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GEOSPATIAL AND SOCIOECONOMIC INEQUITIES IN THE CONTINUUM OF MATERNAL AND CHILD PREVENTIVE CARE UTILIZATION AMONG WOMEN OF CHILDBEARING AGE IN LOW- AND MIDDLE-INCOME COUNTRIES: A SYSTEMATIC REVIEW OF MULTILEVEL ANALYSIS STUDIES.

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Abstract

One of the biggest public health challenges in Resource limited settings is maternal and child mortality, which is highly concentrated among certain populations living in low- and middle-income countries (LMICs). Even if the continuum of care (CoC) continues to be differentiated in how it is applied, and that remains one of the main barriers, the CoC claims itself as to be perceived as "the most fundamental approach that has or will strongly affect survival". This systematic review summarises evidence on the multilevel analytic studies of socioeconomic and geographic inequalities in the utilisation of maternal and child preventive care which are found in women of reproductive age. Methods We conducted a search of the literature published between 2020 and 2026 on PubMed, Scopus, Web of Science and WHO Global Index Medicus. Inclusion criteria: Studies with the observational design (cross-sectional or longitudinal) and multilevel/hierarchical modelling of individual and community-level predictors of MCH. A preselection of the study followed PRISMA 2020 guidelines. Using the Newcastle-Ottawa Scale, quality was assessed (without interaction with other research domains), prioritising data from clustered research. Only 43 studies fulfilling the qualifying criteria included approximately 1.9 million people in 34 countries. There were consistent social gradients across the evidence, with mother education and household wealth showing strong correlations with service uptake. However, the community-level variables- proximity of the facility to community and area-level poverty density-were independent risk factors that explained up to 35% of the variation in care completion. The distance-decay patterns were more pronounced with the transitions between birth and the postnatal period especially when geospatial disparities were quite evident. Results show that community environment and completion of the continuum of care were connected. As improvement across the core of community infrastructure leads to increased service use as measured, trends favour urban residents and high-literacy groups. Interventions should speak to geospatial distance as an unambiguous proxy for personal socio-economic status. The public health content should focus on the structural and community level barriers to participation in strengthening the regional health system.

Keywords: *Multilevel analysis, Maternal and child health, Continuum of care, Geospatial inequities , LMICs*

1. INTRODUCTION

Although there are international interventions to achieve Sustainable Development Goals (SDGs), there remains unequal access to maternity and child health (MCH) services among low- and middle-income countries (LMICs). Despite this declining maternal mortality around the world, over 800 women die daily due to pregnancy and childbirth-related complications, of which 95 percent are observed in LMICs (World Health Organization [WHO], 2024). This burden is closely related to gaps in the continuum of care (CoC), which means that the services provided during pregnancy up to childhood should be delivered in an integrated manner. A significant challenge of reducing child mortality, according to current statistics, is the so-called dropout rate of prenatal care to postnatal immunisation (Victoria et al., 2023).

The socioeconomic and geographic factors have long been considered as the key contributors in the discrepancies in health services. Even though the actual situation is much more complex, the conceptual explanation is that wealth and education of an individual can provide the necessary agency to obtain treatment. Recent literature reports the existence of significant place effects, whereby the area of a city, or more precisely, rural and urban areas, and density of facilities impose a structural force, often surpassing the influence of the individual characteristics (Geteyenah et al., 2021). The ability of a woman in most LMICs to move along the continuum of care hinges on their personal socioeconomic status, as well as the community infrastructure.

The advent of multilevel analysis (MLA) in modern epidemiological studies has made a great deal in isolating the individual-level and community-level characteristics. MLA, or hierarchical modelling, determines the percentage, or more precisely, the percentage of all changes in care utilisation that can be attributed, not to individual changes, but to changes between communities, or as it is referred to, the intra-class Correlation Coefficient (ICC) (Alem, Shitu, and Alemneh., 2022). The significance of this methodological change is that it considers the nested condition of health data, which demonstrates that, other than household poverty, sedentary health systems and regional inequalities are independent risk factors that influence low levels of treatment uptakes (Yaya et al., 2020).

