, researchers have delved into the correlation between socio-economic factors and healthcare utilization, revealing disparities that hinder the equitable provision of healthcare services (21). Additionally, they've scrutinized the nexus between healthcare accessibility and the prevalence of infectious diseases, stressing the pivotal role of spatial factors in disease prevention and control, particularly in West Africa (22, 23). Another study has further investigated the relationship between healthcare access and infectious disease prevalence, emphasizing the critical role of spatial factors in disease prevention and control efforts (24). Given Nigeria's significant burden of infectious diseases, understanding how healthcare accessibility influences disease prevalence is paramount, as highlighted (25, 26). Various studies have shed light on the uneven distribution of healthcare facilities in Nigeria, with an urban concentration and rural scarcity contributing to disparities in healthcare accessibility (27, 28). This disparity could potentially impact the spread and control of infectious diseases, as emphasized by researchers who have underscored the link between rural-urban disparities in healthcare access and infectious disease prevalence (29, 30). The spatial location patterns of health facilities and their correlation with the prevalence of infectious diseases have been extensively studied globally and within regional perspectives, as indicated (10, 31, 32). Several studies conducted both domestically and internationally, have indicated that regions with limited access to healthcare facilities are at a heightened risk of infectious diseases (33-35). In Cross River State, specifically in Calabar, numerous investigations have focused on the impact of healthcare accessibility, socioeconomic factors affecting access, and obstacles encountered in rural communities (36-39). Despite the plethora of studies examining spatial and locational patterns across various phenomena in Cross River State, there remains a notable gap in research concerning the spatial distribution of health facilities and the prevalence of infectious diseases, particularly in Calabar (40, 41). The objectives of this study are to delineate the spatial location patterns of healthcare facilities, examine the prevalence of infectious diseases in Calabar, identify healthcare facilities nearest to residences, and analyze the distribution of infectious diseases across healthcare facilities. A part from these, this study will provide valuable insights for policy development and resource allocation, ensuring the equitable distribution of healthcare facilities in underserved areas. It will also enhance disease surveillance and control measures, enabling targeted interventions to reduce the prevalence of infectious diseases. Furthermore, it will assist in designing localized public health campaigns and fostering collaboration among healthcare providers to address disparities in access and care. This research will contribute to informed decision-making, improved healthcare infrastructure, and

the more effective management of public health challenges.

Methodology

The research was conducted in Calabar, the capital of Cross River State, Nigeria, covering two local government areas: Calabar Municipality (with ten wards) and Calabar South (with approximately twelve wards) (Figure 1). The study area is situated between latitudes 4.501°N to 4.541°N and longitudes 8.018°E to 8.024°E, encompassing an area of approximately 164 km^2. It is bordered in the North by Odukpani LGA, in the East by the great Kwa River, in the West by the Calabar River, and in the South by the estuary. Calabar is positioned on a peninsula formed by the Calabar River, the Kwa River, the Cross River Estuary, and the Atlantic Ocean. The city is characterized by high socio-economic and tourism activities, accompanied by a sizable population, potentially contributing to an elevated crime rate in the area.The Geographic Information Systems (GIS) was used in this research work to analyze the spatial distribution of healthcare facilities in Calabar. However, several systematic steps were employed to collect, process, and analyze relevant data. First, geospatial data on the precise locations of healthcare facilities were obtained through GPS field surveys. These data were complemented with ancillary information such as facility capacities, types of services offered, and catchment populations. Public health records detailing disease prevalence and demographic data, including population density and socio-economic variables, were also gathered to provide contextual insights. All datasets were integrated into a GIS platform for analysis. Spatial analysis tools within the GIS environment, such as nearest neighbor analysis, were applied to evaluate patterns of clustering, randomness, or dispersion of healthcare facilities across Calabar. Service area analysis was conducted to determine the accessibility of healthcare facilities by modeling travel distances or times along the city's road networks. Additionally, hotspot analysis was employed to identify areas of high or low healthcare service density. The analysis was further enhanced by overlaying healthcare facility data with demographic layers to assess equity in service distribution and identify underserved regions. Results were visualized through maps and statistical outputs, providing a clear and actionable representation of the spatial distribution of healthcare facilities in Calabar. The second method utilized a structured questionnaire and checklist to collect information from 1066 residents, following the guidelines for sample size determination. The information on the incidence of infectious diseases in healthcare facilities was obtained from healthcare management records and infectious disease data covering the period from 2014 to 2023.Descriptive statistics, including tables, maps, graphs, frequencies, and percentages, were employed for data analysis (42). The study adopted Nearest Neighbour Analysis (NNA) statistics to test the null hypothesis: "The occurrence of crime dynamics in Calabar does not exhibit significant clustering." The Rn statistic was used to assess the level of clustering, with values ranging from Rn = 0 (totally clustered pattern) to Rn = 1 (random pattern) and Rn = 2 (uniform dispersed pattern). A Z-test was performed to determine the significance of the observed average distance between health facility locations and their closest neighbors compared to the expected average distance. A statistical finding was considered significant if $P < 0.05$, relative to the normal distribution.

