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Digital and Social Determinants of Health in E-Health Implementation: A Systematic Literature Review of Health Inequities in Rural LMICs

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Abstract

Background

E-health presents a cost-effective strategy to expand healthcare access in rural low- and middle-income countries (LMICs). However, its implementation may unintentionally reinforce existing health inequities if equity considerations are not central. This systematic review synthesises how social and digital determinants of health influence health inequities following e-health implementation in rural LMICs.

Methods

This review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) equity extension guidelines. It used five search term categories: e-health, implementation outcomes, LMICs, rural populations and health inequities. The Digital Health Equity Framework was used to guide deductive thematic analysis and map equity effects across four social levels.

Result

Twenty studies were included, identifying 27 determinants and 81 equity effects. Social determinants, particularly sociodemographic status, gender norms and health literacy, were often associated with negative equity effects, especially at an individual level. Digital determinants, such as design standards and community infrastructure, resulted in mixed effects arising from the digital domain. Two key patterns emerged: the impact of social stratification on mediating structural and intermediate determinants and the evolution of the digital divide as e-health systems develop.

Conclusion

This review reveals that digital health equity in rural LMICs is influenced by multi-level determinants and structural disadvantages. As e-health interventions become increasingly technologically demanding, they risk exacerbating existing inequities without equity-sensitive implementation. Equity-sensitive implementation strategies are essential to enhance access for disadvantaged groups and strengthens the reach and sustainability of e-health in resource-limited settings.

1 Introduction

This thesis conducts a systematic literature review to examine how the implementation of e-health influences health inequities among the rural population in low- and middle-income countries (LMICs). Over 40% of the global population resides in rural areas (United Nations, 2024) and an estimated 2 billion rural individuals lack access to essential health services (WHO, 2021). In LMICs, inequalities in access to essential health services are evident across places of residence (i.e., rural versus urban), income and education. For instance, rural women are nearly twice as likely to forgo healthcare services due to geographical barriers compared to their urban counterparts. (WHO, 2023). Differences in measurable health outcomes, such as higher maternal mortality rates (Ward et al., 2024) and reduced life expectancy (Weeks et al., 2023), highlight rural populations' persistent health inequalities. When such inequalities are unjust and avoidable, they are considered health inequities. This thesis adopts the World Health Organisation's (2018) definition of health equity as *"the absence of unfair and avoidable or remediable differences in health among population groups defined socially, economically, demographically, geographically, or otherwise."* Health equity thus represents the normative goal, while health inequities reflect the barriers to achieving this goal. This thesis examines how these health inequities are reshaped through e-health interventions.

The emergence of e-health has transformed the landscape of healthcare delivery by integrating information and communication technologies (ICT) to improve the flow of information and provision of services. In rural LMIC settings, e-health is viewed as a cost-effective strategy to enhance healthcare access, improve outcomes and support patient autonomy among hard-to-reach populations (WHO, 2019). In this review, e-health is defined as digital health interventions that engage directly with users, including telemedicine, mobile health (m-Health), electronic medical records (EMR), electronic health records, online information platforms and patient web portals (WHO, 2012; Metting & Bouwes, 2025). In the rural context, e-health has been associated with benefits such as reduced travel time and enhanced service access, as well as disadvantages including technological limitations and resource inequalities (LeBlanc et al., 2020). However, the design and impact of e-health are shaped by the maturity of national e-health systems. In less developed countries, e-health remains in the early stages of development, limited to mobile-based services due to constrained ICT infrastructure, insufficient government investment and a lack of strategic workforce planning (International Telecommunication Union, 2021; Olufadewa et al., 2024; Mars & Scott, 2010). These maturity-specific challenges influence both the feasibility of implementation and the equity implications of e-health interventions.

Almost two decades ago, Liaw and Humphreys (2006) raised the concept of the rural e-health paradox, where rural populations expected to gain the most from e-health yield the least benefit. E-health shows promising potential for addressing health inequities among rural populations, yet its implementation faces significant structural barriers, such as inadequate digital infrastructure and limited technical capacity. To date, increasingly digitalised rural areas are shifting the primary source of digital use barriers from mere physical to socio-cultural (Ferrari et al., 2022), particularly in more developed countries where differences in attitudes and ability towards e-health use were observed across demographic and patient groups (Jongebloed et al., 2024; Landgren & Cajander, 2021; Shi et al., 2025). In LMICs, poorly developed rural digital and healthcare infrastructures remain integral to e-health implementation barriers (Eze et al., 2022).

Thus, although diverging patterns are observed across different countries, evidence shows that the paradox may still exist.

Evidence suggests that factors across multiple social levels shape how e-health implementation affects health inequities in rural LMIC settings. At the individual level, several studies indicate that lower income, educational level or comorbidities are associated with lower acceptance of e-health interventions (Vijay et al., 2024; Zhou et al., 2024; Ye et al., 2019). Interpersonal and community-level dynamics such as family decision-making norms or gender-based access to mobile devices also affect uptake (Irani et al., 2022; Laar et al., 2019). At the societal level, challenges include a lack of strategic coordination, inequalities in digital infrastructure and limited investment incentives for private sector engagement (Jang-Jaccard et al., 2014; Eze et al., 2022). These findings illustrate how fragmented and context-specific the literature is across domains and levels. Therefore, a systematic literature review is needed to synthesise this evidence and develop a more comprehensive understanding of how these determinants collectively shape health inequities in e-health implementation.

E-health has increasingly been used to support rural healthcare systems in LMICs (McCool et al., 2021) and improve health outcomes for hard-to-reach populations (Butzner & Cuffee, 2021). However, growing concerns have been raised about whether introducing e-health reduces or exacerbates health inequities for disadvantaged populations (König et al., 2023; Latulippe et al., 2017). In this thesis, disadvantaged populations focus on rural populations in LMICs, where e-health is expected to reduce health inequities by improving access to healthcare and outcomes (Maita et al., 2024). A systematic literature review can integrate findings from diverse rural LMIC contexts to examine how multi-level determinants influence health inequities in e-health implementation. Existing systematic literature reviews have examined barriers and facilitators of e-health implementation in remote settings (Salmi et al., 2025), their impact on health outcomes (Kruse et al., 2019) and effects on health inequities (Burton et al., 2024). However, no current review has been conducted on the exact scope of how the implementation of e-health influences health inequities among rural populations in LMICs. This review seeks to bridge the gap in evidence and contribute to the emerging field of digital health equity in two main ways. First, this review brings together evidence from empirical studies on equity outcomes related to e-health implementation in rural LMICS. Second, by employing the Digital Health Equity Framework (Richardson et al., 2022), the review categorises these factors into relevant domains and social levels, identifies common themes and highlights gaps in the evidence from existing studies. The research question for this paper is as follows: *How does the implementation of e-health affect health inequities among rural populations in low- and middle-income countries?*

By addressing this research question, this thesis contributes to three streams of literature. First, within implementation science, it demonstrates the feasibility of conducting an equity-focused evaluation of e-health interventions for disadvantaged populations using a structured framework. Second, in social epidemiology, it examines how digital and social determinants of health influence health inequities in the context of e-health implementation. Third, it contributes to the emerging field of digital health equity by exploring how digital and social domains interact to shape equity outcomes, with particular attention to the role of the digital divide. The following sections introduce the theoretical framework, outline the methodological approach and present the results and implications.

2 Theoretical Framework

Understanding the effects of e-Health implementation on health inequities requires examining determinants from both social and digital domains. This phenomenon of interconnected digital and social determinants mirrors the antecedents and drivers of the digital divide identified by Lythreatis et al. (2021). Digital divide refers to the gap between those with sufficient ICT access and those with limited or no access (Soomro et al., 2020). Different levels of the digital divide emerge as technology progresses, ranging from differences in access to essential equipment (Anderson et al., 1996) and unequal diversity in device ownership (Van Deursen and Van Dijk, 2018) to disparities in digital skills and usage (Hargittai, 2001) and the translation of internet usage into favourable outcomes (Van Deursen & Helsper, 2015). The factors driving the digital divide, including digital training, socio-economic status and infrastructure (Lythreatis et al., 2021), resemble the social determinants of health contributing to health inequities (Saeed & Masters, 2021). Hence, while digital and social determinants operate in separate domains, the equity effects of e-health implementation depend on their combined influence (Badr et al., 2024). A framework that addresses both domains can structure the synthesis of evidence and facilitate the examination of how digital and social determinants jointly shape health equity.

To support a structured synthesis considering the contextual overlap of factors in the digital and social domains, this thesis adopts the Digital Health Equity Framework proposed by Richardson et al. (2022). A wide range of alternative frameworks could also depict social factors' contribution to health inequity, such as the rainbow model of Dahlgren and Whitehead (2021) and the Commission on Social Determinants of Health Framework Conceptual Framework (Solar & Irwin, 2010). However, these frameworks focus solely on the social domain and lack an extension towards digital factors that also influence health inequities in e-health implementation. A similar framework for digital health equity has been proposed by Crawford and Serhal (2020). While the framework addresses both social and digital determinants, it lacks an adequate structure that separates factors into different social levels, which limits the capacity to examine patterns across these levels.

The Digital Health Equity Framework accommodates the breadth required by the multidisciplinary nature of this thesis. It builds upon the National Institute on Minority Health and Health Disparities Research Framework (NIMHD, 2017) and incorporates a domain focused on the digital environment. The framework aligns with the scope of the research question of this thesis as follows: 1) The targeted population of the framework consists of health disparity populations, including underserved rural populations. 2) Social and digital determinants of health are divided into separate domains to distinguish their impact, enabling the examination of their influence on health inequities individually. 3) Domains of influence are categorised into different levels of social influence ranging from individual-level to societal-level. This allows for examining common patterns, the distribution of determinants and their influence across the social spectrum. These characteristics enable evaluations of digital health inequities in e-health implementation that require an intersectional approach to incorporate multi-level interventions addressing health inequities (Badr et al., 2024).

The framework (Figure 1) structure facilitates cross-domain and cross-level evidence synthesis. It is organised into six domains: biological, behavioural, physical/built environment, sociocultural environment, healthcare system and digital environment. Social factors in the first five domains represent the social determinants of health – 'non-medical factors that influence health outcomes. They are the conditions in which people are born, grow, work, live, worship, and age" (CDC, 2024). In contrast, the digital environment domain is the habitat enabled by technology and digital devices that affects health risks and digital health outcomes, referred to as the digital determinant of health. Definitions of each digital determinant of health were elicited and directly quoted from Richardson et al. (2022) and can be found in Appendix 1. Furthermore, determinants are categorised into four social levels: individual, interpersonal, community and societal.

