REVIEW ARTICLE

Spatial Analysis in Primary Health Care Utilization: A Systematic Review

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ABSTRACT

Utilization is an important indicator for health service planning and can be determined through the count of actual usage of health services. There are also several determinants to health care utilization. This systematic review aims to explore the technical components from spatial analysis in primary health care utilization, the determinants frequently discussed, and the gap in the spatial analysis from these studies. Two databases were searched according to search strategy. A total of 15 articles were eligible. Each study was different in terms of analysis unit, spatial analysis, and utilization outcome. Spatial accessibility, sociodemographic, and geographical aspect were the frequent determinants discussed among the study of spatial utilization in this review. Several studies found the association between the determinants with utilization. However, spatial analysis in primary health care utilization studies still subjected to several limitation in term of their unit of analysis and source of data.

Keywords: Utilization; Primary Health Care; Primary Care; Spatial Analysis

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INTRODUCTION

Utilization is an important indicator for health service allocation and planning (1). Health care services will only remain as potential accessible health services until the intended population who are in need utilize them (1,2). Hence, gaining access means that the population started to utilize the services (1).

Primary health care utilization is an activity-based oriented and consumer driven which derived from many domains (3). Study of utilization is important in order to know the trends and characteristics concerning the health care usage (4). Current evidence has shown, especially in the developing countries that a lot of population are in need for accessible primary health care but many failed in getting them for a lot of reasons (5,6). Thus, information on health care utilization is paramount in order to properly plan health services in certain area.

World Health Organization also has stressed its objective, programs and implementation that very much tuned up towards utilization (7). However, this attempt would not be in success without adequate structure along with other reasons such allocation of resource,

quality of the services, inefficiency of health programs, growth in the number of population, and increase of demand towards health care (3).

Utilization can be determined through the frequency of health services' usage (4). It can be done through several methods eithers household survey, health care records data examination, or spatial aggregation (4). There are also several determinants to health care utilization. Several authors describe these determinants differently. Penchasky and Thomas (8) theorized that utilization has been determined by service affordability, accommodation and acceptability of the services, while other authors added that utilization also been determined by population characteristic, incomes, and organizational barriers (9).

Spatial analysis can be defined as "a type of geographical analysis, which seeks to explain the patterns of human behavior and its spatial expression in terms of mathematics and geometry called locational analysis" (10). With the advancement of geographical information system, utilization now can be quantified more objectively (11,12). However, the current evidences still show the lack of understanding on the aspect of spatial analysis from primary health care utilization's studies (5,13), and there is a need to understand the gaps left between these years.

Thus, this systematic review aims to explore technical components of spatial analysis specially in primary

health care utilization's studies, the determinants frequently discussed, and the gap in the analysis from those studies.

MATERIALS AND METHODS

This systematic review was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) statement (14). The search was conducted in September 2018 for articles regarding spatial utilization of primary care.

Eligibility

Studies were eligible if they met the following criteria: (i) quantitative study which include spatial analysis or geographical information system on assessment of primary health care utilization, (ii) Studies which were conducted from 1st January 2003 until 30th September 2018. Year 2003 was chosen as the starting date for article search as spatial analysis started to be used extensively in measuring accessibility and utilization from that year. (iii) Available in full text format and the reported articles were written in English.

Type of Primary Health Care

Primary health care in this systematic review would be based on the definition of primary health care as per the Alma Ata declaration (15) as well as the definition given by World Health Organization (16). As there is a variation for type of primary health care throughout the world, this search included primary health care as a stand-alone outpatient clinic regardless of the targeted population, antenatal, maternal, and child care. However, any hospital-based services would be excluded including outpatient department of the hospital. This systematic review also emphasized on primary health care as a first level of essential health care to the community. Thus, any studies which discussed on specialized services such as psychiatric and pediatric were excluded.