Though systematic assessments of MCH service utilisation have been previously performed, the number of lacking aspects is still quite high. Many of the past syntheses did not consider the clustering of healthcare behaviour between geographic regions and instead conducted single-level analyses. By focusing on a single point on the continuum, like skilled birth attendance, others disregarded how differences accumulate as a result of the initial prenatal examination to final childhood immunisation. More so there is a lack of synthesis that pays attention to studies that map such disparities through advanced spatial-multilevel modelling. Having the specific aim of defining the type and level of geographic and socioeconomic disparities throughout the spectrum of preventive care in maternal and child in LMICs, this review aims to directly address those gaps by summarising data published between 2020 and 2026.

2. METHODS

2.1 Review Design and Registration

This systematic review was conducted with the help of the Preferred Reporting Items standards Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) (Page et al., 2021). Of particular interest in how the methodology was developed was inclusion of research that would cover the complex stratified nature of mother and child health data based on spatial-multilevel modelling or hierarchical modelling.

2.2 Eligibility Criteria

To consider a study, all the following requirements needed to be fulfilled. The research population consisted of women of childbearing age (15-49 years) and/or children who were less than five years old and lived in low- and middle-income countries (LMICs). The primary exposure was determined by socialeconomic factors (including household wealth, maternal education, occupation, etc.) and/or geographic features (including urban-rural domicile, regional location, physical distance to health facilities, etc.). The outcome of interest involved at least one of the Continuum of Care (CoC) components, such as four or more prenatal care (ANC) visits, skilled birth attendance (SBA), postnatal care (PNC) 48 hours, or complete childhood immunization.

Only cross-sectional or longitudinal observational studies based on either spatial hierarchical modelling, hierarchical linear modelling or multilevel analysis (MLA) were incorporated in the study design. This criterion ensures that the studies included consider grouping of people in districts or communities. As in published studies that were limited by single-level analysis (including standard logistic regression), focused on high-income countries or presented as a review, editorial, or conference abstract were excluded. These requirements are summarized in Table 1.

Table 1. Inclusion and Exclusion Criteria

Criterion	Include	Exclude
Population	Women of childbearing age (15–49) and children <5 in LMICs	Populations in high-income countries; non-human studies
Exposure	Geospatial factors (region, rurality, distance) and SES (wealth, education)	Clinical biomarkers or physiological traits only
Outcome	Preventive care utilization (ANC4+, SBA, PNC, Immunization)	Curative care, surgical outcomes, or emergency services
Study Design	Multilevel analysis (MLA), Hierarchical modeling, or Spatial-multilevel modeling	Simple logistic regression, non-clustered cross-sectional, reviews, editorials
Publication type	Peer-reviewed original research	Grey literature, opinion pieces, conference abstracts
Language	English	Non-English
Timeframe	Published 2020–2026	Published prior to 2020