Figure 1

Digital Health Equity Framework (Richardson et al, 2022)

		Levels of Influence*			
		Individual	**Interpersonal**	**Community**	**Societal**
Domains of Influence (Over the Lifecourse)	**Biological**	Biological Vulnerability and Mechanisms	Caregiver–Child Interaction Family Microbiome	Community Illness Exposure Herd Immunity	Sanitation Immunization Pathogen Exposure
	Behavioral	Health Behaviors Coping Strategies	Family Functioning School/Work Functioning	Community Functioning	Policies and Laws
	Physical/Built Environment	Personal Environment	Household Environment School/Work Environment	Community Environment Community Resources	Societal Structure
	Digital Environment	Digital Literacy, Digital Self-Efficacy, Technology Access, Attitudes Towards Use	Implicit Tech Bias, Interdependence (e.g. shared devices), Patient-Tech-Clinician Relationship	Community Infrastructure, Healthcare Infrastructure, Community Tech Norms, Community Partners	Tech Policy, Data Standards, Design Standards, Social Norms & Ideologies, Algorithmic Bias
	Sociocultural Environment	Sociodemographics Limited English Cultural Identity Response to Discrimination	Social Networks Family/Peer Norms Interpersonal Discrimination	Community Norms Local Structural Discrimination	Social Norms Societal Structural Discrimination
	Health Care System	Insurance Coverage Health Literacy Treatment Preferences	Patient–Clinician Relationship Medical Decision-Making	Availability of Services Safety Net Services	Quality of Care Health Care Policies
Health Outcomes		**Individual Health**	**Family/ Organizational Health**	**Community Health**	**Population Health**

3 Methods

This thesis conducted a systematic literature review to identify, collect and synthesise evidence from empirical studies on the implementation of e-health and its influence on health inequities in rural LMIC settings. A systematic literature review was chosen over other review types, such as narrative reviews, to minimise selection bias and improve replicability. While narrative reviews rely heavily on expert judgement, systematic literature review follows a transparent and predefined procedure to ensure method appropriateness and findings trustworthiness (Smela et al., 2023; Crowther et al., 2010; Page et al., 2021).

For this research question, a systematic review is especially suitable as empirical studies tend to focus on individual interventions or contexts, resulting in fragmented evidence. By combining evidence from various settings, a systematic review can reveal patterns across primary studies and identify knowledge gaps in the literature. This review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines (Page et al., 2021). The reporting guideline consists of a checklist of 27 items for systematic reviews to ensure transparent and comprehensive reporting. Given the equity-focused nature of this review, the equity extension of PRISMA, PRISMA-E 2012 (Welch et al., 2012), has been adopted to modify existing PRISMA items and incorporate a focus on equity. This review complies with PRISMA-E in all sections and ensures that all items have been checked. The complete checklist with all items and their corresponding reported page location can be found in Appendix 2.

The following subsection describes the methodological process of this review in the following order: eligibility criteria, search strategy, selection and data collection process, risk of bias assessment and data analysis method. Eligibility criteria were developed using the Population, Intervention, Comparison, and Outcome (PICO) framework. The study search was conducted using the Web of Science database, followed by abstract and full-text reviews. Data were synthesised with a deductive thematic analysis using the Digital Health Equity Framework (Richardson et al., 2022). This method enables classification of social and digital determinants of health and their equity impact across six contextual domains and four social levels to facilitate structured interpretations of how the implementation of e-health influences health inequities.

3.1 Eligibility Criteria

To ensure the included studies are consistent and relevant, eligibility criteria were developed using the PICO framework. This framework guided the identification of studies focusing on rural populations in LMICs, their interaction with e-health interventions and the reported effects on health inequities. Studies were included when empirical findings were based on actual e-health implementation. The complete list of inclusion and exclusion criteria is as follows:

3.1.1 Inclusion Criteria

1. The study population includes individuals residing in rural areas of LMICs.
2. The study examines the interaction between the target population and at least one form of e-health category.
3. The study addresses health inequity effects following e-health use or implementation.
4. Peer-reviewed empirical studies written in English.

3.1.2 Exclusion Criteria

1. The study population consisted solely of healthcare professionals, experts, or developers, with interventions limited to improving professional practices or without interaction or uptake among the rural population.
2. The e-health interventions were implemented exclusively within clinical settings, with no evidence of delivery beyond the healthcare facilities.
3. The study presents only protocols, implementation plans, or guidelines without reporting empirical findings on e-Health use or outcomes.
4. The publication is an editorial, commentary or literature review that does not include primary data collection.

3.2 Search Strategy

3.2.1 Database

Web of Science (WoS) was selected as the database for the systematic literature review. Yeung et al. (2024) demonstrate that WoS had 31,555 papers on e-Health, and among the top 100 most cited papers, a total of 49,653 citations were received. This result illustrates the comprehensiveness and high quality of evidence regarding e-Health that can be obtained. When comparing journal coverage with other widely used databases such as Scopus and Dimensions, WoS is regarded as the most selective, despite its lower coverage (Singh et al., 2021). Hence, WoS was chosen for its balance of specificity and the risk of bias within the focus area.

3.2.2 Search Terms

The search terms were categorised into the following categories: e-Health, implementation outcomes, rural populations, low- and middle-income countries (LMICs) and health inequities. To the author's knowledge, no prior systematic review has examined the same scope of themes. Therefore, search strings were adopted from multiple published sources to ensure the comprehensiveness of each keyword category. The complete sets of search strings can be found in Table 1.

e-Health

This chain of search terms is adapted from a comprehensive list of e-health interventions by Coetzer et al. (2024). The search terms include core e-health interventions, such as "m-health," "telemedicine," and "electronic health record," along with their functional description such as "remote counselling" and "patient monitoring.". The set ensures broad coverage of e-health intervention types across studies.

Implementation Factors and Outcomes

This chain of search terms was also adapted from Coetzer et al. (2024). This set incorporates commonly used keywords in other implementation science studies, such as *"barriers"*, *"facilitators"*, *"adoption"* and *"acceptability"* (Proctor et al., 2023; Haynes & Loblay, 2024). This category aimed to capture studies that reported real-world experiences with e-health implementation, rather than exploratory, theoretical, or design-only research.

Low- and middle-income countries

This category comprises two parts. First, it adapted a variety of generic descriptions of LMICs and their populations (e.g. *"developing countries"*, *"low-income countries" and "deprived population")* from Bohren et al. (2014). Second, it integrates a full list of LMICs according to the World Bank Group (2025) classification. This ensures that studies referring to specific countries are included.

Rural Population

The search string is synthesised from two studies. Search terms from Hage et al. (2013) such as "rural" and "remote area" capture a broad range of rural settings. To increase inclusiveness in the variety of terminologies used for disadvantaged groups, additional terms from Campos et al. (2025) such as "small communities" were included.

Health Inequities

To ensure that the studies retrieved were focused on or related to health inequities, this chain adopted search terms from Latulippe et al. (2017). These include terms such as "health (in)equity" and also "health (in)equalities", "health disparities," and "social (in)equalities. " This diversity of terminology ensures the inclusion of studies with different framing or contextual perspectives of health equity. The inclusion of terms related to health inequalities is necessary because evidence of health inequities may be inferred from observed differences in health outcomes, especially when unfairness is not explicitly stated.

3.3 Data Collection and Selection Process

A search was conducted in the Web of Science database based on predefined search terms from each category. All search terms within each category were connected with the Boolean operator "OR" to create a keyword chain. The Boolean operator "AND" was used between categories to ensure that the studies retrieved include at least one keyword from each.

The searches resulted in 334 study records. Titles and abstracts of the identified studies were exported into Microsoft Excel for initial screening by a single author. Each study's eligibility was assessed based on the available information presented in the title and abstract sections, according to predefined inclusion and exclusion criteria. Records with unclear eligibility or insufficient abstract details were reserved for full-text review. Retracted studies were excluded.

Following the initial screening, 88 eligible studies were retrieved for full-text review. At this stage, priority was given to ensuring that the studies reported the actual implementation outcomes of e-health interventions. Consequently, 20 studies met all eligibility criteria and were included for final synthesis. The PRISMA flow diagram in the Results section illustrates a summary of the full screening process and the reasons for study exclusion at each stage.

After study selection, key characteristics of each retrieved study were extracted and recorded in a Microsoft Excel file. Extracted variables included the year of publication, country of the data collection and its region and national income levels, e-Health intervention category, communication medium, study method and design, data collection methods, health objectives and rural population subgroups. These data are summarised and presented in Table 2 in the Results section.

