SYSTEMATIC / NARRATIVE REVIEW ARTICLE

Factors associated with the spatial accessibility of healthcare services measured by the floating catchment area (FCA)-based method: A scoping review

Jabrullah Ab Hamid, MSc[1,2], Muhamad Hanafiah Juni, MPH[1], Rosliza Abdul Manaf, PhD[1], Sharifah Norkhadijah Syed Ismail, PhD[3,4], Lim Poh Ying, PhD[1]

[1]Department of Community Health, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Serdang, Selangor, Malaysia, [2]Centre for Health Equity Research, Institute for Health Systems Research, National Institutes of Health, Ministry of Health, Shah Alam, Selangor, Malaysia, [3]Department of Environmental and Occupational Health, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Serdang, Selangor, Malaysia, [4]Malaysian Research Institute on Ageing (MyAgeing), Universiti Putra Malaysia, Serdang, Selangor, Malaysia

ABSTRACT

Introduction: The floating catchment area (FCA) method has emerged as the most comprehensive and accurate method for quantifying the spatial accessibility of health care services. There were variants of the FCA-based method that was continuously improvised by the researchers to suit specific local contexts and the different nature of healthcare service delivery. This scoping review identifies factors associated with the spatial accessibility of healthcare services that were specifically measured using the FCA-based method.

Materials and Methods: This scoping review was performed through electronic databases (PubMed and ScienceDirect) using keywords: 'spatial accessibility', 'floating catchment area' and 'factors'. Google Scholar and Mendeley Network were also used as additional sources to obtain relevant studies.

Results: A total of 32 articles were included in this review. Factors identified can be distinguished into two broad categories, which are spatial and non-spatial factors. Spatial factors were remoteness or distance from the urban centre, areas in close proximity to main roads, and some specific geographical characteristics such as mountainous and deltaic regions, whereas non-spatial factors were the degree of urbanisation, population density and various demographic profiles of the population such as socio-economic status, health need, and minority ethnic composition.

Conclusion: This study adds to the body of literature pertinent to the factors associated with spatial accessibility to healthcare services. These findings could give insight for researchers to consider and incorporate those additional variables to further improve the FCA-based method calculations.

KEYWORDS:
spatial accessibility; healthcare services; floating catchment area; factors

INTRODUCTION

Accessibility is a huge concept, which comprises four main elements: geographical accessibility, availability, affordability and acceptability.[1] Spatial accessibility encompasses geographic accessibility and availability due to its association with geographical location and is influenced by the spatial impedance between the service and the user, subject to the availability of the services in a specified location. Measuring the spatial accessibility contributes to evidence-based health policies and planning for a better understanding of the performance of the healthcare delivery system.[2] There were several methods for measuring spatial accessibility, such as nearest distance, provider-to-population ratio and the number of services within a specific threshold distance from the population.[3] Besides that, due to advancements in geographical information systems (GIS) and its application in health-related fields, the floating catchment area (FCA)-based method has emerged since the last decade[4,5] and is now widely used to measure the spatial accessibility.

In short, the FCA-based method is basically a two-step process as it considers the: (i) service catchment area and (ii) population catchment area. The first step is assigning an initial supply–demand ratio for each service location; this is calculated by dividing the number of services, with the number of people that reside within the service catchment area. The second step is the summation of all services that were located within the population catchment area (the threshold distance of the population to travel to seek care). The summation will result in a numerical score, which is the spatial accessibility score, where a higher score indicates better access. Details of the calculation were described elsewhere by Wang and his associates.[5-7] There were various FCA-based methods that existed, which were the evolution and originated from the two-step FCA (2SFCA) method by Wang & Luo circa 2004.[5] The variants were mainly due to the improvements made to the original 2SFCA as well as modifications made specifically to cater to their health care and local context,[3,7,8] such as integrating other components into the formula, the use of multiple modes of transport, variable catchment size, depending on data availabilityand

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Corresponding Author: Poh Ying Lim
Email: pohying_my@upm.edu.my

are still constantly being improvised to suit specific local contexts and/or healthcare services.

In the theoretical framework of access, various external factors from the population characteristics and macroenvironments were often associated with the accessibility of healthcare services in general.[1,9] However, there is still a lack of knowledge in relation to the factors associated specifically with the spatial component of accessibility. By incorporating those factors in the calculation of the method, a better understanding of the association of the external factors could contribute to establishing a more comprehensive and accurate quantification of the spatial accessibility than available FCA-based methods. Thus, this scoping review was conducted with the intention to summarise existing literature, using a scoping review framework to identify factors associated with the spatial accessibility of healthcare services that were specifically measured using the FCA-based method, as well as exploring what factors can be incorporated into the current available FCA-based method to provide a better measure of spatial accessibility.