Database Source and Search Strategy

Pubmed and ScienceDirect database were searched. The search strategy involved keywords such as Spatial or GIS or Geographical, Utilization or Usage or Utilisation, Primary care or Primary health care, Outpatient or Clinic or Antenatal care or Maternal Child care or Infant care or perinatal care. Terms were also developed using MeSH term (Medical Subject Headings used by the National Library of Medicine to index articles). Boolean, truncation, and proximity operators were also used in order to combine the searches of the key concepts for each individual database.

Study Selection

All articles found through the search were exported to bibliographic database for duplication removal and further screening purposes. All titles and abstracts were examined according to eligibility criteria. Systematic review article which found from the search were explored for any eligible articles. If study protocol was found, a search need to be made to find whether the result is available or vice versa. Result of the screening were later proceeded to full-text screening for the final inclusion of systematic review. Any dispute in the selection of full text was discussed between the authors to come with a final agreement.

Data Extraction and Analysis

Content analysis were done to the final eligible articles. Data from the article were extracted to Microsoft Excel database, which was developed specially for this review. Afterwards, the database would be independently checked by other authors to ensure validity and accuracy. Any disagreements were discussed to come out with a consensus.

Content analysis was done to answer these specific questions: (i) What are the methods used in spatial analysis of primary health care utilization? (ii) What are the determinants included in the studies? (iii) What are that technical aspects taken into consideration in conducting the spatial analysis of primary health care utilization? To answer these review questions, following data were extracted: i) Study information including, authors' name, year of publication, ii) Study design, iii) Source of data, iv) Population involved, v) Unit of analysis, vi) Type of primary health care, vii) Utilization outcomes, and viii) Research finding.

Meta-analysis was not conducted due to huge differences in study design, outcomes, and finding. Instead, a narrative synthesis was done, where the results were summarized according to the type of determinants used and the utilization outcomes measures from the articles.

Quality Assessment of the Article

Quality of the methodology and the reporting of the study were assessed by first author. Findings were discussed with the rest of the team. The quality and risk of bias assessment were conducted by using STROBE criteria (17). Only articles conformed to more than 50% of all the criteria would be included in full article content analysis.

RESULTS

Figure 1 shows the result of the articles determined through database search. Through the full text screening, 10 articles were excluded. Three of the articles have been rejected due to irrelevancy. Another three have been rejected because these articles featured disease specific health utilization. Two articles have been rejected as no spatial analysis included in the studies. One article has been rejected as it was a research protocol, and one for having hospital-based outpatient clinic. All 15 eligible articles were proceeded for content analysis.

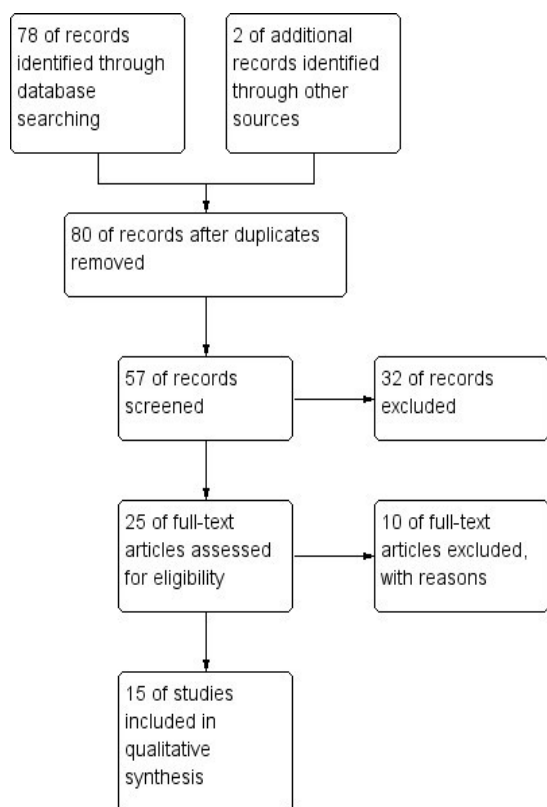Table I listed all eligible articles for content analysis. Nine

78 of records identified through database searching

2 of additional records identified through other sources

80 of records after duplicates removed

57 of records screened

32 of records excluded

25 of full-text articles assessed for eligibility

10 of full-text articles excluded, with reasons

15 of studies included in qualitative synthesis

Figure 1: Flowchart of literature search

articles involved studies in developing countries while six articles involved studies in developed countries. All the studies in the review focused on observation or cross sectional in their design method while one study was classified as a mix method study. Six of the studies involved outpatient clinic, four of them involved maternal care, and five of them involved both outpatient and maternal care.