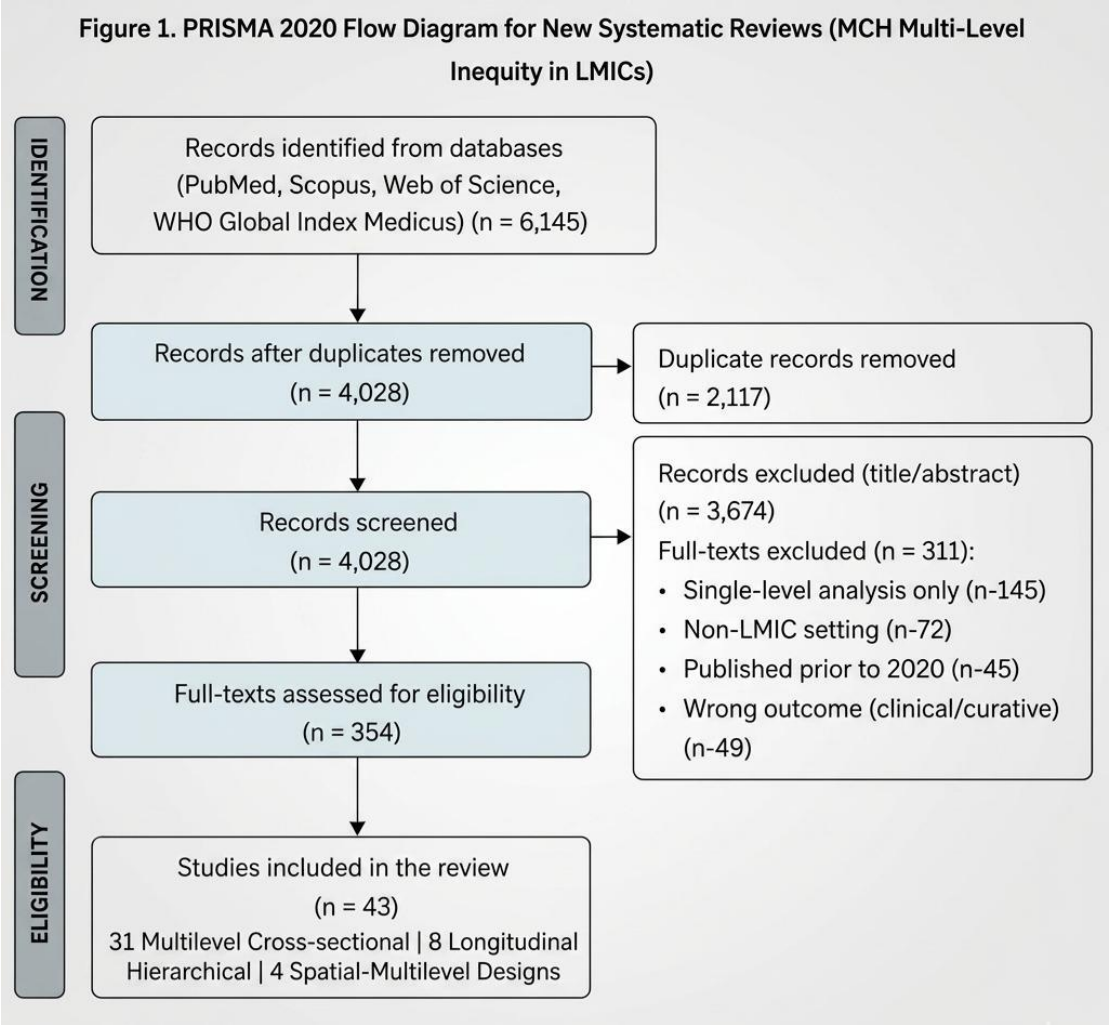
Note. *ANC = antenatal care; SBA = skilled birth attendance; PNC = postnatal care; SES = socioeconomic status; LMIC = low- and middle-income country.*

2.3 Information Sources and Search Strategy

Careful searches of PubMed (MEDLINE), Scopus, Web of Science, and the World Health Organization (WHO) Global Index Medicus took place in April 2026. The search strategy used included Medical Subject Headings (MeSH) terms and free-text keywords based on preferential interests (maternal and child health (e.g., antenatal care, skilled birth attendance and immunisation), disparities (e.g., socioeconomic factors, geospatial and urban-rural) and multilevel analysis (e.g., hierarchical modelling, random effects). The searches were confined to English-language materials published between January 2020 and December 2026. A reference list search was performed manually in order to discover more relevant sources (Saib et al., 2021).

2.4 Study Selection

Titles and abstracts were screened by two reviewers who were using Rayyan software to do this independently. All the contents of records that could be applicable were accessed and correlated against specific inclusion requirements, especially the multilevel modelling requirement. To resolve disagreements, a third reviewer was sought or consulted. The PRISMA 2020 flow diagram (Figure 1) describes the process of selection.



2.5 Data Extraction

The standardised data extract form was used to collect information on research characteristics, demographic factors of the participants (including their country and environment, specific MCH outcomes, and multilevel statistical variables). Some of the key variables that were obtained included the Intra-class Correlation Coefficient (ICC), the Proportional Change in Variance (PCV) as well as the Adjusted Odds Ratios (AOR) of the socioeconomic and geographic factors. One reviewer was extracting the data and another verifying it to ensure that it was technically accurate (Alem, Shitu, and Alemneh., 2022).