Table 1

Search Terms

Category	Search Terms	Source
e-Health	“econsult*" OR "e-consult*" OR "ediagnos*" OR "e-diagnos*" OR "mobile-health*" OR "mhealth*" OR "m-health*" OR "telehealth*" OR "tele-health" OR "remote-consult*" OR "teleconsult*" OR "tele-consult*" OR "telenursing" OR "tele-nursing" OR "telediagnos*" OR "tele-diagnos*" OR "telemedic*" OR "tele-medic*" OR "telemonitor*" OR "tele-monitor*" OR "ehealth*" OR "e-health*" OR "telecare" OR "tele-care" OR "digital-health" OR "health-technolog*" OR "health-application*" OR "webportal*" OR "web-portal*" OR "patient-portal*" OR "telecounsel*" OR "tele-counsel*" OR "remote-counsel*" OR "distance-consult*" OR "distance-counsel*" OR "distant-consult*" OR "patient-monitoring" OR "mhapps" OR "e-coach*" OR "wearable*" OR "personal-health-record*" OR "health-kiosk*" OR "electronic-medical-record*" OR "electronic-health-record*" OR "health-ict*" OR "Public Health Informatics" OR "Medical Informatics" OR "Nursing informatics"	Coetzer et al (2024)
Implementation Factors and Outcome	“implement*" OR "adopti*" OR "accept*" OR "nonaccept*" OR "facilitat*" OR "barrier*" OR "interoperab*" OR "usab*" OR "lessons-learn*" OR "lesson-learn*" OR "implicati*" OR "experienc*" OR "integrat*" OR "user-cent*" OR "opportunit*" OR "challeng*" OR "percepti*" OR "attitude*" OR "acceptab*" OR "utiliz*" OR "utilis*" OR "approach*" OR "deliver*" OR "need" OR "needs” OR "Patient Acceptance of Health Care" OR "Health Information Interoperability"	Coetzer et al (2024)
Rural population	“rural” OR “deprived area” OR “remote area” OR “Rural Population” OR “Rural Populations” OR “Communities, Rural” OR “Community, Rural” OR “Distribution, Rural Spatial” OR “Distributions, Rural Spatial” OR “Medium Communities” OR “Population, Rural” OR “Populations, Rural” OR “Rural Communities” OR “Rural Community” OR “Rural Settlements” OR “Rural Spatial Distribution” OR “Rural Spatial Distributions” OR “Small Communities” OR “Small Community”	Hage et al. (2013); Campos et al (2023)
Low- and lower-middle-income countries	"developing country” OR ”developing countries” OR ”developing nation” OR ”developing nations” OR ”developing population” OR ”developing populations” OR ”developing world” OR ”less developed country” (…) “Afghanistan" OR "Albania" OR "Algeria" OR "Angola" OR "Argentina" OR "Armenia" OR "Azerbaijan" OR "Bangladesh" OR "Belarus" OR "Belize" OR "Benin" OR "Bhutan" OR "Bolivia" OR "Bosnia and Herzegovina" OR "Botswana" OR "Brazil" OR "Burkina Faso" (...) *(For the full list of search terms, see Appendix 4)*	Bohren et al. (2014); World Bank Group (2025)
Health Inequity	“Underprivileged” OR “health inequalit*" OR "inequalit* in health" OR "poverty" OR "inequalit*" OR "social inequalit*" OR "socioeconomic inequalit*" OR "health for all" OR "health-related exclusion" OR "health disparit*" OR "health *equit*" OR "*equit*" OR "in health" OR "vulnerable group*" OR "inequalit*" OR "disparit* in health”	Latulippe et al. (2017)

3.4 Risk of Bias Assessment

No formal risk of bias tool was applied in this review due to the diversity of included study methods, namely qualitative, quantitative and mixed methods. This review did not restrict evidence type based on methodological hierarchy but adopted the "fitness of purpose" inclusion approach suggested by the health equity-focused systematic review guideline (Tugwell et al., 2010). Due to this review's primary focus on interpreting contextual factors that influence health inequity, qualitative or mixed methods studies may yield richer insight than randomised controlled trial studies. Instead, during full-text review, the author ensured that all studies met the eligibility criteria and were published in peer-reviewed journals. The characteristics of the included studies, including the study design and data collection method, are presented in Table 2 to ensure transparency.

3.5 Data Analysis

This thesis adopted a deductive thematic analysis approach using the Digital Health Equity Framework developed by Richardson et al. (2022). This framework was selected to identify and classify factors from both social and digital domains that influence health inequities. Additionally, it facilitates structured mapping of extracted evidence across predefined domains and social levels, enabling the identification of recurring patterns in whether these determinants reduce or worsen health inequities. For clarity, this thesis defines a positive equity effect as one that reduces health inequities, and a negative equity effect as one that worsens them. To avoid ambiguity, the term "equity" is used instead of "inequity" when describing effect directions (e.g. "positive equity effect"), ensuring clarity in interpreting whether a determinant reduces or exacerbates health inequities.

During coding, data extracted from each study were assigned to the predefined factors within the framework. Each coded entry included:

1. Study identification number and citation
2. Relevant determinant and its corresponding domain and social level
3. The direction of the health equity effect (positive or negative)
4. A description of the mechanism linking the determinant and the observed health equity outcome.

The direction of the health equity effect was interpreted based on the context and description in each study. In most circumstances, this review adopted the perspective of the original authors regarding the effect on health equity. For instance, when rural women were reported to rely on their husbands for phone access to contact midwives or engage with e-health programmes, it was coded with a negative equity effect, with *Interdependence* as a determinant. Alternatively, in certain instances, this review utilised a layered coding approach to differentiate the various equity effects of individual determinants within the same context. For instance, particularly in studies where within-group heterogeneity was reported, circumstances such as an overall positive equity effect reported for increased health *service accessibility* for the study population but a negative effect reported on particular remote communities due to poor *community infrastructure* will result in two distinct code entries. This approach ensures all equity effects for each reported determinant are captured individually. All coded mechanisms are documented to

ensure transparency, and the full codebook can be found in Appendix 3. The synthesis results were visually presented in summary figures and tables. These visualisations illustrated the determinants' distribution and equity effects across studies. Individual determinants and their influence on health inequities were categorised by domains in Figures 3, 4 and 5 and social levels in Figure 6. Tables 3 and 4 display the frequency of determinants' appearance across included studies. Figures 3 to 6 were created using Tableau to enhance readability.

4 Result

4.1 Study Selection

The initial database search identified 334 records. One retracted paper was removed before screening. Title and abstract screening excluded 245 papers based on predefined eligibility criteria. 88 papers were included for full-text review. As a result, 68 studies were excluded, leaving 20 studies included in the final review. The PRISMA flow diagram illustrates the full screening process with exclusion reasons at each stage (Figure 2).

In the full-text review, particular focus was placed on whether the studies reported actual e-health implementation outcomes and provided evidence of health equity effects for the rural LMIC population. Several studies were excluded because they reported only anticipated outcomes based on stakeholder perception. These studies typically focused on the design stage of e-health implementation, such as acceptability assessments without actual user interaction. Excluding these studies ensures the consistency of evidence examined is based on the actual implementation outcome. Studies were also excluded if they did not demonstrate a clear health equity impact on rural populations. For example, some studies showed an increased use of digital records (e.g. EMRs) in rural healthcare settings, but no direct link to a reduction in inequalities or an improvement in care access was provided. Some other studies showed relevant evidence, such as improved health knowledge, but did not disaggregate the findings between rural and urban populations. Hence, the effect on the rural subgroup cannot be determined.

4.2 Study Characteristics

Geographic and Time Patterns

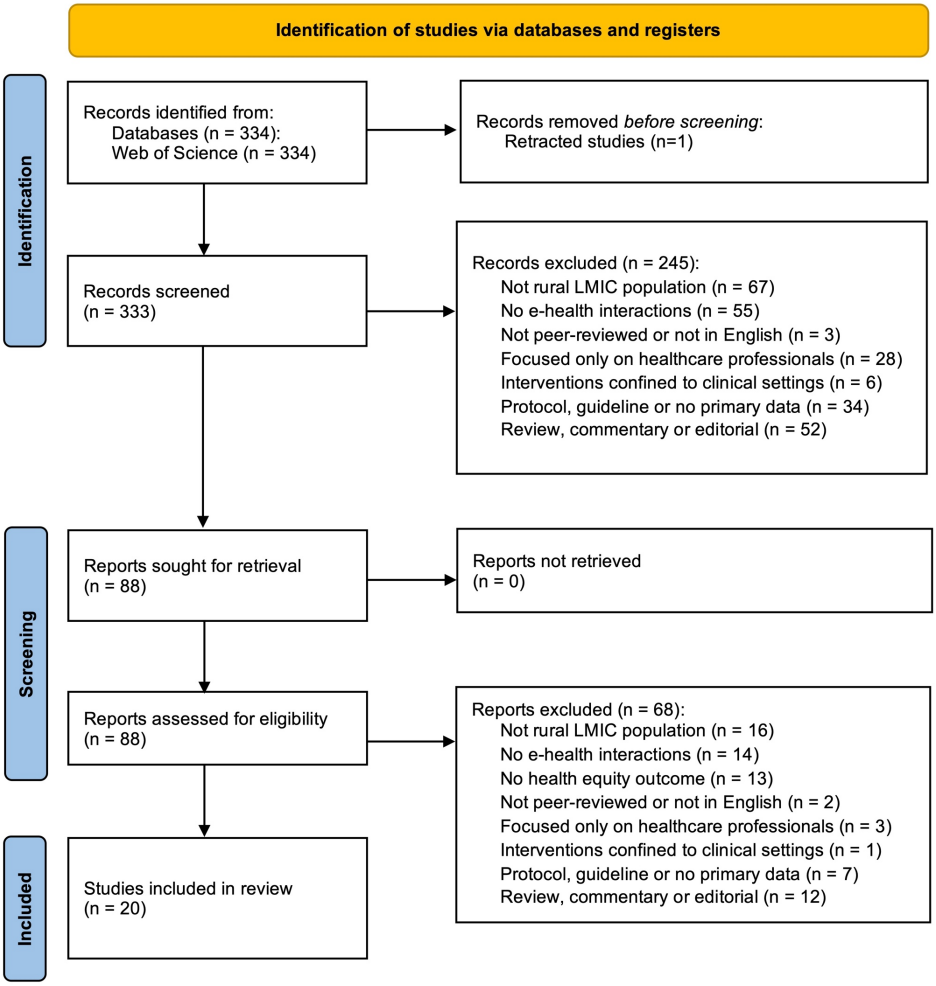
Table 2 shows a detailed summary of the study characteristics of the 20 studies in the final review. Most studies were conducted in Asia (n = 13) with a concentration in India (n = 7) and China (n = 5), whereas fewer studies were in Africa (n = 5) and Latin America (n = 2). In terms of the World Bank income classification, over half of the studies included lower-middle income country (n = 13), followed by upper-middle (n = 8) and low-income countries (n = 2). The majority of studies were published in 2024 (n = 6), 2022 (n = 4) and 2019 (n = 4). Only three studies were published prior to 2019, with the earliest study in 2012.

Study Design and Methods

The study methods varied from the sample in this review. Half of the studies used quantitative methods (n = 10), followed by qualitative methods (n = 5) and mixed methods (n = 5). Most studies used cross-sectional designs (n = 13), followed by five randomised controlled trials and two pre-post studies. No longitudinal studies were identified. Most studies employed surveys or interviews for data collection (n = 16), highlighting the significance of self-reported outcomes.

Figure 2

PRISMA Flow Diagram



Intervention Type, Health Objectives and Rural Population Subgroups

mHealth (n = 12) emerged as the most commonly utilised e-health intervention, followed by information systems (n = 5) and telemedicine (n = 3). In terms of communication media, a wide variety of media was observed, including SMS, phone calls and web portals (e.g. Udenigwe et al., 2022; Laar et al., 2019). Some studies indicated a mixed utilisation of media, such as SMS for users and web portals for healthcare providers (Wahedi et al., 2018). For health objectives, maternal care was the most common targeted (n = 7), followed by child care (n = 4) and improving care accessibility (n = 4). Maternal care was often combined with child care (e.g. Irani et al., 2022; Sosanya et al., 2024). Various population subgroups were observed, including mothers, indigenous people and the hard-to-reach population.