MATERIALS AND METHODS

The scoping review was performed according to the five-stage Arksey and O'Malley framework of a scoping review: (i) identifying the research question; (ii) identifying relevant studies; (iii) study selection; (iv) charting the data and (v) collating, summarising and reporting the results.[10]

Stage One: the Research Question

The review was guided by the following research questions: (i) to what extent has the FCA-based method been used to quantify the spatial accessibility to various healthcare services?; (ii) what are the factors and how is it associated with the spatial accessibility to the specific health care services? and (iii) how those factors can be incorporated into the FCA-based calculation to further improve the method?.

Stage Two: Identifying Relevant Studies

The three-step method by the Joanna Briggs Institute (JBI)[11] was applied. In the first step, the articles were identified through searching the public domain PubMed and ScienceDirect bibliographic electronic databases. The searches were performed on 25th January 2022. The keywords for the searches include: (spatial accessibility) AND (floating catchment area) AND (factors), based on the title or abstract. Searches only include full-text articles published from 2000 onwards, in English, and related to the healthcare field. In second step, articles were screened using search term 'health' through the text, title and abstract in the included databases, to the ensure the relevance for eligibility of the selected articles only resolve around factors associated with the spatial accessibility to health care services as the primary outcome of interest. Screening was done by two investigators (JAH and MHJ) independently and any discrepancies that arose were resolved by consensus. In the third step, reference list of the identified articles was also searched to identify additional papers. In addition, related documents were also examined and identified through Google Scholar searches and the Mendeley network to supplement the searches through electronic databases.

Stage Three: Study Selection

Articles or studies that did not deliberate on factors associated with the spatial accessibility score or when the spatial accessibility score for the specific health services was not the main outcome (as the dependent variable) of the study were excluded. Only studies with an ecological cross-sectional design were included. Studies on any types of healthcare services (primary care, inpatient care, and any specialised care) and any types of users were included. The full-text screening was conducted by two investigators (JAH and MHJ) and discrepancies were resolved by consensus. Figure 1 depicts the study selection process and additional details on excluded studies.

Stage Four: Charting the Data

Data were extracted by JAH and MHJ, including authors, title, year of publication, location (including country), types of health care services, outcomes on reported significant factors associated with the spatial accessibility score to the specified health services, the study design (with level of spatial aggregation), population (basically is the potential user of the services) as well as the grant involved in the respective study. Information for each of the included study is charted in Table I.

Stage Five: Collating, Summarising and Reporting the Results

Studies were then grouped based on types of health care services, tabulated against identified factors (which were organised thematically according to similar characteristics; which are either spatial or non-spatial factors) as shown in Table II, summarising findings addressing the first two research questions. The third research question was discussed accordingly after collating all the findings from the included studies.

RESULTS

Of the 53 records obtained, a total of 21 were excluded, where 5 were excluded upon screening at the title and abstract level and 16 records were further excluded after assessing the full text of the articles due to being outside the focus of this study. This was illustrated in the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews)[12] flowchart of the literature included in the study (Figure 1).

A total of 32 articles were reviewed, where notable findings on identified factors associated with the respective studied healthcare services are listed in Table I. The FCA-based method has also been widely used across several healthcare services, such as primary care (14 articles),[5,7,8,13–23] in-patient care (8 articles),[2,24–30] maternal care (2 articles),[31,32] elderly care (2 articles)[33,34] and other specialised services (6 articles).[35–40] Factors associated with those studies can be identified based on the general spatial pattern of the calculated accessibility score across the map, often visualised using choropleth maps, supplemented by geostatistical analysis such as Moran's I index or Getis-ord-Gi* or using regression analysis.