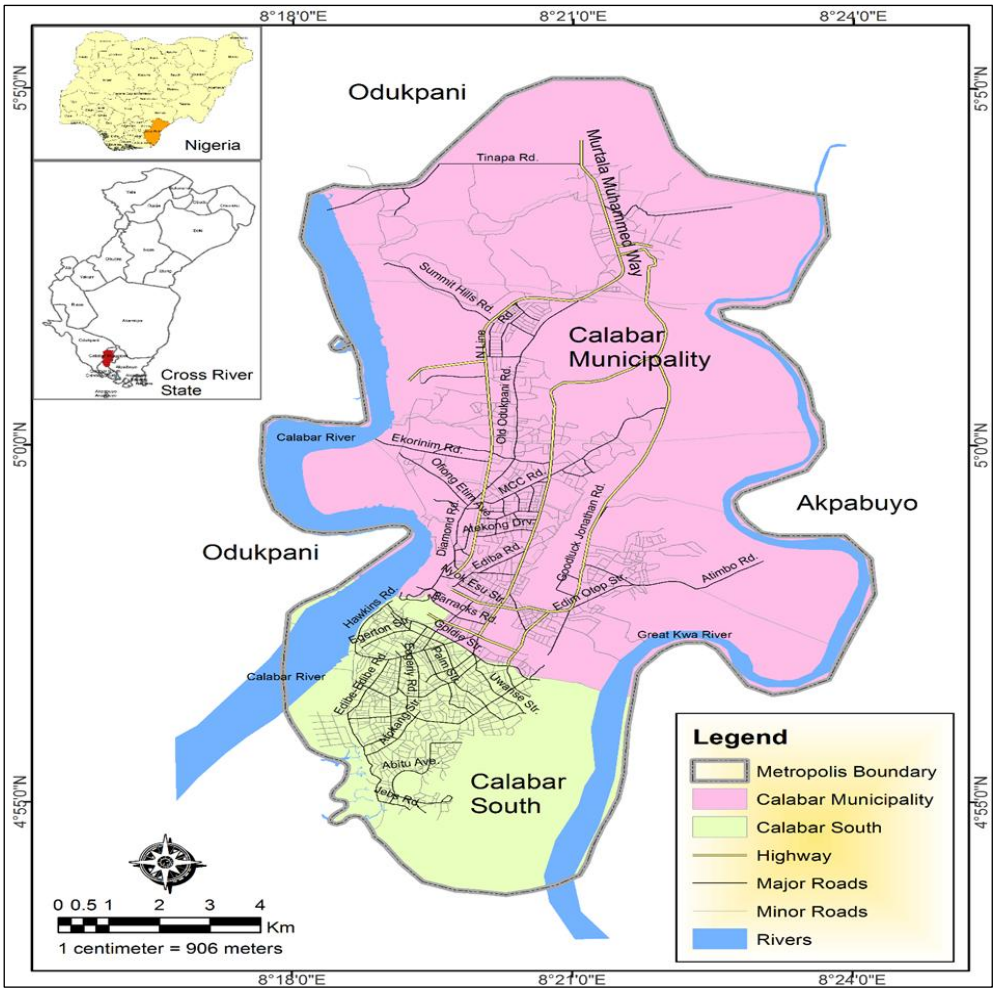

Figure 1: Calabar Metropolis

Results and Discussion

Spatial Location Pattern of Health Facilities and the Prevalence of Infectious Diseases in Calabar

The data presented in Figure 2 categorizes healthcare facilities into primary, secondary, and tertiary tiers, each offering different levels of care and services. Primary healthcare facilities serve as the first point of contact for individuals seeking medical attention, providing essential and preventive services to the general population. Secondary healthcare facilities offer specialized care, typically available to patients referred from primary care providers. Tertiary healthcare facilities provide highly specialized services, including advanced medical care and surgical interventions, though these facilities are not the focus of the current study. Figure 2 indicates that primary healthcare facilities dominate the clustering within the study area, reflecting their essential role in meeting the healthcare needs of the local population. These facilities are predominantly concentrated around the metropolitan areas, where access to healthcare is typically more readily available due to higher population density and better infrastructure. The widespread distribution of secondary healthcare facilities across the study area suggests that these services are aimed at catering to a broader population, extending beyond the immediate urban center to ensure specialized care is accessible throughout the region (43, 44). In addition, Table 1 further illuminates the geographic distribution of healthcare facilities by providing the coordinates (longitude and latitude) for the 92 facilities mapped in the study. According to the data, primary healthcare facilities are the most prevalent, appearing 55 times, compared to 33 appearances for secondary healthcare facilities. Local or traditional healing homes, which reflect the region's cultural approach to healthcare, are present but less frequent, with only three appearances (45, 46). This data shows that while

modern healthcare facilities dominate the region, traditional healing practices are still part of the healthcare landscape, albeit to a lesser extent. The clustering of healthcare facilities around the metropolis, as illustrated in Figure 2, underscores the urban-centric nature of healthcare service provision. The concentration of healthcare services in urban areas is likely driven by the larger population base, economic opportunities, and better infrastructure, which make it more feasible to establish and maintain healthcare facilities in these regions. However, the study also highlights the issue of sparse distribution of healthcare facilities at the periphery of the study area. These areas are underrepresented in terms of healthcare infrastructure, suggesting that residents in more rural or peripheral zones may face challenges in accessing necessary healthcare services (47). The spatial distribution of healthcare facilities was mapped and analyzed using average nearest neighbor analysis (ANN) to determine whether the distribution exhibited clustering, randomness, or dispersion (Figure 3).

Table 1: Location of Healthcare Facilities in Calabar

S/N	Facility Name	Facility type	Management	Community	Ward	LGA	Longitude	Latitude
1	St Mary Health Centre EfutAbua	Primary	Public	EfutAbua	12	South	8.32284941	4.9352304
2	Primary Health Center AksniEsuk	Primary	Public	Afokang	11	South	8.31282064	4.9284288
3	Family Health clinic	Primary	Private	Moore road	3	South	8.3228963	4.9643672
4	Primary Healthcare Centre	Primary	Public	Nasarawa	10	Municipality	8.3562616	5.0777134
5	PHC Ekorinim	Primary	Public	Ekorinim 1	5	Municipality	8.32201344	4.9975682
6	Government Dental centre	Secondary	Public	Big Qua	4	Municipality	8.32308642	4.9646933
7	Government House Clinic	Secondary	Public	Big Qua	4	Municipality	8.3194553	4.9664561
8	Establishment Staff Clinic	Primary	Public	Diamond	5	Municipality	8.33117879	4.9798553
9	Polyclinic IkotOmin	Primary	Private	IkotOmin	10	Municipality	8.3520079	5.0565232
10	CRUTECH Medical Centre	Secondary	Public	EfutEtakIkot	11	South	8.33233441	4.9263198
11	Primary Healthcare Centre IkotEffanga.	Primary	Public	IkotEffanga	9	Municipality	8.35063767	5.0354628
12	PHC Anantigha	Primary	Public	Anantigha	11	South	8.31977688	4.9181049
13	Mary Magdalene Pry Health Centre	Primary	Private	EfutEkondo	6	South	8.32152017	4.9556885
14	IkotEkpo Health Center	Primary	Public	IkotEkpo	10	Municipality	8.34623627	5.078926
15	Murray Primary	Primary	Private	Murray	10	South	8.32911508	4.9501618