All fifteen studies in systematic review were conformed at least to 50% criteria of STROBE statement. Majority of the studies in this review did not informed on how the missing data were addressed (n=11; 73%) nor indicated the missing data in the descriptive data (n=12; 80%). Majority of the studies also did not describe any method of sensitivity analyses (n=11; 73%). A small number of the studies did not used flow diagram in descriptive statistic (n=6; 26%), gave reason for non-participatory (n=4; 26%), or describe effort to address bias within their studies (n=3; 20%).

All the studies in the review had different source of data. Two of the studies involved data extracted from other study done earlier. Two studies had an original primary data from face-to-face interview. Four of the studies derived their data from national data or census, while seven of them derived their data from nationwide survey.

Unit of Analysis
Unit of analysis choice in spatial is paramount due to the notion of the modified areal unit problem (MAUP).

It is a statistical bias which occurred due to differences in result based on the choice of analysis unit and area of data aggregation (6,11,18). In this review, studies used either individual (19–24), household (25,26), health service area (27), statistic or census tract area (28), village (4,29) and regional (20,23). Studies which took large area of aggregation as a unit of analysis have higher risk to type-II error (30). Even tough when researchers tried to move away from arbitrarily administrative boundary (5), certain circumstances still require the studies to analyze the outcome in a large aggregation area. This is common especially when decision making for health service planning with policy maker (19,27,31) or illustration of area with inequality of service (20,22,23) involved. Analysis using individual as the unit also involved a large volume of data (22,32,33) and problem in geocoding of each individual location. Certain studies attempted to overcome the problem concerning the unit of analysis by doing multilevel analysis (24). Despite this, researchers still were careful in interpreting result from one level of analysis to another (5).

Utilization Outcome
Through the review, most of the studies use number of visits as a proxy towards utilization of primary healthcare. The indicators however may be differed depending on the context of the studies. Studies which involved outpatient clinic as their subject of interest took the number of clinics visit as the proxy for utilization while studies which involved maternal care took the number for antenatal care visit as their proxy for utilization. The indicator for the number of clinics visit also differed either the sum of clinic visit (32), number of visits within 12 months (19,28,31,33), number of visit rate (32), average number of consultations per patient (27) or either participants has any visit to any outpatient clinic within the last 2 weeks (20). As for studies which involve maternal care, utilization is determined through number of antenatal care visit (21,29), or as either the participant have antenatal care more than 4 times (22,32). Different type of outcome depends on the data available from their source of data. Nevertheless, despite the heterogeneity in the measurement, researchers still compare their outcome with other studies from different location.

Spatial Analysis in the Studies
Spatial analysis is a form of analysis using geographical information system (6,11). In this review, spatial analysis has been used to illustrate the spatial distribution of the outcome where the thematic map classified the outcome according to certain boundaries (20,22,34). Spatial analysis also been used for cluster analysis of utilization in order to determine whether there was any clustering effect within the villages (29). Using cluster analysis, Owoo (29) postulated that village which has high utilization been surrounded by other villages that also have high utilization. Spatial analysis also has been used to do interpolation from known utilization value