National and Regional Differences in e-Health Interventions

The distribution of e-health interventions in health equity studies across regions reflects disparities in digital infrastructure, technological access and national e-health maturity levels. In low-income sub-Saharan African countries such as Uganda and Malawi, interventions primarily utilise SMS and phone calls that require lower technology and network demands (Chib et al., 2012; Hampshire et al., 2016). Alternatively, in Nigeria, another sub-Saharan country with a relatively

higher income, the study of gamified health apps indicates improved technological access among the rural population (Sosanya et al., 2024). In Asia, particularly in China and India, e-health strategies demonstrate integration with web portals, smartphones and end-user telemedicine platforms (e.g., Ye et al., 2019; Choudhury and Choudhury, 2022; Haenssgen et al., 2020). These regional differences demonstrate that local socio-technological capabilities restrict the range of e-health options available to users.

National and Regional Differences in e-Health Objectives

The health objectives of e-health interventions in this review differ across countries' income levels reflecting a diverging pattern of healthcare needs. In low- and lower-middle-income countries such as Ghana, Uganda and India, e-health interventions primarily aim to improve access to essential health services, such as maternal care (e.g., Udenigwe et al., 2022; Laar et al., 2019; Modi et al., 2019) and managing infectious diseases (Chib et al., 2012; Johri et al., 2020), highlighting the needs in essential care provision for the rural population. Conversely, health equity studies in upper-middle-income countries such as China and Thailand shift to a focus on accessing medical information and chronic disease management (e.g., Zhou et al., 2024; Haenssgen et al., 2020). Simultaneously, forms of digital health inequalities evolve from device ownership to device variety and digital skills within increasingly complex e-health systems.

Table 2

Study Characteristics

#	Citation	Published Year	Country	Region	World Bank Classification (income)	E-Health Category	Medium	Study Method	Study Design	Data Collection Method	Health Objectives	Rural Population Subgroup
1	Udenigwe et al. (2022)	2022	Nigeria	Africa	Lower-middle	mHealth	Web Portal; SMS	Qualitative	Cross-sectional	Interviews	Maternal Care	Pregnant Woman
2	Laar et al. (2019)	2019	Ghana	Africa	Lower-middle	mHealth	Voice Messages; Text Messages; Phone Calls	Mixed Methods	Cross-sectional	Surveys; Focus Group; Discussion; Interviews	Maternal Care	Mothers
3	Sneha et al. (2023)	2023	India	Asia	Lower-middle	Tele-medicine	Tele ophthalmology	Qualitative	Cross-sectional	Observational Study	Eye Care	Hard-to-reach
4	Ye et al. (2019)	2019	China	Asia	Upper-middle	Information System	Web Portal	Mixed Methods	Cross-sectional	Medical Record	Care Accessibility	General
5	Irani et al. (2022)	2022	India	Asia	Lower-middle	mHealth	Interactive Voice System	Mixed Methods	Pre-post	Surveys; System Data	Maternal Care; Child Care; Family Planning	Women
6	Sosanya et al. (2024)	2024	Nigeria	Africa	Lower-middle	mHealth	Gaming App	Qualitative	Pre-post; RCT	Focus Group Discussions	Maternal Care; Child Care	Mothers; Low Income
7	Choudhury and Choudhury (2022)	2022	India	Asia	Lower-middle	mHealth	Mobile App	Quantitative	RCT	Surveys	Maternal Care; Child Care; Health Education	Mothers
8	Johri et al. (2020)	2020	India	Asia	Lower-middle	mHealth	Interactive Voice System	Quantitative	Pre-post; Clustered RCT	Surveys; System Data	Immunisation; Health Education	General
9	Capasso et al. (2024)	2024	9 Latin America Countries	Latin America	Lower-middle; Upper-middle; High	Information System	ICT	Mixed Methods	Cross-sectional	Surveys; Interviews	Maternal Care	General; Indigenous
10	Ji et al. (2024)	2024	China	Asia	Upper-middle	Information System	Web Portal	Quantitative	Cross-sectional; RCT	Surveys	Care Accessibility	General

Result

#	Citation	Published Year	Country	Region	World Bank Classification (income)	E-Health Category	Medium	Study Method	Study Design	Data Collection Method	Health Objectives	Rural Population Subgroup
11	Yankappa et al. (2024)	2024	India	Asia	Lower-middle	Tele-medicine	Tele-consultation	Quantitative	Cross-sectional	Interviews	Paediatric	Children
12	Hampshire et al. (2016)	2017	Ghana; Malawi	Africa	Lower-middle; Low	mHealth	SMS	Qualitative	Cross-sectional	Interviews	Health Services Quality Improvement	Health Workers
13	Zhou et al. (2024)	2024	China	Asia	Upper-middle	Information System	Web Portal	Qualitative	Cross-sectional	Interviews	Lung Cancer	Cancer Patients
14	Haenssgen et al. (2020)	2021	Laos; Thailand	Asia	Lower-middle; Upper-middle;	mHealth	Mobile Phones	Quantitative	Cross-sectional	Surveys	Care Accessibility	General; Hard-to-reach
15	Li et al. (2019)	2019	China	Asia	Upper-middle	Information System	Web Portal	Quantitative	Cross-sectional	Surveys	Care Accessibility	Hard-to-reach
16	Chib et al. (2012)	2012	Uganda	Africa	Low	mHealth	SMS	Quantitative	Cross-sectional	Surveys	HIV/AIDS; Health Education	General
17	Wahedi et al. (2018)	2018	Guatemala	Latin America	Upper-middle	mHealth, Information System	SMS; Web Portal	Mixed Methods	Cross-sectional	Interviews	Health Complaints	Community Leaders; Indigenous
18	Dev et al. (2023)	2024	India	Asia	Lower-middle	Tele-medicine	Tele-consultation	Quantitative	Pre-post	Cohort study	Paediatric	General; Hard-to-reach
19	Zhang et al. (2022)	2022	China	Asia	Upper-middle	mHealth	Web Portal	Quantitative	Cross-sectional	Surveys	Health Information Seeking	Older Adults; Elderly
20	Modi et al. (2019)	2019	India	Asia	Lower-middle	mHealth	Mobile App	Quantitative	Cross-sectional; Clustered RCT	Surveys	Maternal Care; Child Care	Mothers; Indigenous; Low Income; Hard-to-reach

4.3 Data Analysis

This section presents the results of the thematic analysis on how specific determinants of health influence equity outcomes in the implementation of e-health in rural LMICs. The analysis was guided by the Digital Health Equity Framework (DHEF) (Richardson et al., 2022), which informed the categorisation of factors by domain and social level. The section begins by outlining the range of digital and social determinants identified across the included studies. Findings are presented across two analytical dimensions in line with the DHEF structure. First, at the domain level, digital and social determinants are examined to assess how individual factors contribute to reducing or reinforcing health inequities. Second, at the social level, the analysis explores how these factors interact within and across levels of influence: individual, interpersonal, community and societal, to reveal common patterns shaping equity outcomes in e-health implementation.

4.3.1 Overview for digital and social determinants of health

Across all the studies included in this review, 27 factors were identified as influencing health inequities after e-health implementation. Of these, 11 were in the digital domain and 16 in the social domain. These factors can have positive, negative, or mixed equity effects across different studies. For positive effects, 12 factors were coded 32 times, while 19 factors were coded 49 times for negative effects. Five factors showed mixed effects in different contexts. A detailed breakdown of these findings, including domains, equity effects and code entry counts, is shown in Table 3.

Table 3

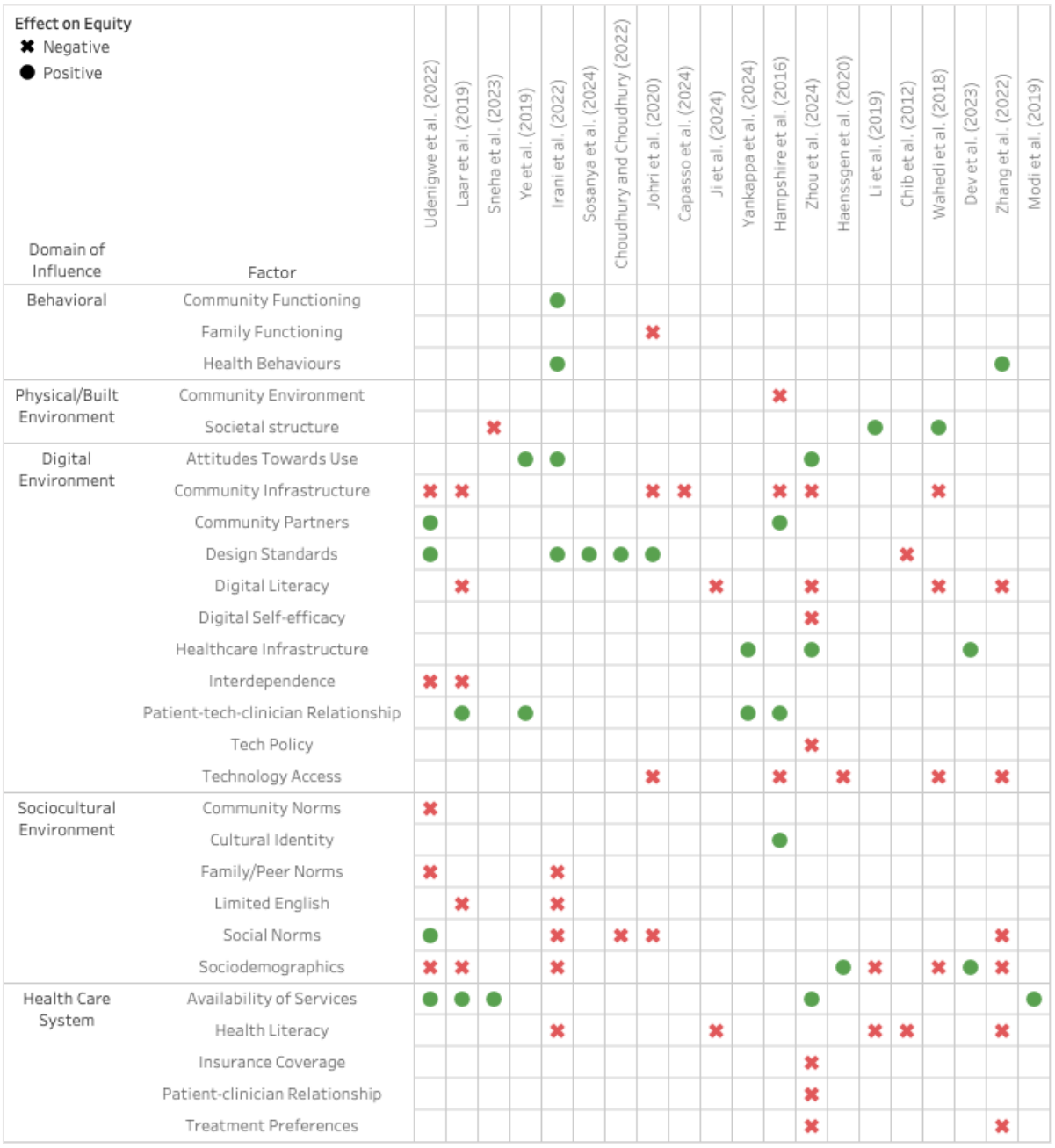
Number of Digital and Social Factors and Their Health Equity Effects