The distribution of accessibility scores was generally unequally distributed across the study areas of the included studies. Several factors were reported to be associated with spatial accessibility scores (calculated using the FCA-based

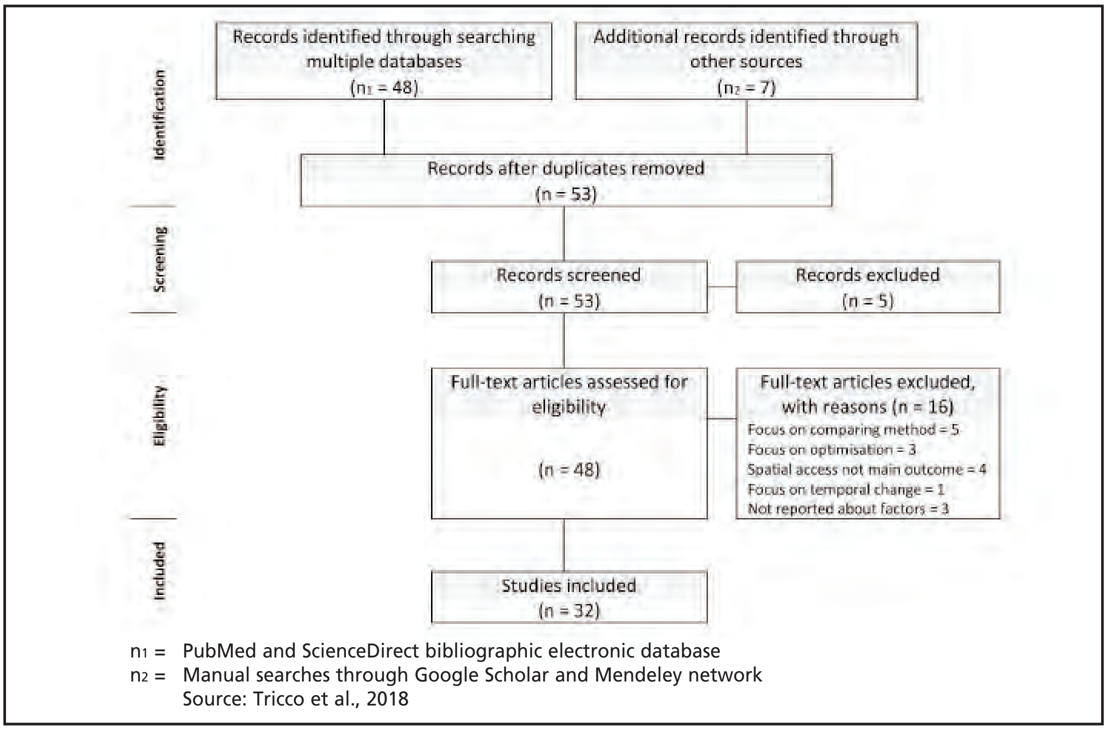

Fig. 1: PRISMA-ScR flowchart for eligible articles included

method) for healthcare services. In summary, the associated factors that contribute to the variation of spatial accessibility can be either spatial or non-spatial factors. Spatial factors are often related to the remoteness or distance from the main urban centre or some specific geographical locations (such as mountainous regions). Non-spatial factors, such as degree of urbanisation, socio-economic demographic profiles, health needs and socio-cultural factors were also reported by those studies. Table II shows the factors associated with the spatial accessibility scores for studied healthcare services.

Spatial Factors

High spatial accessibility scores for healthcare services often occur at the main city or urban centre, as well as its surrounding areas,[7,13–16,21,26,29,30,33] while lower accessibility scores are often seen in the periphery region, inclined outwards or further from the urban centre.[2,7,14,15,30,33] Remote areas are often associated with lower accessibility scores,[14,15,21,29,32,39] but one study[22] found otherwise. The study found that spatial accessibility to Family Medicine Specialist (FMS) in particular was better in the remote areas due to the fewer potential users (patients) in the area, as remote areas are mostly inhabited by the elderly population, hence fewer health needs specifically for the FMS, while the FMS were fairly distributed.[22] The accessibility score was also often reported to be higher in areas with higher road density and for those populations who live nearby or along the main roads.[15,23,34] In terms of specific geographical characteristics, deltaic[32] and mountainous[39] regions also reported low accessibility scores.