Table 1 List of Reviewed Articles

	Author, Year	Title	Study Design	Population, Location	Type of Primary Healthcare
1	(Bazemore, Phillips, & Miyoshi, 2010)	Harnessing Geographic Information Systems (GIS) to Enable Community-Oriented Primary Care	Sequential explanatory mixed method study	Patients who attend community health center in Maryland, California, United state	Outpatient clinic
2	(Baker & Liu, 2006)	The Determinants of Primary Health Care Utilization: A Comparison of Three Rural Clinics in Southern Honduras	Observational study	Population attending primary healthcare in southern Honduras	Outpatient and Maternal Care
3	(Busato, Matter, & Künzi, 2009)	Factors Related to Treatment Intensity in Swiss Primary Care	Observational study	Population attended primary Care in Swiss	Outpatient, and Maternal Care
4	(Feikin et al., 2009)	The Impact of Distance of Residence from a Peripheral Health Facility on Pediatric Health Utilisation in Rural Western Kenya	Observational study	Children attending outpatient department in Kenya	Outpatient clinic
5	(Hiscock, Pearce, Blakely, & Witten, 2008)	Is Neighborhood Access to Health Care Provision Associated with Individual-Level Utilization and Satisfaction?	Observational study	New Zealand	Outpatient clinic
6	(MacRae, Kingham, & Griffin, 2015)	The Effect of Spatial Barriers on Realised Accessibility to Health Services after a Natural Disaster	Observational study	General population in New Zealand	Outpatient clinic
7	(Masters et al., 2013)	Travel Time to Maternity Care and Its Effect on Utilization in Rural Ghana: A Multilevel Analysis	Observational study	Ghana	Maternal care
8	(Owoo & Lambon-Quayefio, 2013)	National Health Insurance, Social Influence and Antenatal Care Use in Ghana	Observational study	Women who has child delivery within 5 years in Ghana	Outpatient clinic
9	(Pulok, Uddin, Enemark, & Hossin, 2018)	Socioeconomic Inequality in Maternal Healthcare: An Analysis of Regional Variation in Bangladesh	Observational study	Productive age women who give birth at least once in Bangladesh	Maternal care
10	(Ruktanonchai et al., 2016)	Equality in Maternal and Newborn Health: Modelling Geographic Disparities in Utilisation of Care in Five East African Countries	Observational study	Pregnant mother in Burundi, Kenya, Rwanda, Tanzania, Uganda	Maternal care
11	(Stentzel et al., 2018)	Is There An Association between Spatial Accessibility of Outpatient Care and Utilization? Analysis of Gynecological and General Care	Observational study	Rural Germany	Outpatient clinic
12	(Tanser, Gijsbertsen, & Herbst, 2006)	Modelling and Understanding Primary Health Care Accessibility and Utilization in Rural South Africa: An Exploration Using A Geographical Information System	Observational study	Population in Hlabisa, South Africa	Outpatient and Maternal Care
13	(Turrell, Oldenburg, Harris, & Jolley, 2004)	Utilisation of General Practitioner Services by Socio-Economic Disadvantage and Geographic Remoteness	Observational study	Population attending general practitioner in Australia	Outpatient and Maternal Care
14	(Vahedi, Rezapour, Mohammadbeigi, & Khosravi, 2018)	Economic Inequality in Outpatient Healthcare Utilization the Case of Iran	Observational study	Population in Iran	Outpatient and Maternal Care
15	(Yeneneh, Alemu, Dadi, & Alamirrew, 2018)	Spatial Distribution of Antenatal Care Utilization and Associated Factors in Ethiopia: Evidence from Ethiopian Demographic Health Surveys	Observational study	Women in reproductive age (15-49 years old) in Ethiopia	Maternal care

of certain area to other area with unknown utilization value (21). Interpolation would give a thematic map with gradient hue according to the utilization value classification (21).

Geographical information system (GIS) has been used to geocode the location of participants (25,29), physicians (19,33), and health services (27). Geocoding of the address has been used to convert the address of the interest subjects from their data sources into coordinates in GIS software (19,25,27,33). Coordinates of the services have been collected on field by using Global Positioning System unit (35). The coordinates that had been determined will be converted and displayed on GIS software.

Another notable usage of spatial analysis was on distance cost calculation. In this review, distance cost has been calculated either through imperial unit in kilometres (22,25,28) or through distances time (19,24,32,33,35) in minutes. Distance time was made possible by using GIS software through network analysis, where the duration of time taken for population to reach the facilities could be determined along the route assigned with specific speed limit (19,33,35) and applied with certain algorithm such as cost grow algorithm (35), least cost path algorithm (32), cost distance model (24), and Dijksa's algorithm (33).