	Healthcare Centre							
16	Primary Healthcare Centre IkotAnsa.	Primary	Public	IkotAnsa	8	Municipality	8.3395182	5.0115778
17	Primary Healthcare Centre Oyo Efam	Primary	Public	EfutAbasiObori	12	South	8.33601705	4.9363568
18	Family Support Primary Healthcare Centre	Primary	Private	Big Qua	4	Municipality	8.33996907	4.9759622
19	PHC Anderson	Primary	Public	Anderson		South	8.31218502	4.957578
20	Nyaghasang Health Centre.	Primary	Public	Nyaghasang	3	Municipality	8.3635291	4.9774987
21	Staff Clinic-Ministry of health headquarters	Primary	Public	Big Qua	4	Municipality	8.32449257	4.9701811
22	PHC Akim	Primary	Public	Akim Qua	1	Municipality	8.3396729	4.9578095
23	Ebuka Primary Healthcare Centre	Primary	Public	Ebuka	11	South	8.32588219	4.9161547
24	Duke town Primary Healthcare Centre	Primary	Public	Eyamba	2	South	8.31645918	4.9608382
25	Bogobiri Primary Healthcare Centre	Primary	Public	EdemEffioOkoho	1	South	8.32699601	4.9587884
26	OkonEne-Idang Primary Healthcare Centre Extension	Primary	Public	Idang	11	South	8.3130844	4.9317006
27	GSS Idang Sick Bay	Primary	Public	Idang	11	South	8.31239299	4.9342727
28	InyeneAbasi Assembly maternity home	Primary	Private	Efut	12	South	8.32120365	4.9342728
29	NsibungIbom Community Health Centre	Primary	Public	Nsibung	8	South	8.31012983	4.9512575
30	Peace Medical Centre	Secondary	Private	Henshaw Town	5	South	8.31595797	4.9524521
31	Essierebom Primary Healthcare Centre	Primary	Public	Idang	8	South	8.31057683	4.9388369

32	O & I health care	Secondary	Private	Henshaw town	5	South	8.31777775	4.9538982
33	Dr Lawrence Henshaw	Secondary	Private	Essiero	8	South	8.31745523	4.9489225
34	Ikpeme medical centre	Secondary	Private	Mbukpa	11	South	8.31476048	4.9374889
35	Police clinic, Calabar	Secondary	Public	Akim Qua	1	Municipality	8.33225947	4.9631215
36	Seventh Day Adventist Primary Healthcare Centre	Primary	Private	Akim Qua	1	Municipality	8.33193778	4.9518854
37	Peoples specialist clinic	Secondary	Private	Akim	1	Municipality	8.33838711	4.9624485
38	Specialist Clinic	Secondary	Private	Akim	1	Municipality	8.3394382	4.9713411
39	Esor Clinic	Secondary	Private	IKOT UDUAK	6	Municipality	8.35240833	4.9977153
40	Amazing specialist clinic	Secondary	Private	IKOT UDUAK	6	Municipality	8.34990381	4.9981432
41	Primary Healthcare Centre IkotEffangaMkpa	Primary	Public	IkotEffanga Mkpa	9	Municipality	8.350381851	5.0359708
42	HEALTH CENTER KASUK	Primary	Public	KASUK	7	Municipality	8.33992236	5.0026952
43	Spring Road Specialist Clinic	Secondary	Private	Essien Town	5	Municipality	8.32833349	4.9895448
44	University of Calabar Teaching Hospital	Tertiary	Public	Eta Agbor	2	Municipality	8.35086402	4.9546659
45	Mevom specialist clinic	Secondary	Private	Akim	1	Municipality	8.34007248	4.9589308
46	University of Calabar Medical Centre	Secondary	Public	Eta Agbor	2	Municipality	8.34202089	4.9546841
47	Primary Healthcare Centre IkotNkebre	Primary	Public	IkotNkebre	9	Municipality	8.355574608	5.0597674
48	Victoria Itam Secondary	Secondary	Private	Big Qua	4	Municipality	8.33679527	4.973001
49	Federal Neuro psychiatric Calabar	Secondary	Public	Henshaw Town	5	South	8.31827163	4.9535183
50	Nyahasang Primary	Primary	Public	Nyahasang	3	Municipality	8.35459592	4.9770695