Non-Spatial Factors

The spatial accessibility score to health care services can also be associated with non-spatial factors. Urban areas or areas with a higher degree of urbanisation were mostly reported to be positively associated with higher accessibility scores.[5,13,17,19–21,25,26,27,31,33,35,37,38] In addition to that, denser populated areas are also commonly reported to be positively associated with higher accessibility scores.[18,23,25,27,37]

Some studies found that a high accessibility score is associated with a population with higher socio-economic status (SES) and its related parameters such as education and household income[5,7,14,23,32,36–38,40] although Wang & Roisman (2011)[17] found no correlation between the accessibility score and socio-economic variables. Theoretically, SES (such as income, house ownership, vehicle ownership, education level) could be positively associated with spatial accessibility as it relates to the capability or affordability of the individual to access health care (such as cost of services or travel). Those with disadvantaged SES (e.g. lower income and lack of education) generally had lower spatial accessibility scores.[2,32]

Studies have found that areas with higher healthcare needs, such as a higher percentage of elderly population, are associated with low accessibility scores.[5,14,40] Lower accessibility scores were also associated with socio-culture disadvantages, such as social deprivation[13] or higher proportion of non-natives, ethnic minorities, aborigines or immigrants.[14,23,25,38,40] Table II summarises our findings on commonly reported factors associated with the spatial accessibility score for specific healthcare services.

DISCUSSION

This scoping review has mapped out several factors that are commonly associated with the spatial accessibility of various healthcare services, which could be further divided into spatial or non-spatial-related factors as aforementioned. Of

Table I: Articles included in scoping review (n = 32)

	Author, year	Location	Health care services	Findings/factors associated with spatial accessibility to healthcare services
1.	Bauer et al., 2018[13]	England	Primary care services	• Positively associated: areas surrounding major cities; higher degree of urbanisation • Negatively associated: higher social deprivation • Design: ecological cross-sectional (aggregated at Office for National Statistics boundary classification) • Population/participant: all population • Grant: none stated
2.	Bozorgi et al., 2021[38]	South Carolina, USA	Opioid treatment programs (OTP)	• Positively associated: metropolitan areas; areas with low social vulnerability index (calculated based on socio-economic status, household composition and disability, minority status and language, housing and transportation) • Design: Ecological cross-sectional (aggregated at census block group level) • Population/participant: all population • Grant: Open Access Fund from University Libraries, University of South Carolina
3.	Cao et al., 2019[37]	New Hampshire, USA	Opioid use disorder treatment	• Positively associated: higher population density areas; higher degree of urbanisation; areas with higher SES related variables (higher proportion of full-time employed population, higher median household income and higher proportion of adult population with tertiary education) • Design: ecological cross-sectional (aggregated at county subdivision/town level) • Population/participant: all population • Grant: National Institute on Drug Abuse of the National Institute of Health
4.	Cheng et al., 2012[33]	Beijing, China	Residential care services for elderly aged above 60	• Positively associated: city centre; degree of urbanisation • Negatively associated: outwards to periphery of city centre • Design: ecological cross-sectional (aggregated at census subdistrict level) • Population/participant: population aged 60 and above • Grant: Ministry of Education, China
5.	Delameter, 201328	Michigan, USA	Acute care (hospital)	• Positively associated: higher degree of urbanisation • Design: ecological cross-sectional (aggregated at census tract/zip code level) • Population/participant: all population • Grant: Michigan Department of Community Health
6.	Dewulf et al., 2013[20]	Belgium	General physician (doctors)	• Positively associated: degree of urbanisation • Design: ecological cross-sectional (aggregated at census tract level) • Population/participant: all population • Grant: none stated
7.	Eberth et al., 2014[35]	14 selected states in south region of United States (USA)	Mammography services	• Positively associated: urban areas • Design: ecological cross-sectional (aggregated at census block group level) • Population/participant: women aged 40 and above • Grant: National Cancer Institute and National Institute of Health US
8.	Gao et al., 2016[31]	France	health professional for general practitioner, maternal health services)	• Positively associated: urban area • Design: ecological cross-sectional (aggregated at census block level) • Population/participant: all pregnant women population • Grant: none stated
9.	Hu et al., 2013[15]	Donghai, China	Primary care (clinics)	• Positively associated: city centre; areas along highway • Negatively associated: edge/periphery of city centre; rural areas; remote areas • Design: ecological cross-sectional (aggregated at administrative village level) • Population/participant: all population • Grant: National Science and Technical Basic Research Key Project of China
10.	Izumi et al., 2016[26]	Japan	Hospital bed for Tuberculosis (TB)	• Positively associated: areas surrounding major cities; higher degree of urbanisation • Design: ecological cross-sectional (aggregated at Japan’s medical administrative unit level) • Population/participant: all newly diagnosed TB patients • Grant: Japan Agency for Medical Research
11.	Jamtsho et al., 2015[18]	Bhutan	Primary care services, health personnel (doctors and health assistant)	• Positively associated: higher population density areas • Design: ecological cross-sectional (aggregated at town enumeration block level) • Population/participant: all population • Grant: none stated