Factors	Unique Count	Total Count	Source
Positive Equity Effect			
Digital Factors	5	18	e.g. Udenigwe et al. (2022); Ye et al. (2019)
Social Factors	7	14	e.g. Dev et al.2023; Hampshire et al., 2016
Negative Equity Effect			
Digital Factors	7	22	e.g. Zhou et al. (2024); Udenigwe et al. (2022)
Social Factors	12	27	e.g. Udenigwe et al. (2022); Irani et al. (2022)
Total	27	81	
Positive and Negative Equity Effect			
Digital Factors	1	-	e.g. Chib et al. (2012); Johri et al. (2020)
Social Factors	4	-	e.g. Dev et al. (2023); Zhang et al. (2022)

Note. The discrepancy between the sum and the total of unique counts arises from factors with both positive and negative equity effects. Unique counts refer to how many factors were coded at least once across all studies. Total counts refer to the overall number of equity effects coded.

Figure 3

Distribution of Factors and Their Influence on Health Inequities Across Studies by Domains



4.3.2 Digital determinants of health

Digital determinants shape how users interact with e-health and influence health inequities across settings. Factors with either a positive or negative equity effect in one study often resemble those in others, showing the systemic nature of their influence across different settings (see Figure 3). For instance, community infrastructure, digital literacy and technology access consistently show negative equity effects (e.g. Udenigwe et al., 2022; Johri et al., 2020; Laar et al., 2019). On the other hand, attitudes towards use and healthcare infrastructure were consistently associated with positive equity effects. These factors reduce the geographical barriers that enable hard-to-reach populations to access previously inaccessible medical services and health

information through e-health interventions (e.g. Ye et al., 2019; Irani et al., 2022). There was also a mixed equity effect. Although most studies found that design standards were linked to positive equity effects, one study showed how an e-health programme with insufficient equity consideration in its design can actually reinforce health inequities after the programme is implemented (Chib et al., 2012).

Negative Equity Effect

Community infrastructure is consistently recognised as negatively influencing health inequities in low-resource settings in e-health implementation (see Figure 4), showing its nature as a structural barrier. Inconsistent network and electricity coverage across geographical areas often results in unequal access to e-health programs due to inadequate digital infrastructure in poorer communities. Poor network coverage excludes certain populations from participating in e-health programs (Capasso et al., 2024; Wahedi et al., 2018), creates barriers to the continuity of care (Laar et al., 2019) and causes preventable mortality when emergency medical services cannot be reached (Hampshire et al., 2016).

The negative equity effect of technology access was observed across all country income settings, but the underlying cause varies with a country's income level. In lower-income countries, the negative effects stem from disparities in device ownership (e.g. Udenigwe et al., 2022; Johri et al., 2020; Hampshire et al., 2016). In higher-income countries, the nature of disparities in device ownership transitions from mere physical access to the range of devices available. A prerequisite for accessing certain e-health services, such as telemedicine, is the availability of an advanced mobile phone model or smartphone (Wahedi et al., 2018; Zhang et al., 2022). Despite various mechanisms across different income levels, the general causes were associated with socioeconomic factors like gender norms and income level (e.g. Udenigwe et al., 2022; Zhang et al., 2022).

Digital literacy was reported more frequently in studies of upper-middle-income countries (e.g. Ji et al., 2024; Haenssgen et al., 2020), reflecting a different dimension of challenges in e-health systems with more sophisticated e-health interventions. Evidence from this review shows that disadvantaged populations with lower digital capabilities fail to perform complex internet behaviour required by an advanced e-health system. Digital health inequity emerges when social development falls behind technological advancement. For example, Zhou et al. (2024) provided evidence that elderly individuals in rural areas with low digital literacy find it challenging to navigate the telehealth system, hindering their adoption of telehealth for continuity of lung cancer care. On the other hand, Ji et al. (2024) demonstrate that the rural population with better digital literacy is able to engage in a wider range of digital health behaviours. The evidence of the widening health equity gap was established in Zhang et al. (2022), where individuals with better e-health literacy and access to technology have a better perceived health status.

Evidence of e-health implementation adaptation was identified. In some less developed regions, intervention programmes tailored to local constraints often utilise phone calls, SMS, and interactive voice messages that require only a 2G network, basic mobile phones and low digital literacy requirements (e.g., Laar et al., 2019; Irani et al., 2022; Johri et al., 2020). Digital solutions such as user-centred design can also promote inclusiveness (Sosanya et al., 2024).

Figure 4

Distribution of Factors and Their Influence on Health Inequities Across Studies (Digital Domain)

Positive Equity Effect

Digital factors with a positive equity effect include design standards, healthcare infrastructure and attitudes towards use. Adequate design standards are key to promoting inclusiveness within cost and literacy level restrictions. In resource-limited settings, phone credit is a significant barrier to the uptake of mHealth programs. The design of a call-back system reduces costs for low-income users and promotes the adoption of mhealth programs (Irani et al., 2022; Johri et al., 2020). Moreover, the rural population in LMICs is often equipped with a low literacy level. Gamification and interactive voice systems (Laar et al., 2019; Irani et al., 2022; Johri et al., 2020) address this barrier through visual and verbal interactions, bypassing the need for text-reading and reducing the demand for literacy level. Sosanya et al. (2024) showed that gamification works well for users with low literacy levels through verbal persuasion and emotional state improvement. In their pilot study, a maternal and child care education program delivered through a gaming app showed higher user adherence amongst young rural mothers. It also achieved better health knowledge dissemination than traditional health training. These examples illustrate the importance of user-centred design in adapting e-health functionality to the local context. Alternatively, health inequities widen when a e-health education program requires adequate health literacy to participate, reinforcing the knowledge gap between the well-educated and less-educated population (Chib et al., 2012).

In resource-limited settings, e-health serves as a tool to enhance accessibility to medical services, enabling users to receive medical attention that was previously unattainable. It enables the rural population to access healthcare infrastructure remotely from local community settings through telemedicine hubs that centrally serve the surrounding neighbourhoods (Yankappa et al., 2024;

Dev et al., 2023). This implementation approach adapts to local limitations, as access to adequate devices was a significant barrier to adopting telemedicine individually in rural LMICs. Telemedicine services at a local healthcare hub concentrated the technological resources required and eliminated the previously significant cost associated with in-person travel to urban healthcare specialist centres (Dev et al., 2023).

Improvement in attitude towards the use of e-health is often linked to users actively seeking access to health resources (Ye et al., 2019; Irani et al., 2022; Zhou et al., 2024). The rural population demonstrates improved willingness to initiate access to e-health resources that match their capabilities. In some resource-limited settings, phone calls and radio serve as the only channels through which the rural population can obtain essential health information such as maternal health, child nutrition and sanitation. The introduction of the integrated e-health programme offers access to pre-recorded health education content through phone calls that are low-cost and available at their convenience (Irani et al., 2022). Similar improvement in engagement also observed in more affluent settings when rural patients see that access to medical services and information is more convenient through the internet (Ye et al., 2019; Zhou et al., 2024). Hence, with appropriate tools and designs, a positive health equity effect is achieved when e-health enhances the flow of health information towards hard-to-reach populations with lower socioeconomic status.

Mixed Equity Effect

In some cases, the design standards of e-health interventions can reinforce health inequity among individuals with different education levels due to an insufficient focus on the equity aspect. A study examined the effects of promoting awareness of infectious diseases through health education via text messages. The study illustrated evidence of widening health inequity, where correct knowledge was only provided to those who responded, while respondents with more incorrect answers tended to complete fewer questions. Consequently, only individuals with better knowledge received more new health knowledge (Chib et al., 2012).

4.3.3 Social determinants of health

Social factors shape the rural context where individuals engage with e-health, either promoting or restricting its potential to improve health inequities. The most commonly reported factors with negative equity effects in this review include sociodemographic factors, social norms and health literacy (Irani et al., 2022; Johri et al., 2020; Li et al., 2019). Compared to digital factors, social factors were associated with a broader range of negative influences on health inequities and fewer positive outcomes (see Table 3). This illustrates the implementation challenges when inequalities intersect with e-health interventions.

Negative Equity Effect

The negative effect of sociodemographic factors in this review is primarily driven by age and marginalisation that affect income and education within rural populations (e.g., Udenigwe et al., 2022; Irani et al., 2022; Wahedi et al., 2018). Younger individuals were shown to have better digital skills necessary to engage with complex e-health interventions (Wahedi et al., 2018; Zhang et al., 2022). Even in lower-income settings with a simpler e-health intervention, younger women demonstrated a better comprehension of health content and greater engagement than older users (Irani et al., 2022). The age divide is often attributed to better education among the younger

cohort. In contrast, marginalisation is exacerbated by material conditions such as low income and poor infrastructure. One study found that a marginalised group in rural setting faces unstable electricity, resulting in inconsistent access to mobile phones and e-health interventions. Furthermore, intra-group health inequities widened as wealthier households in the same community could afford backup power generators (Udenigwe et al., 2022).