	Healthcare Centre							
51	Primary Healthcare Centre, Edimotop	Primary	Public	Edimotop	2	Municipality	8.35431896	4.9658425
52	General Hospital Calabar	Secondary	Public	Akim Qua	1	South	8.33623724	4.9535541
53	Army Medical Centre, Eburutu Barracks	Secondary	Public	IkotAnsa	8	Municipality	8.34689033	5.0191382
54	Primary Healthcare Centre	Primary	Public	IkotEkpo	10	Municipality	8.34654192	5.0779403
55	Bakor Medical Centre	Secondary	Private	Federal Housing Estate	8	Municipality	8.33385904	5.0272371
56	Mission Hill Clinic	Primary	Private	IkotNkebre	9	Municipality	8.35619439	5.0595582
57	Nosam Clinic	Primary	Public	Federal Housing Estate	8	Municipality	8.34218582	5.0245581
58	Efkam Clinic	Secondary	NA	Ediba	4	Municipality	8.34123322	4.9790848
59	Unicem clinic	Secondary	Private	Big qua	4	Municipality	8.33608301	4.9839085
60	Primary Healthcare Centre IkotAnwatim 1	Primary	Public	IkotAnwatim 1	7	Municipality	8.3339576	5.0053204
61	Adi Specialist Clinic	Primary	Private	Akim	1	Municipality	8.32927303	4.9620375
62	Akai Efa Primary Healthcare Centre	Primary	Public	Akai Efa	6	Municipality	8.36141648	5.0073036
63	Victoria Itam Secondary	Secondary	Private	Big Qua	4	Municipality	8.33681547	4.9729038
64	Idang Primary Healthcare Centre	Primary	Public	Idang	11	South	8.31232313	4.9347519
65	Marian Clinic	Secondary	Private	Kasuk,IkotAnsa	7	Municipality	8.33953441	5.0038093
66	Elyon Foundation Medical Centre	Secondary	Private	Big Qua	4	Municipality	8.33306136	4.9726288
67	Primary Healthcare Centre Musaha	Primary	Public	EfutAnantigha	12	South	8.32583984	4.9280143
68	IkotIshie Health center	Primary	Public	IkotIshie	6	Municipality	8.33842182	4.992073

69	Primary Healthcare Centre	Primary	Public	IkotAnwatim 2	7	Municipality	8.33228371	5.0071781
70	Primary Healthcare Centre	Primary	Public	Cobham Town	3	South	8.317916393	4.9623603
71	InyeneAbasi Assembly maternity home	Primary	Private	Efut	12	South	8.32120365	4.9342728
72	City Clinic	Secondary	Private	Big Qua	3	Municipality	8.34215889	4.9797989
73	Immanuel Infirmary	Secondary	Private	IkotEffanga	9	Municipality	8.35093831	5.0345006
74	NYSC/CBHC	Secondary	Public	Efut	9	South	8.32324158	4.9458212
75	School health services	Primary	Public	EkpoAbasi	12	South	8.32471113	4.9382105
76	Ukpong clinic and maternity	Secondary	Private	Big qua	4	Municipality	8.33764495	4.9803727
77	Health Center	Primary	Public	Abenyo	10	Municipality	8.38147527	5.0758956
78	Progress Clinic and Maternity	Secondary	Private	AKIM	1	Municipality	8.34277741	4.9582912
79	Primary Healthcare Centre, EsukUtc an	Primary	Public	EsukUtan	8	Municipality	8.32186087	5.0151607
80	Divine Maternity	Primary	Private	KASUK	6	Municipality	8.33911416	5.0029414
81	Hannah Foundation Clinic & Trauma Centre	Secondary	Private	Akim Qua	4	Municipality	8.34232462	4.9838059
82	Cross River State Eye Care Programme Centre.	Secondary	Public	Akim Community	2	Municipality	8.335149	4.9543547
83	National Blood transfusion service Calabar Centre	Secondary	Public	Henshaw Town	5	South	8.31614187	4.9503247
84	Atekong Primary Healthcare Centre	Primary	Public	Atekong	4	Municipality	8.33524996	4.9755261
85	Primary Healthcare Centre Okoho Ephraim	Primary	Public	Efut	12	South	8.33049055	4.9360383
86	PHC Big Qua	Primary	Public	Big Qua town	4	Municipality	8.33165664	4.9702012

87	Diamond Health centre	Primary	Public	Diamond Hill	5	Municipality	8.3290474 8	4.98304 67
88	Health Center	Primary	Public	IkotEneobong	9	Municipality	8.3611267 2	5.05268 06
89	PHC Ediba	Primary	Public	Ediba Qua	3	Municipality	8.3473415 6	4.98300 76
90	Bone healing home 1	Local	Private	Aba by Atimbo	2	Municipality	8.3617421 1	4.96781 21
91	Bone healing home 2	Local	Private	Nyarowo off Atamunu	3	Calabar South	8.3309510 2	4.94144 04
92	Bone healing home 3	Local	Private	Otomo street off Uwanse	2	Calabar South	8.3366313	4.94022 12