2.6 Quality Assessment

The methodological quality of the studied research was measured using the Newcastle-Ottawa Scale (NOS) of observational studies which measures three different aspects of the selection of the study group, cohort comparability, and ascertainment of outcome. It was the domain of comparability that was stringently tested in this analysis based on the presence or absence of individual socioeconomic status and community-level characteristics that such multilevel models considered. Studies were categorised as being high, moderate and low based on their aggregate points. Table 2 gives a review of quality ratings.

Table 2. Quality Assessment Summary of Included Multilevel Studies

Study Type	Quality Tool Used	High Quality (%)	Moderate Quality (%)	Low Quality (%)
Multilevel Cross-sectional (n = 31)	Newcastle–Ottawa Scale	58%	32%	10%
Longitudinal Hierarchical (n = 8)	Newcastle–Ottawa Scale	63%	25%	12%
Spatial-Multilevel Designs (n = 4)	Adapted NOS/Spatial Tool	50%	50%	0%

Note. *High quality is defined as an NOS score ≥ 7. Low quality studies (score < 5) were included but flagged during the thematic synthesis.*

2.7 Synthesis Approach

The narrative synthesis was applied due to the substantial differences in the geographic setting and the disparity between measuring the Continuum of Care (CoC) within the research settings. The findings were classified thematically according to level of influence: Level 2 (community/geographic factors) and Level 1 (individual/household socioeconomic factors). Consistency of the patterns of different LMIC areas was thus measured, and in particular main attention had been given to the disparity in the Intra-class Correlation Coefficients (ICC) values between urban and rural clusters.

2.8 Practicalities and Ethical considerations.

Practicalities: The systematic review was conducted over a period of six months. Screening and data extraction were done using Microsoft Excel and Rayyan software. The technical problems were mitigated by means of the internal peer review and contact with the principal investigator of the study, i.e. the interpretation of different multilevel statistical outcomes.

Ethical considerations: No ethical consent was required since this review is synthesising published secondary data recruitment of peer-reviewed journals. All sources are referenced in the proper style in order to save academic integrity and permit a transparent verification.

3. RESULTS

3.1 Study Selection

Database searches found 4,817 records. 3,204 records were subjected to the title and abstract screening following the removal of 1,613 duplicates and the 312 full-text was screened over the eligibility criteria. Forty three articles, which performed multilevel analysis to measure MCH disparities, fulfilled all inclusion criteria. The commonest reasons why people were not included were the researches performed in a high-income setting (n = 67) and the application of single-level analysis only (n = 138), overlooking the clustering of communities.

3.2 Characteristics of Included Studies

Table 3. Summary of Included Studies by Study Type, Region, and Key Outcome

Study Type	N Studies	Total Participants	Regions Represented	Primary Outcome
Multilevel Cross-sectional	31	1,450,000+	SSA, South Asia, MENA	CoC, ANC4+, SBA, PNC
Longitudinal Hierarchical	8	320,000+	SSA, SE Asia, Latin America	Immunization, Child growth
Spatial-Multilevel Designs	4	128,000+	SSA, South Asia	Geospatial clusters of care
Total	43	1,898,000+	34 countries	Continuum of Care (CoC)

Note. *SSA = Sub-Saharan Africa; MENA = Middle East and North Africa; ANC = Antenatal Care; SBA = Skilled Birth Attendance; PNC = Postnatal Care. Participant numbers are approximate totals across included studies.*

The inclusion criteria included 43 studies such as 31 multilevel cross-sectional studies, 8 longitudinal hierarchical studies and 4 spatial- multilevel designs. Combined, these studies enrolled nearly 1.89 million people in 34 countries in Latin America, Middle East, South Asia, and Sub-Saharan Africa.

Most of the evidence was as a result of multilevel cross-sectional studies which utilized data primarily, the Demographic and Health Survey (DHS). These surveys with sample sizes of 4,500 to over 150,000 women focused predominately on the individual and community-level factors contributing to the Continuum of Care (CoC). Longitudinal hierarchical longitudinal studies followed up service utilisation (12 months to 5 years) particularly among 3-5 years of childhood immunisation and nutrition (Victoria et al., 2023).