Health literacy influence a different aspect of e-health engagement than access-related issues shaped by sociodemographic factors. While sociodemographic factors limit an individual's ability to access medical and health services, health literacy determines how effectively an individual interprets and absorbs health information (e.g. Irani et al., 2022; Ji et al., 2024). Individuals with better health literacy are more willing to actively seek health information from diverse digital sources (Ji et al., 2024; Zhang et al., 2022). Conversely, individuals with low health literacy struggle to understand health content and reinforce the health inequities when the better-educated subgroups benefit more from e-health (Chib et al., 2012; Irani et al., 2022). Hence, equitable e-health adoption requires design strategies that align with the targeted users' literacy level.

Figure 5

Distribution of Factors and Their Influence on Health Inequities Across Studies (Social Domain)

Social norms negatively influence health equities by reinforcing gender issues that limit rural women's willingness and ability to adopt e-health. In some contexts, women occupy socially disadvantaged positions with low education and limited literacy, which contribute to their reluctance to engage with e-health (e.g. Irani et al., 2022; Choudhury and Choudhury, 2022). For instance, among the Indigenous population, tribal pregnant women resisted using m-Health for maternal care due to scepticism towards learning through technology (Choudhury and Choudhury, 2022). In certain settings, rural pregnant women distrust the cost-free nature of e-health services (Irani et al., 2022). Furthermore, studies have shown that women are less likely than men to use e-health to seek health information (Johri et al., 2020; Zhang et al., 2022). However, these sub-groups are often the primary beneficiaries of mHealth programmes, particularly for maternal care in low-income settings (see Table 2). If the underlying gendered issues are not addressed, e-health implementation may reinforce health inequity, perpetuating these social inequalities.

Positive Equity Effect

The increased availability of health services was facilitated by the mobility of e-health interventions and their successful integration into the public health system (e.g. Udenigwe et al., 2022; Laar et al., 2019). Community health workers (CHW) play a central role in the public health systems of rural LMICS. E-health has enhanced both the frequency and quality of communication between CHWS and the local population through better-supported household visits (Modi et al., 2019) and remote consultations (Laar et al., 2019). For instance, in one integrative programme, subscribing to a low-cost mHealth programme allows rural women to access pregnancy care and emergency hospital transportation without charge (Udenigwe et al., 2022). Sneha et al. (2023) further demonstrated the potential of mobile screening devices to provide eye disease screening services in remote communities. These instances suggest that the equity effects of e-health implementation do not rely solely on digital factors but can be enhanced by collaborative efforts with the local social structure.

Mixed Equity Effect

Findings from this review indicate that in specific contexts, individual social factors can affect health inequities in ways that differ from typical patterns. For example, while existing social norms often lead to negative equity effects, a study by Udenigwe et al. (2022) showed that when e-health interventions empowered women to make their own health decisions, it reduced the negative impact of their lower social status by decreasing their dependence on their spouses and improving their access to health services. Additionally, sociodemographic factors often limit access to e-health for certain subgroups (e.g., Udenigwe et al., 2022; Irani et al., 2022). However, when e-health interventions successfully reached these marginalised groups, they often resulted in the greatest equity gains from e-health due to their initial disadvantage, such as higher cost savings and improved access to healthcare (Haenssgen et al., 2020; Dev et al., 2023).

4.3.4 Overview for Social-level Analysis

Using the Digital Health Equity Framework classification system, this review categorises determinants into four social levels: individual, interpersonal, community and societal. In summary, individual-level factors were coded most frequently, while interpersonal-level factors were coded the least. At the individual level, factors were more often linked to negative health equity effects, whereas community-level factors showed more positive equity outcomes (see

Table 4). This section examines patterns and interdependencies across levels to explore how these determinants jointly shape health inequities in e-health implementation. The distribution of determinants' equity effect categorised by social levels across studies is shown in Figure 6.

Table 4

Number of factors and Their Health Equity Effect by Social Levels

Social Levels	Unique Count	Total Count	Source
Social Levels			
Individual	11	36	e.g. Udenigwe et al. (2022); Laar et al. (2019)
Interpersonal	5	9	e.g. Ye et al. (2019); Irani et al. (2022)
Community	7	20	e.g. Udenigwe et al. (2022); Laar et al. (2019)
Societal	4	16	e.g. Sneha et al. (2023); Irani et al. (2022)
Total	27	81	
Social Levels by Positive and Negative Equity Effect			
Positive Equity Effect			
Individual	4	8	e.g. Ye et al. (2019); Irani et al. (2022)
Interpersonal	1	4	e.g. Laar et al. (2019); Yankappa et al. (2024)
Community	4	11	e.g. Udenigwe et al. (2022); Laar et al. (2019)
Societal	3	9	e.g. Irani et al. (2022); Sosanya et al. (2024)
Negative Equity Effect			
Individual	8	28	e.g. Laar et al. (2019); Yi et al. (2019)
Interpersonal	4	5	e.g. Udenigwe et al. (2022); Laar et al. (2019)
Community	3	9	e.g. Udenigwe et al. (2022); Laar et al. (2019)
Societal	4	7	e.g. Sneha et al. (2023); Irani et al. (2022)

Individual Level

At the individual level, population baseline characteristics such as income, education and digital skills create layered access barriers. Lower-income individuals frequently face overlapping challenges, including limited access to mobile phones, insufficient airtime and low digital literacy that restrict their ability to engage with digital tools and platforms (e.g., Udenigwe et al., 2022; Zhang et al., 2022; Laar et al., 2019). As e-health systems evolve from basic messaging to more interactive applications, these material barriers are increasingly compounded by low educational attainment and reduced health literacy, particularly among older rural adults, which further diminishes their capacity to benefit from e-health interventions (Irani et al., 2022; Wahedi et al., 2018).

Improved attitudes towards e-health use can trigger positive behavioural spillovers. In one study, an m-Health intervention targeting rural women led to better practices in managing diarrhoea, family planning and nutrition, while also raising awareness of household health behaviours (Irani et al., 2022). These effects suggest that individual engagement with e-health may extend beyond the user, particularly in households where health decision-making reflects underlying social roles. This interdependence highlights how individual health behaviours and outcomes are tied to interpersonal dynamics, especially in the context of access to digital tools in rural LMIC settings.

Interpersonal Level

At the interpersonal level, access to and usage of e-health are influenced by household power dynamics and social roles, particularly for women in rural areas. Research suggests that women's access to mobile devices is often controlled by male family members, which limits their participation in m-health programmes (e.g. Udenigwe et al., 2022; Laar et al., 2019). Family financial control, restrictive family norms and fear of conflict all hinder women's autonomy over e-health engagement. For example, some studies have reported that husbands have refused or actively restricted their spouses' use of mobile phones for e-health use (Irani et al., 2022; Laar et al., 2019). The findings highlight how gender inequality within households can lead to health inequities and hinder rural mothers' access to maternal e-health interventions. In contrast, improved patient–clinician communication, enabled by phone calls and remote consultations, enhanced trust and continuity of care (Laar et al., 2019; Ye et al., 2019). However, when e-health systems lacked qualified support personnel, patients reported receiving inaccurate advice, which led to breakdowns in trust (Zhou et al., 2024). These examples demonstrate the interrelationship between individuals dynamically shaping health inequities in e-health implementation.

Community Level

At a community level, differences in local infrastructure such as electricity, mobile networks, and healthcare capacity affect collective access to e-health. Inadequate infrastructure in disadvantaged areas limits the reach and reliability of digital health services (Udenigwe et al., 2022; Laar et al., 2019; Johri et al., 2020). Although e-health can overcome geographic isolation (Zhou et al., 2024), its success relies on minimum thresholds of community-level readiness. Alternatively, some studies demonstrated examples of utilising local networks by involving community health workers (CHWs) as digital intermediaries. CHWs help bridge health literacy and technology gaps, particularly for rural populations unfamiliar with or unable to afford e-health tools. Their integration into e-health systems improved service continuity and care quality for rural populations (Udenigwe et al., 2022; Laar et al., 2019; Zhou et al., 2024). Interventions aligned with local capacity can enable more equitable e-health outcomes, especially when addressing community-level disadvantage.

Societal Levels

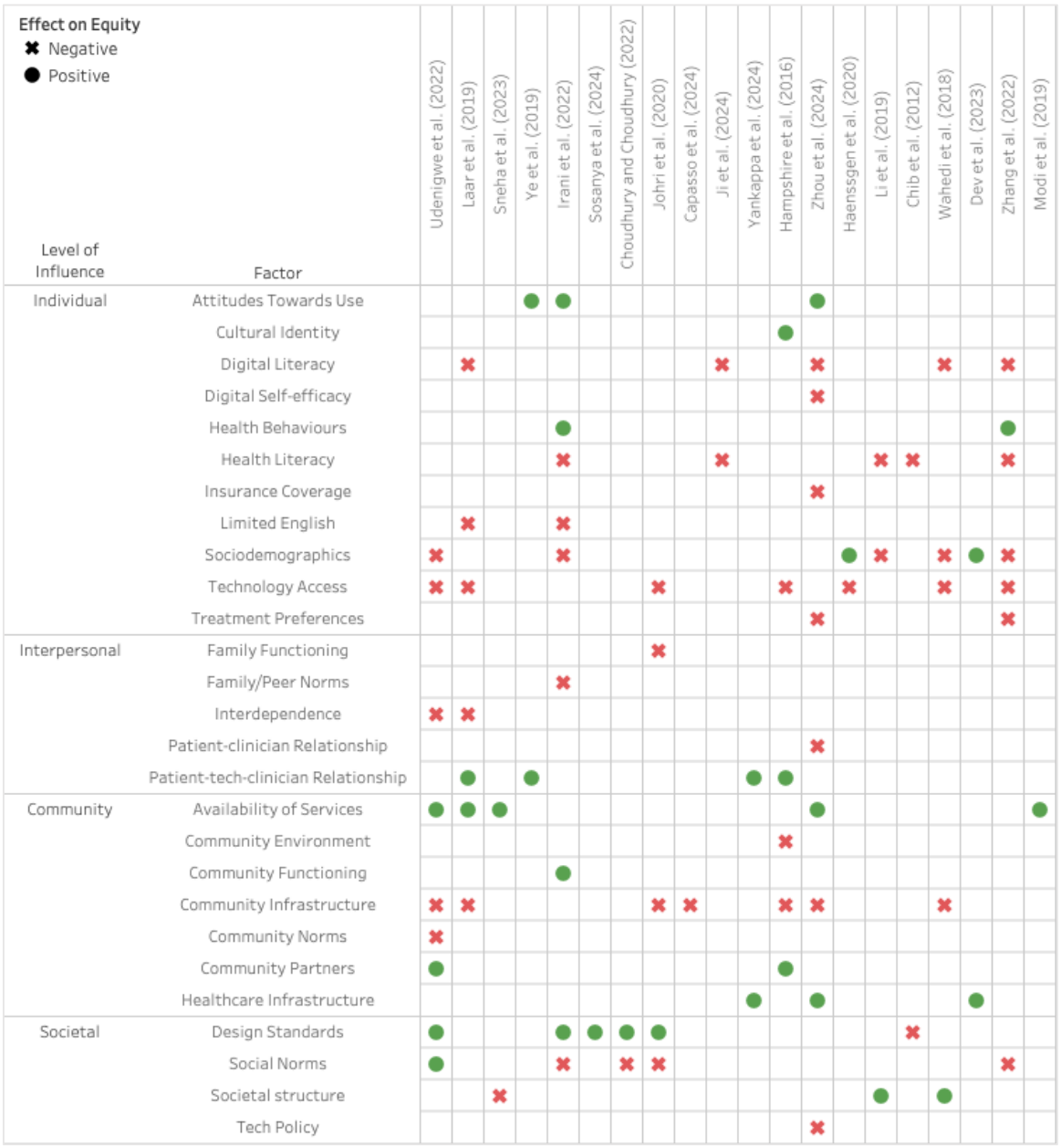
At the societal level, social norms and societal structure influence the condition where e-health is implemented. Social norms are often associated with gender inequity in rural LMIC, assuming women to be poorly educated and to fulfil the role of a housewife (Choudhury and Choudhury, 2022). This reinforced their lower socioeconomic status and restricted their uptake of e-health interventions (Choudhury and Choudhury, 2022; Johri et al., 2020; Zhang et al., 2022). Alternatively, interventions that empowered rural women's health decision-making improved their access to care (Udenigwe et al., 2022). Societal structure also plays a role in regional health inequities. For instance, a study found that an e-diagnostic device couldn't be used in mountainous areas because of inadequate transport systems (Sneha et al., 2023). On the other hand, being remote has actually driven the adoption of e-health as a practical alternative to travelling long distances (Li et al., 2019; Wahedi et al., 2018). As a result, societal-level influences can both enable and hinder equity outcomes, depending on how interventions interact with existing structural conditions.