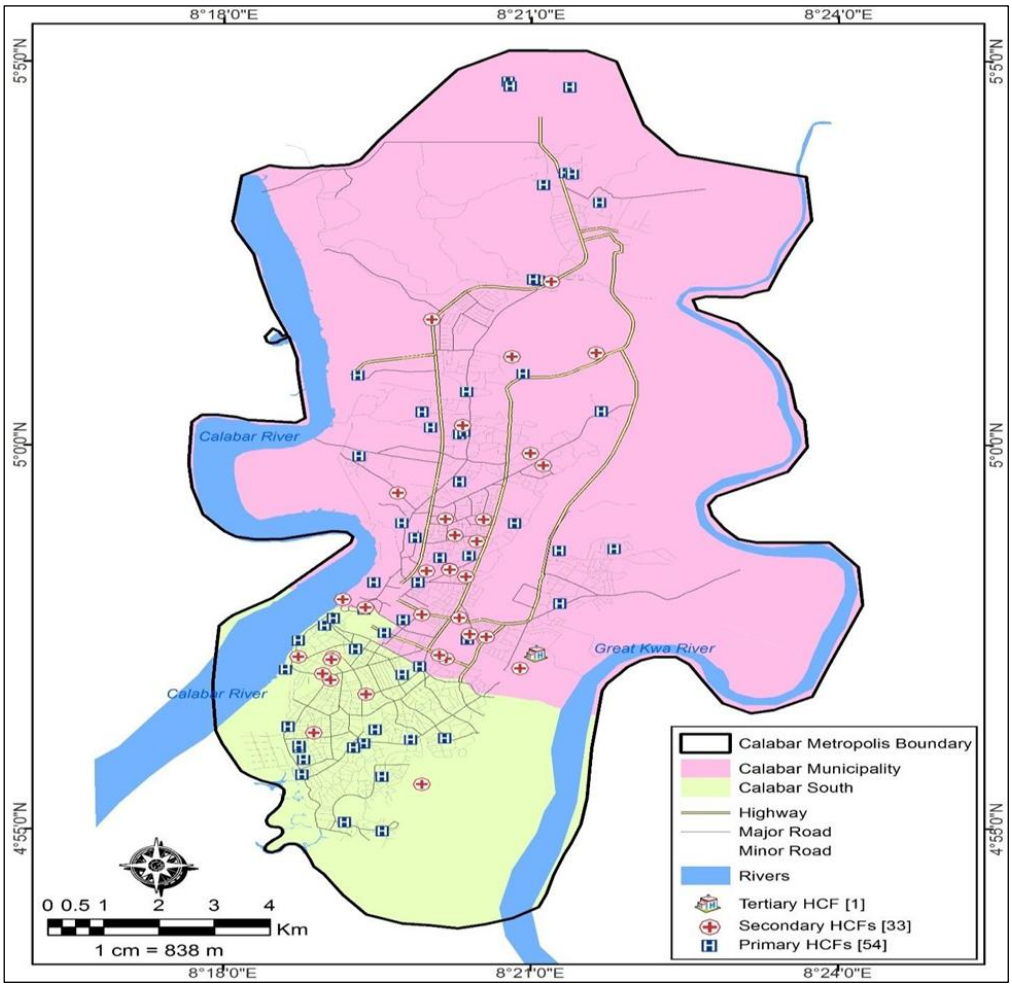

Figure 2: Locational Pattern of Healthcare Facilities in Calabar Metropolis

Similarly, 40.2% of the respondents reported that primary healthcare facilities were the closest to their homes (see Table 2). Additionally, 29.9% of the sampled respondents stated that secondary healthcare facilities were nearest to them. These empirical findings align with the works of (36-39). Furthermore, 14.9% of the respondents mentioned visiting tertiary healthcare facilities, while 9.9% opted for pharmaceutical outlets, and 5.1% of the respondents visited herbal homes (See Table 3). This finding further concurs with the empirical works of past studies also (3, 16). Furthermore, Figure 4 reveals that 40.1% of the respondents reside within a distance of less than one kilometer from a healthcare facility. Additionally, 25.0% of the sampled population lives approximately one kilometer away from a healthcare facility (27, 28). Moreover, 10.0% of the

respondents are situated about two kilometers from the nearest healthcare facility. Furthermore, more than 14.8% of the respondents are located three kilometers away from a healthcare facility, while 10.0% of the sampled population is four kilometers or more from the nearest healthcare facility (10, 11).

Table 2: Healthcare Facilities Nearest to Residence

Healthcare facilities	Frequency	Percent
Primary health care facility	428	40.2
Secondary health care facility	319	29.9
Tertiary health care facility	159	14.9
Pharmaceutical shop	106	9.9
Herbal home	54	5.1
Total	1066	100.0

Distribution of Infectious Diseases in Healthcare Facilities 2014-2023

The distribution of infectious diseases in healthcare facilities between 2014 and 2023 as presented in Table 3 reveals several incidences of diseases such as typhoid, malaria, cholera, STDs, HIV/AIDS, and hepatitis in healthcare facilities in Calabar. The data indicate that the years 2023, 2021, and 2019 recorded the highest incidence rates at 11.7% and 10.5%, respectively, followed by 2022 with a rate of 10.1%. Similarly, table 3 shows that 2016 and 2014 had incidence rates of 9.7% and 9.6%, respectively, across healthcare facilities in Calabar. Additionally, the years 2018 and 2015 recorded 9.5% and 8.6%, respectively. Furthermore, typhoid and malaria were identified as the most prevalent infectious diseases in the healthcare facilities, with rates of 27.1% and 34.4%, respectively. These were followed by STDs and hepatitis, with rates of 13.1% and 11.7%, respectively. Cholera and HIV/AIDS had the lowest incidence rates, with values of 4.7% and 9.0%, respectively, in the healthcare facilities in Calabar.

Table 3: Distribution of Infectious Disease between 2014 and 2023

Dizz Year	Typhoid	Malaria	Cholera	STD	HIV/AIDS	Hepatitis	Total	Percentages
2023	820	1281	115	394	234	390	3234	11.7
2022	739	1013	84	392	219	344	2791	10.1
2021	834	981	143	255	277	404	2894	10.5
2020	779	890	200	327	262	360	2818	10.2
2019	802	885	128	448	271	358	2892	10.5
2018	715	840	114	340	272	344	2625	9.5
2017	732	940	121	352	218	294	2657	9.6
2016	646	1065	104	313	259	280	2667	9.7
2015	584	821	148	293	226	294	2366	8.6
2014	824	780	149	505	247	146	2651	9.6
Total	7475	9496	1306	3619	2485	3214	27595	
%	27.1	34.4	4.7	13.1	9.0	11.7		100