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Table I: Articles included in scoping review (n = 32)

	Author, year	Location	Health care services	Findings/factors associated with spatial accessibility to healthcare services
12.	Jin et al., 2019[29]	Shenzhen, China	Public hospitals (3 tiers; community, town-level, municipal)	• Positively associated: main districts (accessibility to municipal hospitals) • Negatively associated: rural • Other findings: Town and community hospitals had better distribution across study area. • Design: ecological cross-sectional (aggregated at population statistics' community scale level) • Population/participant: all population • Grant: National Natural Science Foundation of China
13.	Lin et al, 2016[39]	Kaohsiung City, Taiwan	Out-of-hospital cardiac arrest (OHCA) services	• Negatively associated: rural areas, mountainous areas • Design: ecological cross-sectional (aggregated at Statistics Department's basic statistical area level) • Population/participant: out-of-hospital cardiac arrest patients • Grant: Academia Sinica
14.	Luo & Qi, 2009[7]	Northern Illionis, USA	Primary care services	• Positively associated: city centre • Negatively associated: periphery to city centre; rural areas; areas with lower population income • Design: ecological cross-sectional (aggregated at census latitude-longitude quadrilateral grid) • Population/participant: all population • Grant: none stated
15.	Luo et al., 2018[34]	Wuhan, China	Elderly services (total bed and number of doctors)	• Positively associated: higher road density areas • Design: ecological cross-sectional (aggregated at urban-rural autonomous unit level) • Population/participant: population aged 65 and above • Grant: National Natural Science Foundation of China
16.	Ma et al., 2018[30]	Wuhan, China	Hospitals (3 tiers)	• Positively associated: centre of the main city • Negatively associated: further distance to main city • Design: ecological cross-sectional (aggregated at geometry centres of buildings) • Population/participant: all population • Grant: National Key R&D Program of China
17.	McGrail & Humpreys 2009[8]	Victoria, Australia	Primary care services	• Positively associated: high population density areas • Design: ecological cross-sectional (aggregated at census collection district level) • Population/participant: all rural population • Grant: Monash University
18.	Naylor et al., 2019[22]	USA	Primary care (physicians, family medicine specialist, nurse practitioner)	• Positively associated: urban areas; areas with higher level of poverty, rural and isolated areas (Family Medicine Specialist) • Design: ecological cross-sectional (aggregated at census block level) • Population/participant: all population • Grant: National Center for Complementary & Integrative Health
19.	Ngui & Apparicio 2011[16]	Montreal, Canada	Primary care services (medical clinics)	• Positively associated: centre of the island • Design: ecological cross-sectional (aggregated at census dissemination area level) • Population/participant: all population • Grant: none stated
20.	Pan et al., 2015[27]	Sichuan, China	General inpatient care (number of doctors, staff and bed)	• Positively associated: higher population density areas • Design: ecological cross-sectional (aggregated at 2 km * 2 km grid) • Population/participant: all population • Grant: National Natural Science Foundation of China
21.	Pan et al., 2016[25]	Sichuan, China	General inpatient care	• Positively associated: higher population density areas • Other finding: government health expenditure has no association with spatial accessibility • Design: ecological cross-sectional (aggregated at country level) • Population/participant: all population • Grant: National Natural Science Foundation of China
22.	Ranga et al., 2014[2]	Selected rural area in northern India	Inpatient care	• Negatively associated: further distance to main urban areas • Design: ecological cross-sectional (aggregated at village level) • Population/participant: all rural population • Grant: European Union's FP7 programme

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Table I: Articles included in scoping review (n = 32)