Across different levels, the findings indicate that health inequities rarely stem from a single factor. Instead, they arise from the combination of material and structural barriers that exist at various

social levels. These interconnected effects show how individual access, household power, community capacity and societal context work together to shape the outcomes of e-health implementation. The next section builds on these findings to develop an integrated model and examine its implications for understanding and addressing health inequities in LMIC settings.

Figure 6

Distribution of Factors and Their Health Equity Effects Across Studies by Social Levels



5 Discussion

This discussion interprets the review's key findings on how e-health implementation affects health inequities in rural LMICs. It first summarises general findings, followed by a discussion of the integrative model and this review's theoretical implications. The section concludes with the review's limitations and recommendations for future research.

5.1 General Findings

This systematic literature review found 334 studies through the literature search, and 20 were selected for the final review based on the eligibility criteria. A deductive thematic analysis was conducted using the Digital Health Equity Framework to examine how e-health implementation affected health inequities in rural populations of LMICs, taking into account digital and social determinants of health. Almost all the included studies were published after 2019, mirroring a trend in studies from high-income countries: a growing interest in e-health and digital health equity in LMIC settings (Badr et al., 2024).

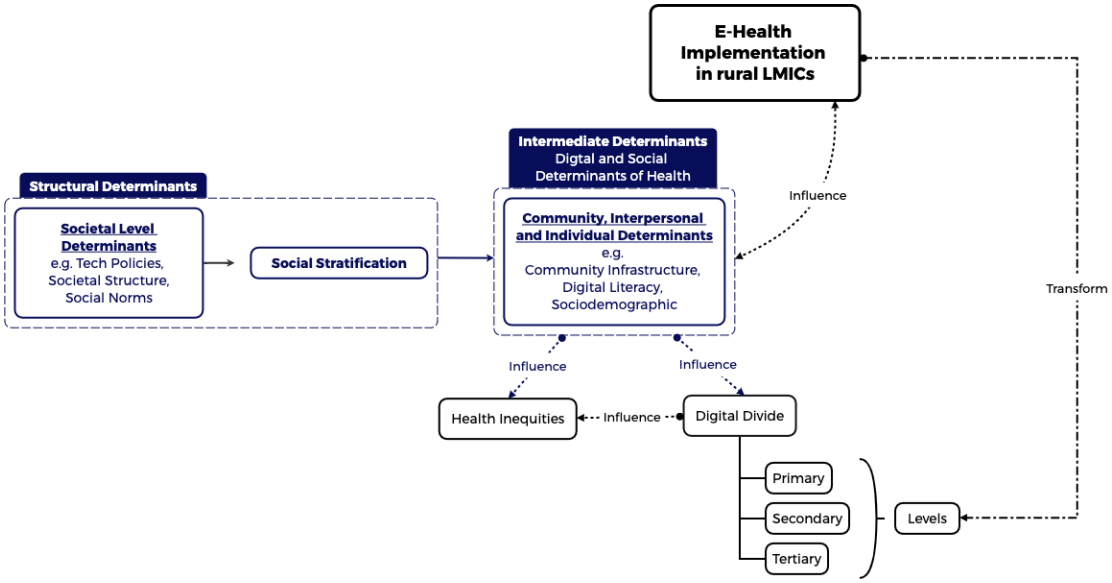
In this review, 27 individual determinants were identified to influence health inequities. The most frequently reported digital determinants associated with worsened health inequities were community infrastructure, technology access and digital literacy, while social determinants included sociodemographic factors, health literacy and social norms. Alternatively, determinants that reduce health inequities include design standards, healthcare infrastructure, attitudes towards use and the availability of services. Generally, determinants were reported to have a consistent direction of equity effects across studies, with social determinants being reported more frequently and more often associated with negative outcomes. Nevertheless, several determinants exert both positive and negative effects in different contexts. Across social levels, determinants from individual levels were reported most frequently, followed by community, societal and interpersonal levels.

Throughout the coding process, the 27 individual factors identified were coded for 81 equity effects across all included studies. Synthesising these findings across social levels, two central patterns emerged: the influence of social stratification and the dynamic effects of the digital divide. This thesis developed an integrative model to consolidate these findings and visualise how e-health implementation interacts with digital and social determinants of health to affect health inequities in rural LMICs (Figure 5). The model adapts the Commission on Social Determinants of Health (CSDH) Framework (Solar & Irwin, 2010) and integrates elements from the Digital Health Equity Framework (DHEF) (Richardson et al., 2022), contextualising them within the rural LMIC setting.

The following subsections begin with an overview of the model structure, followed by a discussion of the two key theoretical implications emerging from these themes, along with propositions. Detailed supporting evidence from the review's findings for the model construction is illustrated alongside the discussion of implications.

Figure 4

The Integrative Model of E-Health Influence on Health Inequities



Note. Solid lines indicate direct causal relationships; dotted lines represent indirect or influencing relationships between domains. Elements in blue are adapted from the CSDH framework and Digital Health Equity Framework.

5.2 Integrative Model of Digital and Social Determinants of Health in E-health Implementation

This model illustrates how determinants of health and the digital divide influence the effects of e-health implementation on health inequities in rural LMICs, based on findings from this review. The explanation is structured in two parts: 1) the integration of the DHEF and CSDH Framework, and 2) the incorporation of e-health implementation and the transformation of the digital divide.

The model distinguishes societal-level determinants from intermediate determinants by drawing on Solar and Irwin's (2010) clarification of the structural drivers of health inequities, which shape social stratification but are "not directly measurable at the individual level" (p. 25). These upstream determinants include broad societal structures and social norms aligned with the societal-level constructs in the DHEF (Sneha et al., 2023; Irani et al., 2022). In contrast, the remaining digital and social factors, including sociodemographic attributes, technology access and digital literacy are categorised as intermediate determinants. These factors function at the individual, interpersonal and community levels, exerting a more immediate influence on health inequities (e.g., Udenigwe et al., 2022; Laar et al., 2019). Social stratification is not treated as a determinant in itself. Instead, it is viewed as a mechanism through which structural determinants shape exposure to intermediate factors. For example, compounding societal forces such as gender norms and rural-urban inequalities place rural women in disadvantaged positions. These social positions limit their access to digital literacy, technology and healthcare. As a result, their ability to benefit from e-health interventions is reduced (e.g., Irani et al., 2022; Wahedi et al., 2018).

The model positions e-health implementation in rural LMICs as the starting point in the chain of influences. During the implementation process, the role and significance of each determinant of health shift in comparison to their roles in traditional healthcare systems. For example, findings from this review indicate that digital factors—such as digital literacy, community digital infrastructure and technology access—feature more centrally in influencing health inequities, while the physical and built environment is less emphasised in the included studies (see Figure 3). As e-health interventions become more sophisticated, the technological and behavioural demands also change. These changes transform the nature of the digital divide among rural populations and may contribute to increased health inequities (Zhou et al., 2024; Zhang et al., 2022; Li et al., 2019). These shifts show that e-health implementation does not merely operate within existing structures but reshapes how determinants influence health inequities. The integrative model provides a conceptual basis for the theoretical implications outlined below.

5.3 Theoretical Implications

The theoretical implications of this review build on the integrative model by examining how determinants of health and digital divide jointly influence health inequities. In particular, the findings highlight the role of social stratification and the evolving nature of the digital divide in shaping differential equity effects in e-health implementation across rural LMICs.

Social Stratification: The Upstream Structural Determinants of Digital and Social Determinants of Health

Societal structures and social relations assign individuals to different positions, creating stratification that leads to unequal exposure and vulnerability to health risks. This health inequity mechanism where social position influences health outcomes is articulated in Diderichsen's "the mechanisms of health inequality" (Diderichsen, 1998; Solar & Irwin, 2010, pp. 23–24). The findings of this review reinforce this theory by demonstrating how social stratification acts as a structural determinant, shaping both between-group and within-group inequities (e.g. Udenigwe et al., 2022; Haenssgen et al., 2020). Hence, societal structures and norms shape lower-level determinants that influence health inequities.