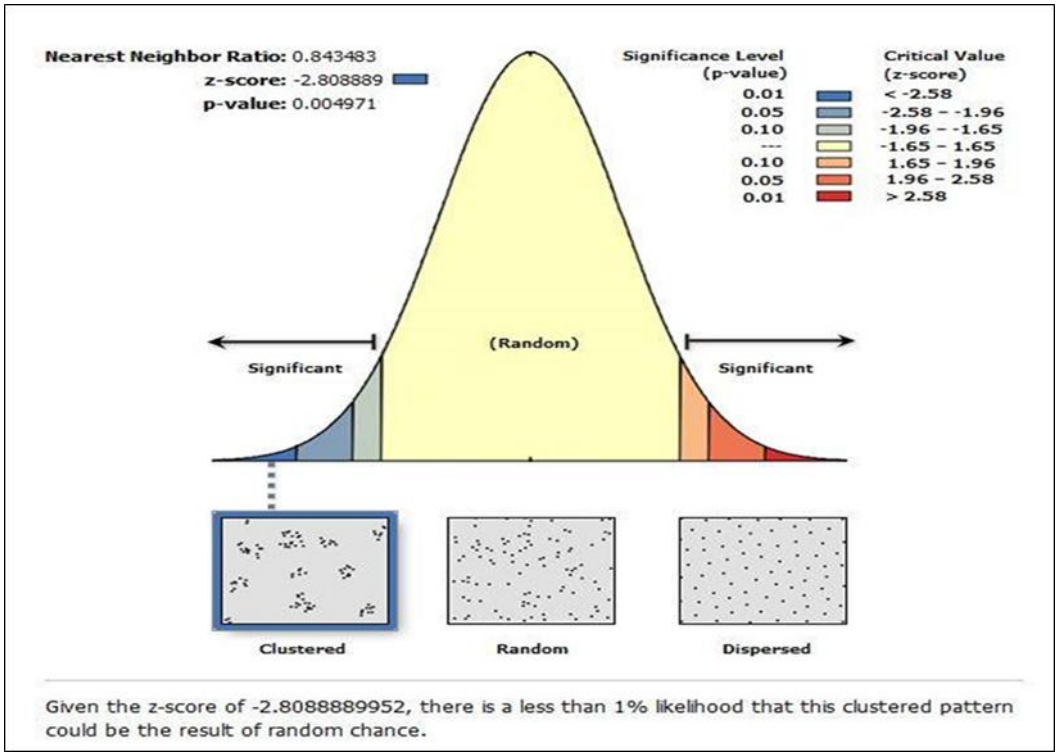

Figure 3: Arrange Nearest Neighbour Analysis Output

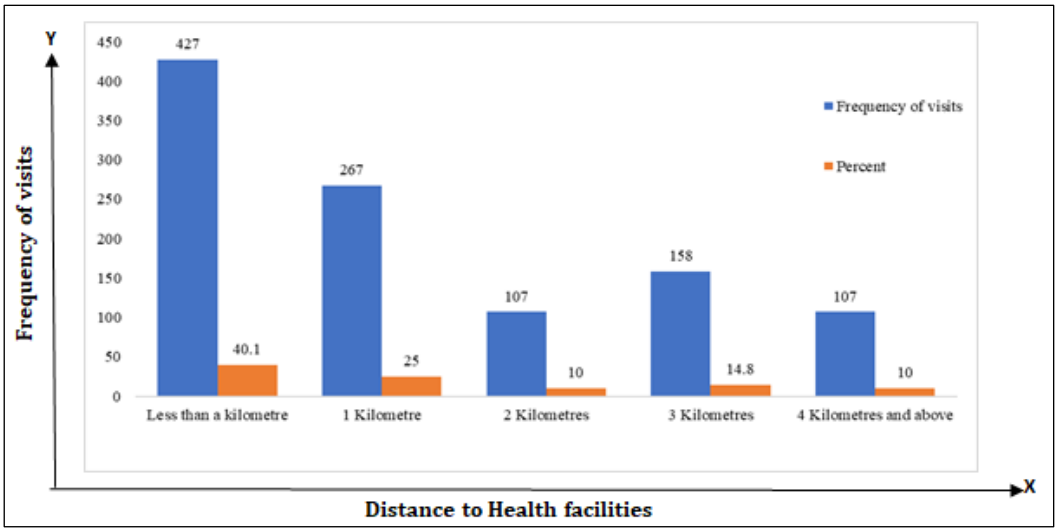

Figure 4: Distance from Residence to the Healthcare Facilities

Significantly, a total of 34.8%, representing 372 respondents, do not reside within the recommended distance set by the World Health Organization (32). Accordingly, Table 3 indicates that typhoid disease accounted for 27.1% of the total cases over the ten-year period (25, 26). Similarly, malaria, on the other hand, contributed to 34.4% of the total cases, with the highest number of cases documented in 2019 (1,281 cases) and the lowest in 2011 (821 cases). Cholera represented 4.7% of the total cases, while STDs accounted for 13.1% of the total cases. This finding aligns with the works of (10, 31). Additionally, Table 3 indicates that hepatitis disease recorded a total of 3,214 cases between 2010 and 2019. The highest yearly cases were 404 in 2017, followed by 390 in 2019, while the lowest cases were 146 in 2010 (24, 29, 30).The findings of this study will play a significant role for various stakeholders in disease management, providing insight into the spatial distribution of infectious diseases across health facilities in the study area. It will serve as a reference point for the government and other healthcare agencies, highlighting areas within the health facilities with high prevalence locations. Moreover, while several studies have focused on

the spatial perspective, there has been little emphasis on the spatial location pattern of health facilities and the prevalence of infectious diseases in Calabar. Therefore, the results of this study will benefit other researchers and contribute to bridging the gap in existing literature.

Conclusion

This study examines the geographical distribution of health facilities and the prevalence of various infectious diseases in the surveyed areas. Additionally, it delineates the proximity of health facilities to residential areas and identifies those that are less accessible to the residents**.** This study shows that primary healthcare facilities dominate the healthcare landscape in the study area, clustering densely around the metropolis, while secondary facilities are more evenly distributed. Geographical analysis indicates that primary healthcare facilities are the most prevalent, with fewer local or traditional healing homes. Respondents identified primary healthcare facilities as the most accessible, followed by secondary facilities. The study also highlights the high prevalence of infectious diseases such as typhoid, malaria, cholera, STDs, HIV/AIDS, and hepatitis in healthcare facilities in Calabar, reflecting significant public health challenges. To address these issues, healthcare infrastructure should be expanded to underserved outskirts, including the establishment of more primary and secondary healthcare facilities. Public health efforts should prioritize disease prevention and management through awareness campaigns, vaccination programs, and improved sanitation. Additionally, healthcare facilities must be adequately equipped with resources and skilled personnel to effectively manage the most common infectious diseases.

Abbreviations

ANN: Average Nearest Neighbour, STD: Sexually Transmitted Diseases, NNA: Nearest Neighbour Analysis, GIS: Geographic Information System, GPS: Global Positioning System.