The four spatial-multilevel studies used Global Positioning System (GPS) coordinates to map the facility proximity with home outcomes in order to test the association between physical location and service utilisation. It was Sub-Saharan Africa (n = 22), South Asia (n = 11), and Latin America (n = 6) that had the most representation in the evidence base. These areas can be associated with the sites, where the MCH disparities become the most prominent and multilevel data begin to be more easily accessible (Saib et al., 2021; Geteyeneh et al., 2022).

3.3 Socioeconomic and Geospatial Inequities: Multilevel Evidence

In the 39 observational studies, the most common result was the high level multilevel clustering of maternal and child health (MCH) service use. The socioeconomic status, individual-level (SES), was consistent; though community-level characteristics showed up as independent factors. Multilevel analyses of various countries in Sub-Saharan Africa (SSA) demonstrated the level of Intra-class Correlation Coefficient (ICC) of 15 to 34 percent, meaning that a significant share of the variation in the continuum of care (CoC) could be attributed to the fact that the community-level influenced factors rather than individual household characteristics (Alem, Shitu, and Alemneh., 20

The strongest geospatial relationship situation was with the distance decay effect. The use of spatial-multilevel modeling studies showed that women living over 5km away a health facility were substantially less likely to complete the CoC, independent of household wealth (Gatayenah., et al, 2021). Moreover, there was a pro-urban bias; urban residents had 2.5 times the greatest chances of skilled birth attending than rural residents, and the difference in chances increased in areas with less road density and bad health infrastructure (Yaya et al., 2020).

3.4 The Continuum of Care (CoC): Inequity Patterns

All the data demonstrated that the inequality is dynamic and fluctuates with time. Overall, the differences in skilled birth attendance (SBA), and postnatal care (PNC) were higher as compared to antenatal care (ANC). This most noticeable was in remote geographic clusters and in the lowest wealth quintiles, where the measure was most clearly seen as an attrition of care. Individually, in a multi-country analysis, it was found that compared to 80% of women in the poorest quintile who began ANC, just 35% of those began reached the full CoC, but 72% of women in the richest quintile did (Victoria et al., 2023).

Independent predictors of service completion were poverty density and literacy on a community basis. Women with low personal education also exhibited increased service utilisation in neighbourhoods with high collective female education, which suggests a neighbourhood effect in which collective knowledge increases health-seeking behaviour of individuals (Alem, Shitu, and Alemneh., 2022).

3.5 Moderating Factors

3.5.1 Maternal Age and Parity

Youthful and primiparous women (first-time mothers) demonstrated a higher degree of consistent CoC use as compared to older, multiparous women. In multilevel models, high parity, or the number of children, was associated with a reduced perceived need of formal care particularly childhood immunisation and PNC. But at the community level, the availability of facilities helped to balance this effect; the parity difference was significantly lower where facilities were dense (Asmare & Agmas, 2023).

3.5.2 Household Wealth v.s. Community Poverty.

The socioeconomic characteristics had a difficult regulation of the CoC. The level of poverty in the community (Level-2) was a structural barrier that individual per capita wealth (Level-1) could not necessarily overcome, but through which individual home wealth (Level-1) was the driving force. The effects of common infrastructural facilities and differences in developmental needs, on the other hand, were emphasized by the fact that women in the top wealth quintile living in the cluster of high deprivation rates had fewer opportunities to get facility deliveries compared with those in wealthy clusters (Gatayeneh et al., 2021; Alemayehu et al., 2022).

3.5.3 Geospatial Access and Rurality.

Geographic access was one of the significant mediators of the effect of SES. The quality of maternal education and the use of SBA was not so manifested in rural as compared to urban areas, which suggests that even educated women are only limited by unavailability of services in inaccessible areas. The results of those studies that employed GPS-measured distance as opposed to subjective measures of perceived distance demonstrated more consistent results indicating that these studies were able to find higher relationships with service adoption (Saib et al., 2021).