	Author, year	Location	Health care services	Findings/factors associated with spatial accessibility to healthcare services
23.	Shah et al., 2016[14]	14 selected urban areas in Canada	Remote health care services (outpatient)	• Positively associated: city centre • Negatively associated: areas at the edge / periphery of the city centre; rural and remote areas; areas with higher following population characteristics: elderly population, without tertiary education, aborigine population, lower socio-economic statuses, recent immigrants • Design: ecological cross-sectional (aggregated at census metropolitan area level) • Population/participant: all urban population • Grant: University of Saskatchewan
24.	Shah et al., 2017[40]	Saskatchewan, Canada	Physiotherapies & family physician	• Negatively associated: higher proportion of elderly aged >65; low income population; areas with higher proportion of recent immigrant and/or aborigine • Design: ecological cross-sectional (aggregated at Canada's census subdivisions level) • Population/participant: all population • Grant: University of Saskatchewan
25.	Subal et al., 2021[21]	Swabia and city of Augsburg, Germany	General practitioner	• Positively associated: urban areas; surrounding main city • Negatively associated: rural areas • Design: ecological cross-sectional (aggregated at one-hectare grid) • Population/participant: all population • Grant: Projekt DEAL, Germany
26.	Vadrevu & Kanjilal, 2016[32]	India	Maternal health services	• Negatively associated: deltaic region and remote areas, which resides by population with lower socio-economics status (SES) • Other finding: proxy variables for SES include: percentage (%) of female population, % illiterate adults, % non-working age, % minority ethnic, % adult working status, household size, % house ownership, household income • Design: ecological cross-sectional (aggregated at village level) • Population/participant: all population • Grant: UK Department of International Development for 'Future Health System Research Consortium'
27.	Wan et al., 2012[19]	Texas, USA	Primary care services	• Positively associated: higher degree of urbanisation • Design: ecological cross-sectional (aggregated at census tract and census block level) • Population/participant: all population • Grant: Freedom Explore Program of Central South University, Beijing China
28.	Wang & Luo, 2005[5]	Illionis, USA	Primary care services	• Positively associated: urban areas • Design: ecological cross-sectional (aggregated at census tract level) • Population/participant: all population • Grant: US Department of Health and Human Services, Agency for Healthcare Research and Quality
29.	Wang & Pan, 2016[24]	Sichuan, China	General inpatient care (public and private)	• Negatively associated: higher percentage of ethnic minority • Design: Ecological cross-sectional (aggregated at 2 km * 2 km grid) • Population/participant: all population • Grants: National Natural Science Foundation of China, the China Postdoctoral Science Foundation, Sichuan University, Health and Family Planning Commission of Sichuan Province, and China Medical Board
30.	Wang & Roisman, 2011[17]	Toronto, Canada	Primary care clinics (with Chinese doctor)	• Positively associated: higher degree of urbanisation • Negatively associated: suburban areas • Other finding: SES indicators (income, tertiary education, proficiency of language) did not associated with accessibility scores • Design: ecological cross-sectional (aggregated at census tract level) • Population/participant: Mainland Chinese immigrant population • Grants: Social Sciences and Humanities Research Council, Canada

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Table I: Articles included in scoping review (n = 32)

	Author, year	Location	Health care services	Findings/factors associated with spatial accessibility to healthcare services
31.	Wang et al., 2018[23]	Sichuan, China	Primary care services	• Positively associated: flat land region; productive plains and well-developed region (higher gross domestic product, GDP); areas with less minority ethnic; areas with higher population density; areas with higher highway road density; areas with higher proportion of non-agriculture population • Negatively associated: mountainous region; underdeveloped region; areas with low proportion of adults with tertiary education level • Design: ecological cross-sectional (aggregated at 2 km * 2 km grid) • Population/participant: all population • Grants: none stated
32.	Zahnd et al., 2019[36]	Mississippi delta region, USA	Mammography	• Positively associated: areas with higher poverty level • Other findings: no difference in accessibility between delta region and non-deltaic region, across racial composition and urban–rural differences • Design: ecological cross-sectional (aggregated at census tract level) • Population/participant: women aged 45–74 years population • Grants: none stated

Table II: Spatial and non-spatial factors associated with the spatial accessibility scores

	Spatial factors						Non-spatial factors				
Health care services	City centre/ nearby	Further distance to urban/city centre	Remote/ rural areas	Higher road density	Mountainous region	Deltaic region	Higher degree of urbanisation	Higher population density	Higher socio-economic status*	Higher proportion of elder population	Higher proportion of minority / immigrants
Primary care services	+[7,13–16,21]	-[7,14,15]	+[22] -[14,15,21]	+[15,23]	-[23]		+[5,13,17,19–21]	+[8,18,23]	+[7,13,23] -[22]	-[5,14]	-[14,23]
Inpatient care services	+[26,29,30]	-[2,30]	-[29]				+[25,26,28]	+[25,27]			-[24]
Maternal health services			-[32]			-[32]	+[31]		+[32]		
Elderly care	+[33]	-[33]		+[34]			+[33]				
Other specialised services			-[39]		-[39]		+[35,37,38]	+[37]	+[36–38,40]	-[40]	-[38,40]