Acknowledgments

We extend our sincere appreciation to everyone who contributed to our study on the spatial distribution of health facilities and the prevalence of infectious diseases in Calabar. We are grateful for the collaborative effort and steadfast dedication that made this research possible. Special thanks are owed to the healthcare professionals, local authorities, and governmental organizations in Calabar for their invaluable support and cooperation throughout our endeavor.

Author Contributions

Dan, Felicia Agbor-Obun, Owan, Josephat Emeka, Eja, Eja Iwara, Cletus Ekok Omono, designed and conceptualized the study. Ojiho Isaac Honey, James, Daniel Daniel, Samuel Etim Ndem, Queen Olubukola Ayeni, Udeme Akaninyene Umo, and Nnana Okoi Ofem, conducted the study and collected data. Samuel Etim Ndem, Christiana Aloye Ushie, Dijeh Ann Emani, Francis Abul Uyang, Runyi Daniel James, analyzed the results and drafted the manuscript. All authors critically reviewed the manuscript.

Conflict of Interest

The authors have no conflicts of interest to declare.

Ethics Approval

All survey participants provided their consent, and individuals under the age of 18 were excluded from the study.

Funding

None

References

1. Cassou M, Mousquès J, Franc C. General Practitioners activity patterns: the medium-term impacts of Primary Care Teams in France. Health Policy. 2023;136:104868.
2. Schwarz T, Schmidt AE, Bobek J, Ladurner J. Barriers to accessing health care for people with chronic conditions: a qualitative interview study. BMC Health Serv Res. 2022;22(1):1037.
3. Longtine AG, Greenberg NT, Bernaldo de Quirós Y, Brunt VE. The gut microbiome as a modulator of arterial function and age-related arterial dysfunction. Am J Physiol Heart Circ Physiol. 2024; 326(4):H986-1005.
4. García MC. Preventable premature deaths from the five leading causes of death in nonmetropolitan and metropolitan counties, United States, 2010–2022. MMWR SurveillSumm. 2024;73(2):1–11.
5. Miller S, Wherry LR. Four years later: insurance coverage and access to care continue to diverge between ACA Medicaid expansion and non-expansion states. AEA Pap Proc. 2019;109:327-33.
6. Batool-Anwar S, Quan SF. Sleep Health Disparity and Race/Ethnicity, Socioeconomic Status, and Gender: A Systematic Review. Sleep Medicine Research. 2024;15(3):139-50.
7. Walter-McCabe HA. Coronavirus health inequities in the United States highlight need for continued community development efforts. Int J Community Soc Dev. 2020;2(2):211-33.

8. Zhao D, Shao L, Li J, Shen L. Spatial-Performance Evaluation of Primary Health Care Facilities: Evidence from Xi'an, China. Sustainability. 2024;16(7):2838.
9. Ghaderi M, Jahantigh FF, Koushan M, Wood LC. Positioning of aerial ambulances to improve health care access: A framework using fuzzy DEMATEL and fuzzy ANP. International Journal of Healthcare Management. 2024;17(2):367-78.
10. Wang W, Zhang M, Xu CD, Ye PP, Liu YN, Huang ZJ, Zhou MG. Hypertension prevalence, awareness, treatment, and control and their associated socioeconomic factors in China: a spatial analysis of a national representative survey. Biomed Environ Sci. 2021;34(12):937-51.
11. Sampurna MTA, Handayani KD, Utomo MT, Angelika D, Etika R, Harianto A, Permana PBD. Determinants of neonatal deaths in Indonesia: A national survey data analysis of 10,838 newborns. Heliyon. 2023;9(1):12504.
12. Boakye-Yiadom AP, Nguah SB, Ameyaw E, Enimil A, Wobil PNL, Plange-Rhule G. Timing of initiation of breastfeeding and its determinants at a tertiary hospital in Ghana: a cross-sectional study. BMC Pregnancy Childbirth. 2021;21(1):468.
13. Asante A, Cheng Q, Susilo D, Satrya A, Haemmerli M, Fattah RA, Kosen S, Novitasari D, Puteri GC, Adawiyah E, Hayen A. The benefits and burden of health financing in Indonesia: analyses of nationally representative cross-sectional data. The Lancet Global Health. 2023; 11(5):e770-80.
14. Majumder S, Roy S, Bose A, Chowdhury IR. Understanding regional disparities in healthcare quality and accessibility in West Bengal, India: A multivariate analysis. RegSci Policy Pract. 2023;15(5):1086-1114.
15. Sun JM, Wu HX, Lu L, Liu Y, Mao ZY, Ren JP, et al. Factors associated with spatial distribution of severe fever with thrombocytopenia syndrome. Sci Total Environ. 2021;750:141522.
16. Amoah-Nuamah J, Agyemang-Duah W, Prosper Ninorb G, Gladstone Ekeme B. Analysis of spatial distribution of health care facilities and its effects on access to primary healthcare in rural communities in Kpandai District, Ghana. Cogent Public Health. 2023;10(1):2183566.
17. Yadav AK, Sahni B, Jena PK. Education, employment, economic status and empowerment: Implications for maternal health care services utilization in India. Journal of Public Affairs. 2021;21(3):e2259.
18. Kumah E. The informal healthcare providers and universal health coverage in low and middle-income countries. Global Health. 2022;18(1):45.
19. Adewole DA, Reid S, Oni T, Adebowale AS. Geospatial distribution and bypassing health facilities among National Health Insurance Scheme enrollees: implications for universal health coverage in Nigeria. Int Health. 2022;14(3):260-70.
20. Thomas Y, Oni T, Ebikeme C, Mberu B. Research to address socio-environmental determinants of health and access to healthcare in urban(izing) Africa. Cities Health. 2022;6(1):1-6.
21. Oluwadare T, Adegbilero-Iwari O, Fasoro A, Faeji C. Utilization of Primary Healthcare Centers by Residents of Ido-Ekiti, Nigeria. Ethiop J Health Sci. 2023;33(2):227.
22. Korah PI, Nunbogu AM, Ahmed A. Measuring access to health facilities in Ghana: Implications for implementation of health interventions and the Sustainable Development Goal 3. ApplGeogr. 2023;158:103026.
23. Akpan AI, Zikos D. Rural Agriculture and Poverty Trap: Can Climate-Smart Innovations Provide Breakeven Solutions to Smallholder Farmers?. Environments. 2023;10(4):57.
24. Mousa A, Winskill P, Watson OJ, Ratmann O, Monod M, Ajelli M, Diallo A, Dodd PJ, Grijalva CG, Kiti MC, Krishnan A. Social contact patterns and implications for infectious disease transmission–a systematic review and meta-analysis of contact surveys. Elife. 2021;10:e70294.
25. Hou B, Nazroo J, Banks J, Marshall A. Are cities good for health? A study of the impacts of planned urbanization in China. Int J Epidemiol. 2019;48(4):1083-90.
26. Mankelkl G, Kinfe B. Factors associated with anemia among reproductive age women in Nigeria; evidenced by the Nigeria malaria indicators survey: spatial and multilevel model analysis. ContraceptReprod Med. 2024;9(1):12.
27. Katoue MG, Cerda AA, García LY, Jakovljevic M. Healthcare system development in the Middle East and North Africa region: challenges, endeavors and prospective opportunities. Front Public Health. 2022;10:1045739.
28. Olaboye JA. Assessment of medication access and distribution in Nigeria: Challenges and opportunities for improvement. International Journal of Science and Technology Research Archive. 2024;6(2):083-90.
29. Wenham C, Wouters O, Jones C, Juma PA, Mijumbi-Deve RM, Sobngwi-Tambekou JL, Parkhurst J. Measuring health science research and development in Africa: mapping the available data. Health Res Policy Syst. 2021;19:1-13.
30. Busari SI, Samson TK. Modelling and forecasting new cases of Covid-19 in Nigeria: Comparison of regression, ARIMA and machine learning models. Scientific African. 2022; 1;18:e01404.
31. Azanaw J, Malede A, Yalew HF, Worede EA. Determinants of diarrhoeal diseases among under-five children in Africa (2013–2023): a comprehensive systematic review highlighting geographic variances, socioeconomic influences, and environmental factors. BMC Public Health. 2024; 24(1):2399.
32. Tandu MA, Ogar VJ. Urban Slum Disease Burden/Determinants of Diseases in Squatter Settlement in Calabar, Cross River State Nigeria.Int Res J InnovEng Technol. 2023;7(5):341.
33. Aladuwaka S, Alagan R, Singh R, Mishra M. Health burdens and SES in Alabama: using geographic information system to examine prostate cancer health disparity. Cancers. 2022;14(19):4824.
34. Park JE, Kibe P, Yeboah G, Oyebode O, Harris B, Ajisola MM, Griffiths F, Aujla N, Gill P, Lilford RJ, Chen YF. Factors associated with accessing and utilisation of healthcare and provision of health services for residents of slums in low and middle-income countries: a scoping review of recent literature. BMJ open. 2022;12(5):e055415.