Utilization Determinants
Other than spatial analysis, this review also explored the determinants that correlate with primary health care utilization. Across all the studies, researchers had different way in addressing utilization determinants; each with their own measurement and classification. For the purpose of this review, utilization determinants would be divided into spatial accessibility, socio-demography, and urbanization.

Spatial Accessibility

Researchers determined spatial accessibility either through distance cost, distances time, and accessibility of an area. Across studies, utilization had been inversely related with utilization, different result might be due to different methodological approach and different unit of analysis.

An observational study among general population in five East African countries postulated that the increase in spatial inaccessibility has 25% reduced of odds [0.74 (0.61, 0.89)] in primary health care utilization (22).

Distance-cost between interest population to primary health care was a spatial accessibility that usually been determined between the researchers (19,24,25,32). A study among household in Kenya showed that the rate of visit would reduce in every increase of 0.5km in distance until 4km where it became plateau (25).

Distance-cost was also depicted in a matter of duration of time taken for the population to reach primary health care (24,32,33). Among general population in New Zealand, individual who live in area more than 5.9 minutes had lowest odds to primary health care visit [OR 0.74 (0.63,0.87)] and lower odds [OR 0.76 (0.66,0.88)] of blood pressure usage (19). Observational study in New Zealand also postulated that those with more than 60 minutes in travel times has significantly decrease in utilization (32). In Ghana, travel times was a significant predictor towards primary health care utilization with extra one hour in travel times would reduce odds of utilization by 12% (24). While among general population in South Africa, household which 30 minutes away from the clinic were 10 times more likely to utilize primary health care than those with the distance of 90 minutes from the clinic (26).

Socio-Demography

A study among women who has child in Ghana showed there was a positive autocorrelation of primary health care utilization; village with high utilization was surrounded with other village with high utilization, and this situation was possibly due to the factor of social influences such as leader role, inter-village communication, and similar socioeconomic background (29). In this review, four socio-demographic variables have been found as to have correlation with utilization, and they were age, income, education and urbanization.

Age

Age was frequently discussed among studies of spatial utilization (21,24,25,27,32). Observational studies in Swiss to see the treatment intensity of primary care showed an association between age of patient with number of consultation in primary care (27). Observational studies in New Zealand after natural disaster also postulated that high rate of utilization are among older age population with age of 65 years and above (32). In Ghana, older

maternal age had higher odds to antenatal care visit 7.895 (2.22,28.05) than other group of ages (24). An observational study among reproductive age woman in Ethiopia however showed that those older age [AOR 0.59 (0.41,0.85)] has lower odds in utilization (21). As maternal age advanced, they are also more prone towards comorbidity and complication, which thus making them as having higher needs to primary health care (24). However in Ethiopia, younger mothers have higher odds to antenatal care visit as they have less experience and less knowledge concerning pregnancy (21). Study among general population showed that older population was a vulnerable population after natural disaster (32) and has higher need towards primary health care services (27).

Income and Wealth

Income level and wealth were also discussed throughout spatial utilization study in this review (20–24,29,33). In Bangladesh, an observational study among reproductive age woman postulated that higher income has higher level of utilization and higher odds [OR 1.2 (1.15,1.26)] having visit to primary health care (23). The same finding from observational study in five East African countries which showed that increasing wealth has higher odds [OR 2.82 (2.35,3.39)] in utilization (22). Observational study in Ethiopia which conducted among reproductive age women also found that higher income individual has higher odds [OR 5.79 (95%CI: 4.52,7.4)] in utilization. However, observational study in Germany postulated that as the social index (income, occupation, education) increase, the utilization will reduce by 0.9 (33). In Australia, highly accessible area has negative association between socioeconomic status with primary health care utilization, while however in low accessible area, socioeconomic status has positive association with utilization (26).