Notes:
* Refers to all socio-economic related variables such as household income, poverty level, proportion of working population, proportion of population with tertiary education
Plus (+) sign indicates positive association, while negative (-) sign indicates negative association, as reported by the study(ies) in superscript.

the 32 studies included in this review, most of the studies were conducted in high-income and developed nation settings, such as Americas[5,7,14,16,17,19,22,28,35–38,40] and European countries,[13,20,21,31] as well as from China.[15,23–25,27,30,33,34] Most studies have shown similar associations among the studied factors, although only a few contradictory results were found. This review not only includes studies that were conducted primarily to search for the associated factors or affirm their findings through statistical significance. The association between factors could also be indirectly reported based on the spatial pattern observed when mapped (such as surrounding the city center and mountainous areas).

Most studies have reported a positive association or a higher spatial accessibility score of various health care services in the city centre and its surroundings. This is also directly related to the higher degree of urbanisation. This is because the health facilities and services are commonly concentrated in the urban areas and city centres.[4,23,29] This also could be the reason for higher population density positively associated with accessibility score, because urban areas are often classified based on areas with higher population density as compared to rural areas. Rural areas are also often associated with inferior availability of a wide range of infrastructures and build environments,[32] and a lack of these can serve as barriers to accessing health care. For example, road density was also positively associated with spatial accessibility to healthcare services, as demonstrated by a few published studies,[15,23,34] indicating that areas with scarce road networks had lower spatial accessibility scores.

Geographical characteristics certainly play a role in affecting spatial accessibility. Disadvantageous features such as non-flat areas or ground, mountainous and deltaic areas often had negative associations with the spatial accessibility score. This could be attributed to the nature of scarce resources and less productive plains for population economic activities and suitability for development.[23] Remote areas are typically negatively associated with the accessibility score. However, in some instances, the spatial accessibility score in remote areas is even better for certain healthcare services. This is commonly due to the demand–supply imbalance of the population and services. Having a decent distribution of resources, coupled with low demand for that specific health care area, results in a higher accessibility due to a lack of competition and congestion.[22,29]

Non-spatial-related factors refer to population characteristics. This study found that SES-related variables of the population were frequently reported to be associated with spatial accessibility. Populations with certain characteristics, such as low income, lack of education or ethnic minority, frequently had negative associations. Although it might not be the direct cause of having a low spatial accessibility score to the services, the consequences could be detrimental to those vulnerable populations.

Considering the fact that ensuring equitable access according to health needs is the ultimate goal towards universal health coverage, it is fairly important to know how the health needs of the population can be quantified and incorporated into the calculation of the spatial accessibility score.[31] The health needs of the population can be quantified using proxy variables such as age, proportion of the elderly population, children and female population.[5] Later studies followed similar attempts to incorporate the health need into the calculation of the FCA-based method[8,31] with the basis that areas with higher population health needs would have reduced access due to competition as the consequence of higher service utilisation. The SES of the population could also be incorporated into the FCA-based method with the basis that those with SES disadvantageous theoretically have some sort of financial barrier (affordability) to access health care, particularly for those fees-for-services. Such findings could provide the researchers with a basis for further improvement of the FCA-based method by incorporating non-spatial factors.[19]

This study has summarised the factors associated and their relationships, specifically for spatial accessibility to several healthcare services, from the existing literature. The limitation of this study is that most of the studies included in this review originated from high-income countries, and the scenario could differ in middle- and low-income countries (LMIC), as the accessibility could be very context-specific. Nonetheless, a few LMIC studies in this review did show similar findings in high-income countries. Another limitation is that this study only looks at studies that use FCA-based methods to measure spatial accessibility. In fact, the spatial accessibility could also be measured using other methods, such as using the nearest distance to services[3] or population coverage. The FCA-based method is the most accurate method for measuring spatial accessibility (compared to other methods aforementioned) because of its comprehensiveness and closer to real-world setting.[4,20,27,40]

CONCLUSION

The spatial accessibility to healthcare services was best determined using the FCA-based method, and the method has continuously evolved and enriched since it was last introduced, with growing interest among the researchers. This study collates and identifies factors that are specifically associated with the spatial component of accessibility to healthcare services, which can be distinguished from spatial or non-spatial-related factors. Some of these factors can be quantified and incorporated into the current available FCA-based method to provide a better measure of spatial accessibility of health care services.

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