35. Xu W, Agnew M, Kamis C, Schultz A, Salas S, Malecki K, Engelman M. Constructing Residential Histories in a General Population-Based Representative Sample. Am J Epidemiol. 2024;193(2):348-59.
36. Eja EI. Exploring spatial pattern of crime dynamics and vulnerability within tourism infrastructure in Calabar, Nigeria. Spat Inf Res. 2023;31(4):381-8.
37. Ebong RI, Ojong IN, Esienumoh E, Uka VK, Nsemo AD. Provision of emergency obstetric care: Midwives' knowledge and involvement in rural health facilities of Cross River State, Nigeria. Journal of Education and Health Promotion. 2023 Nov 1;12(1):392.
38. Omang TA, Bukie FB, Odinka GE. Population Growth, Urbanization, and Insecurity in Cross River State, Nigeria. J Public Adm Policy Gov Res. 2024;2(1):132-9.
39. Nalley JC, Maduka O. Completeness and timeliness of immunization among children aged 12 to 23 months in South-South Nigeria. Journal of Community Medicine and Primary Health Care. 2019;31(1):22-31.
40. Okwoche AS. The Impact of Calabar Marina Resort and Implication to Tourism and Hospitality Development.Journal of Hospitality & Tourism Management. 2022;6(1):19-23.
41. Vendemmia B, Pucci P, Beria P. An institutional periphery in discussion. Rethinking the inner areas in Italy. ApplGeogr. 2021;135:102537. https://doi.org/10.1016/j.apgeog.2021.102537
42. Woolford MH, Stacpoole SJ, Clinnick L. Resident-to-resident elder mistreatment in residential aged care services: A systematic review of event frequency, type, resident characteristics, and history. J Am Med Dir Assoc. 2021;22(8):1678-91.
43. Arisanti R, Pontoh R, Winarni S, Aini S. Assessing service availability and accessibility of healthcare facilities in Indonesia: A spatially-informed correspondence analysis with visual approach. Decision Science Letters. 2023;12(3):591-604.
44. Leogrande A, Costantiello A, Leogrande D, Anobile F. Beds in Health Facilities in the Italian Regions: A Socio-Economic Approach. Available at SSRN. 2023. http://dx.doi.org/10.2139/ssrn.4577029
45. Zhang Y, Smith JP, Tong D, Turner BL II. Optimizing the co-benefits of food desert and urban heat mitigation through community garden planning. Landsc Urban Plan. 2022;226:104488. https://doi.org/10.1016/j.landurbplan.2022.104488
46. Mwine P, Atuhaire I, Ahirirwe SR, Nansikombi HT, Senyange S, Elayeete S, Harris JR. Readiness of health facilities to manage individuals infected with COVID-19, Uganda, June 2021. BMC Health Serv Res. 2023;23(1):441.
47. Le Tourneau FM. "It's not for everybody": Life in Arizona's sparsely populated areas. Ann Am AssocGeogr. 2022;112(6):1794-811.