In developed country such as Germany, higher social class population with higher income and education would utilize preventive and screening facilities more than general practitioner for treatment (33). In developing countries such as Bangladesh, private facilities would be available more only in the area with higher number of higher income population, which thus improve the utilization only for this population. (23). The access of similar facilities was also suggested as to be provided in the remote area of Australia and any area that has more marginalized population such as indigenous community. This is important rather than solely focuses on the development of facilities in highly accessible area (28). Thus, it explained the dependency between this marginalized population with primary health care.

Education

Other than age and income, education level also frequently reported in spatial utilization studies (22–25,29). Higher education individual in Ethiopia has higher odds [OR 7.44 (95% CI: 6.98, 9.01)] in

utilization (21). Partner education from observational study in Ghana also showed that higher education up to secondary school has the higher odds [OR 7.895 (95% CI: 2.22,28.05)] to utilization (24). In Kenya, among the household that has children who visited outpatient clinic postulated that as the education level increase, the visit will also increase (25). It was suggested that education does influence the population health-seeking priorities (25). Education also would influence population to give more concern on their health and more likely to participate in activities and utilize services which could improve their health (21).

Urbanization

Urbanization also frequently discussed across the studies. It is either reported whether the area is urban, rural or peri-urban (19–21,23,26). A study also reported about clustering effect of utilization on how location of the population effected utilization (29). In observational study from New Zealand, individual who live in rural area has lower odds [OR 0.79 (95%CI: 0.67,0.92)] to primary health care utilization (19). Three studies from Bangladesh, Iran and Ethiopia showed that those who living in urban area has higher utilization than those who live in rural area (21,23,26). While an observational study among household in Hlabisa South Africa postulated that those in peri-urban area has higher odds to utilize primary health care (26). It was suggested that utilization might be poor in rural area as longer travel times is required in the respective area (19). In developing countries, urban population has higher income, which formed their higher financial ability to utilize primary health care (21,23).

DISCUSSION

This review gave an insight into technical aspects that were taken into consideration in the spatial analysis of primary health care utilization. Choice of utilization determinants and unit of analysis have characterized each study and differentiate one study from another. As previous review pointed out that there might be correlation between one outcome with another, it is however dangerous to make a general conclusion especially when it involves different population and context (5).

Across studies on spatial analysis of primary health care utilization, different unit of analysis was chosen. Researchers currently moving away from arbitrarily border to continuous measurement and using multilevel analysis (5). However, limitation still occurs due to availability of secondary administrative data for the study. Previous review also stated that a lot of utilization studies had to depend mostly on the existing registries, administrative data, population study or panel data (5). Due to confidentiality, this data needs to undergo spatial aggregation, which leading to problem generalization and transfer the finding to other population.

Using secondary data from administrative and other population study for spatial analysis of primary health care utilization also lead to another problem, where the lack of information and the lack of geographical location are inevitable in the previous or the latter studies (36). Conducting another study solely for this purpose is ideal but it would involve extra cost. Thus, the challenge is to incorporate several sets of data to provide suitable explanation in term of primary health care utilization (36).

This review also has identified that there was a gap in spatial analysis of primary health care utilization in term of temporal analysis. Temporal analysis in spatial study arises when data is collected and interpreted across time (5). Other study has found specific pattern of health service utilization over period of times as possibly been influenced by the availability of services, and improvement of transportation (37). As common with other previous review, this review also has identified that there were also gaps in determining the correlation between utilization with the health outcome and service performance (13). Other studies had correlated accessibility with neonatal mortality (38), oral cancer mortality (39), or effectiveness of ambulances' response (40). Our review has found correlation between utilization towards treatment intensity (27) and this association still subjected to a various confounding factors that need to be understood by the researchers (5,27).

CONCLUSION

The usage of spatial analysis in utilization of primary health care has increase over the time with the application of geographical information systems. The findings from these studies also had shown significant correlation between spatial accessibility, sociodemographic variable, and geographical location with the utilization of primary health care. However, spatial utilization of primary health care still subjected to several limitation concerning the unit of analysis choice and the source of data. Way forward for spatial utilization study is to incorporate temporal analysis and correlation with health outcome indicator.

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