Table 4. Summary of Moderating Factors in MCH Care Utilization Inequities

Moderating Factor	Key Findings	Cited Evidence
Maternal Age/Parity	High parity associated with decreased CoC completion; moderated by community facility density.	Kassie & Tesema (2023)
Socioeconomic Status	Community-level poverty acts as a structural barrier overriding individual household wealth in some regions.	Teshale & Tesema (2022)
Geospatial Access	Distance-decay effect is stronger in rural clusters; physical access moderates the benefit of maternal education.	Ameyaw et al. (2021)
Community Literacy	Collective education levels create a "neighborhood effect," boosting care-seeking for uneducated women.	Agbadi et al. (2022)

Note. *CoC = Continuum of Care; MCH = Maternal and Child Health; AOR = Adjusted Odds Ratio. All cited evidence is from studies published between 2020-2026.*

4. DISCUSSION

4.1 Overview of Main Findings

The presence of a consistent multilayer association between geographic and socioeconomic features and the continuum of maternity and child health (MCH) care in low- and middle-income countries (LMICs) is informed by the collection of the research available in this study. Household affluence and maternal education are associated with improved service utilisation, but the community level factors do have significant negative impacts on the benefits of outstanding individual level. These findings indicate that geographic "cluster" in which a woman resides explains 15 to 35 percent of the variation in care completion, even considering that individual socioeconomic status (SES) is considered (Alem, Shitu, and Alemneh., 2022; Saib et al., 2021). This result is in line with and extends past past studies.

4.2 The Action of Community-Level Determinants.

The discovery that the service uptake depends on the community-level factors, including collective literacy and poverty concentration in the region, are independent is an important contribution of the current multilevel work. Based on this review, there is a neighbourhood effect meaning that women who currently live in the neighbourhood with high average education levels are more likely to have skilled births (SBA) despite their own individual education levels (Yaya et al., 2020). It means that the process of receiving the health care is socially contagious and it is influenced by the common information and social norms. Conversely, high rates of community-level poverty-related structural anchor results in relatively affluent households in poor groups consuming services more infrequently due to an apparent shortage of facilities and infrastructure (Getayeneh et al., 2021).

4.3 Geospatial Inequities and Continuum of Care.

The results of geospatial data analysis demonstrate that the distance decay effect is prevalent in CoC. Although prenatal care (ANC) initiation is also relatively good in most of geographic clusters, the progression of the continuum, and postnatal care and childhood immunisation, also reduces drastically with the distance to medical services. Since in rural LMIC contexts, the cost of transport can often exceed the cost of the medical care, the

spatial-multilevel models demonstrate that the geographic barriers can be not only physical but can also be monetary (Saib et al., 2021). The consequences of the findings indicate that inequality is largely due to the urban-rural divide, with rural residents having a tripled burden of disadvantaged SES, increased distance, and reduced density of facilities.

4.4 Socioeconomic and Structural Determinants.

A common theme was the social patterning of access to healthcare with marginalised groups facing disproportionate barriers. In cases where structural barriers such as unsafe roads, lack of female health care providers in certain communities, and prohibitive out-of-pocket costs persist, individual-level behaviour change strategies are inadequate (Victora et al., 2023). The findings emphasize the role of pro-poor and pro-rural policies to fill the gap between agency and structural constraint, which includes decentralisation of MCH services and expanding community health worker programmes.

5. CONCLUSIONS

This quantum research paper provides robust multifaceted evidence that the maternity and child care spectrum in LMICs is beginning and ending with the socioeconomic and geographical inequality. A 34 country study indicates that much of the variance in the utilisation of health services can be attributed to community-based factors. The distance decay effect remains an important geographical challenge with inequalities being remarkably evident within the neonatal period to postnatal care.

Effective public health programs must not be just individual based interventions. The structural determinants of health have to be directly addressed because to achieve universal health coverage community-based literacy classes and improved regional infrastructure are required. Top priority in the future study should be given to the use of spatial-multilevel modelling to identify the most common CoC "cold spots" and evaluate the impact of the community-based interventions on the CoC.

6. LIMITATIONS

A couple of limitations must be mentioned. The heterogeneity of multilevel statistical output (e.g. the diversity in the presentation of ICC and PCV) prevented the use of meta-analysis, so narrative synthesis was utilized. There is a possibility that language bias was created as the review was restricted to English-language literature. Moreover, even though the assessment involved the data of 34 LMICs, the research studies involving Central Asia and other parts of Latin America are still under-represented. Finally, unmeasured community-level confounding that can affect the geographical effect estimates could include the quality of care provided at institutions (facility preparedness) (Arsenault et al., 2024).

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