With regard to between-group inequities, this review illustrates how rural marginalisation shapes the equity outcomes of e-health implementation along the urban–rural continuum (e.g. Haenssgen et al., 2020; Li et al., 2019). Baseline sociodemographic disadvantages, such as lower socioeconomic status (SES) among rural populations, contribute to digital literacy gaps and adoption barriers, limiting their ability to benefit from e-health (Irani et al., 2022; Wahedi et al., 2018). These findings echo the perspective of Weeks et al's (2023) urban-rural inequalities as a driver of health inequities. However, this review also reveals that following e-health implementation, marginalisation can influence the health inequities in other directions. For example, distance from healthcare facilities may encourage e-health utilisation, thereby improving access to healthcare resources for rural users and reducing health inequities (Li et al., 2019).

Structural determinants also influence within-group equity outcomes, particularly gender-related inequities. Long recognised in social epidemiology, the unequal distribution of power enables dominant groups to better avoid health risks (Link et al., 1998). This concept is also an

integral element for the development of the CSDH Framework (Solar & Irwin, 2010, pp. 20-22). This review affirms that power inequalities persist in LMIC rural settings, where entrenched gender norms restrict women's access to both technical tools and healthcare services (e.g. Udenigwe et al., 2022; Laar et al., 2019). As Azad et al. (2020) argue, persistent gender inequities in these regions undermines the potential of e-health to address the pressing challenges of rural maternal mortality in LMICs by limiting e-health adoption among rural mothers (Ward et al., 2024). These restrictions further exacerbate health inequities between men and women in rural populations. Accordingly, this review proposes the following:

Proposition 1: Social stratification intensifies the effect of e-health implementation on health inequities in disadvantaged populations by influencing determinants of health at lower levels.

The Dynamic Digital Divide and The Unintended Consequences of E-Health Implementation

In the context of rural LMICs, findings from this review illustrate that e-health implementation influences health inequities by transforming the digital divide in two key ways: (1) modifying how existing determinants of health affect digital access and use, and (2) contributing to new or intensified inequities as the digital divide evolves from primary to more complex forms with system maturity. Scholars have noted similarities between digital health inequities and the digital divide, highlighting the influence of factors such as digital training and socioeconomic status (SES) on both phenomena (Lythreatis et al., 2021; Saeed & Masters, 2021). Building on this, findings from this review indicate that e-health implementation shifts the technological and behavioural requirements for participation, thereby changing how determinants like SES and digital literacy influence access. For instance, user-centred designs such as call-back systems, SMS platforms and gamified apps can reduce the impact of low literacy or limited financial resources (Laar et al., 2019; Irani et al., 2022). In contrast, interventions requiring smartphones tend to deepen access gaps, as higher SES becomes a more critical factor for participation (Zhou et al., 2024; Zhang et al., 2022).

Furthermore, as e-health systems mature and become more technologically sophisticated, the digital divide transforms from basic access issues (primary level) to more complex disparities in digital skills (secondary level) and health-related outcomes (tertiary level). In lower-income countries, early-stage e-health systems often rely on SMS and voice messages that require minimal digital literacy and financial investment (e.g., Laar et al., 2019; Hampshire et al., 2016; Chib et al., 2012). In these settings, health inequities primarily reflect the original form of the digital divide: limited device ownership. This is consistent with the prevalence of access-related determinants identified in this review, including sociodemographic disadvantage and weak community infrastructure (e.g., Udenigwe et al., 2022; Laar et al., 2019; Johri et al., 2020).

As national income levels rise and digital systems advance, inequities increasingly stem from secondary and tertiary divides. Disparities in digital skills—such as navigating complex interfaces or managing health via web portals—emerge as new barriers (e.g., Ji et al., 2024; Haenssgen et al., 2020). In parallel, the primary divide also evolves: inequalities in the type and quality of device access (e.g., smartphone models or internet connectivity) deepen, further stratifying health benefits (Taylor et al., 2019). Hence, the evolving demands of e-health technologies may unintentionally widen health inequities, particularly among already marginalised rural populations.

Proposition 2: The implementation of e-health unintentionally reinforced health inequities as the transformation of the digital divide widened the existing gap among rural populations.

However, evidence from this review also highlights how tailored implementation strategies and inclusive e-health designs can help mitigate the digital divide, thereby contributing to reduced health inequities (Irani et al., 2022; Johri et al., 2020). Further research is needed to examine whether the emphasis on user-centred design observed in broader implementation literature holds relevance within the rural LMIC e-health context. The following sections begin by outlining the limitations of this review, followed by directions for future research that build on its findings and identified gaps.

5.4 Limitations

The generalisability of this review's findings is a key limitation. Effects on health inequities following e-health implementation are often shaped by barriers to use and adoption (e.g., Udenigwe et al., 2022; Laar et al., 2019), which vary across social contexts and population characteristics. Even in rural LMICs, influences of determinants differ according to factors such as countries' income levels, specific e-health objectives and SES of end users (see Table 2, Figures 3 and 4). Nonetheless, recurring themes such as gender inequities and the digital divide highlight common challenges that e-health implementation strategies must tackle to ensure equitable adoption. For example, given the vulnerability of rural women and the high rate of maternal mortality in these settings (Ward et al., 2024; Azad et al., 2020), future research into the interplay between gender inequalities and e-health adoption could be valuable for reducing the rural maternal mortality in rural LMICs.

This review also has methodological limitations, particularly regarding the operationalisation of health equity. In this review, health equity was defined as "absence of unfair and avoidable or remediable differences in health" (WHO, 2018). However, the interpretation of equity outcomes may vary depending on the reviewers' choice of reference point. For instance, this review examines the within-group heterogeneities of rural populations in equity outcomes as well. While this approach aligns with Penman-Aguilar et al.'s (2015) call to consider both within- and between-group inequities, it risks overestimating the negative influence when intra-group inequalities are extensive. The need for equity effects interpretation also reflects the challenges stemming from the lack of consensus on the definition of health equity and the limited availability of methods for its measurement (Hoyer et al., 2022). As Zimmerman (2019) suggests, relying on health inequalities as proxy measures may not accurately capture the health inequity phenomenon. Future empirical health equity studies should consider using more precise health equity measures distinct from general health disparities.

Limitations also arise from the coding approach adopted in this study. The social determinants in the Digital Health Equity Framework lack extended explanations, and without employing a collaborative coding process, the review may introduce potential subjective bias in how determinants were classified. For transparency, a complete codebook can be found in Appendix 2. Furthermore, the development of eligibility criteria and the screening process were conducted by a single author, introducing potential selection bias. The author used the PICO framework for eligibility criteria development to mitigate this risk and followed a structured screening process. Lastly, the literature search was limited to a single database and publications in English, potentially excluding studies not indexed in the WoS or published in the local languages of LMICs.

Based on the discussed review's findings, model's theoretical contributions, implications and limitations, the following section proposes a forward-looking research agenda to guide future inquiry across disciplinary domains.

5.5 Research Agenda

This section outlines research questions derived from the review's findings and integrative model, organised by thematic focus and disciplinary relevance (see Table 5). While this review focused on rural LMICs, further research is needed to understand whether the model applies to other disadvantaged groups' contexts. For example, rural populations in higher-income countries may experience different degrees of digital divide due to differences in income or infrastructure. Also, whether the digital literacy gap persists consistently across global rural settings remains unclear.

Moreover, new challenges may arise as e-health in LMICs increasingly targets non-communicable diseases (NCDs). These interventions often require smartphones and advanced e-health literacy, which may not be accessible to all. Evidence suggests that digital literacy is a key equity barrier in chronic disease management, particularly in upper-middle-income countries (Zhou et al., 2024; Zhang et al., 2022). Bridging this higher-order digital divide may demand structural investment in education, yet the gap may persist or even widen due to existing inequalities (Kuo-Hsun et al., 2018; Büchi et al., 2015). Further research is needed to understand how evolving e-health demands interact with persistent inequities in NCD care.

Finally, while gender health inequities appeared in some included studies, further research is needed to assess their consistency across rural LMICs. Interventions tailored to the local marginalised subgroups, such as empowering rural women in health decision-making and facilitating healthcare access for remote communities, showed positive equity effects (Udenigwe et al., 2022; Haenssgen et al., 2020). However, it remains unclear whether such design-phase considerations are sufficient to address deeper structural power inequalities.

Table 5 Summary Future Research Opportunities

Major Topic	Relevant Discipline	Research Questions
Generalisability of the model	Health Equity, Global Health, Implementation	• How transferable is the model to other disadvantaged contexts (e.g. rural HICs)? • How do baseline income levels shape the digital divide across contexts? • Is the digital literacy gap consistent across rural populations in HICs and LMICs?
NCD-oriented E-health and Digital Divide	E-Health, Public Health, Global Health	• How do the technological requirements for e-health evolve as e-health systems mature in LMICs? • How can e-health systems address the secondary digital divide in NCD management? • To what extent does investment in education reduce the digital divide among digitally underserved groups, such as rural adolescents?
Gender Health Inequities	Social Epidemiology, Health Equity	• How persistent and widespread are gender-based health inequities in rural LMICs during e-health implementation? • Can equity-oriented design features effectively shift structural gendered power dynamics?

6 Conclusion

This thesis explored the impact of e-health implementation on health inequities in rural low- and middle-income countries (LMICs) through a systematic literature review, guided by the Digital Health Equity Framework. Using deductive thematic analysis, the review identified 27 digital and social determinants of health and examined their patterns of influence across individual, interpersonal, community and societal levels. Social determinants, particularly socio-demographic status, health literacy and gender norms, were often linked to negative equity effects. In contrast, digital determinants showed more mixed effects, with equity effects influenced by technological design and community readiness.

Two key themes emerged from the synthesis. First, the influence of social stratification, where structural determinants shape social positions and affect downstream determinants. Second, the transformation of the digital divide, where technological and behavioural demands evolve with system maturity, potentially reinforcing existing health inequities. These themes informed an integrative model that connects structural and intermediate determinants, the digital divide, and e-health implementation to illustrate how health inequities shift over time.

Overall, this review illustrates that advancing health equity is not merely an ethical concern but also a practical necessity for effective e-health implementation. Equity-sensitive design and infrastructure readiness are important for rural LMIC populations who already experience exclusion from traditional health systems. These strategies can help alleviate the structural disadvantages shaped by social stratification and ensure that e-health does not reinforce existing inequities. Placing equity at the heart of e-health implementation strategies strengthens the reach and sustainability of e-health in resource-limited settings.

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7 Appendices

Appendix 1 *Definition of digital determinants of health at each social level (Richardson et al., 2022)*

Level of Influence	Definition
Individual Level Determinant	***Digital literacy*** - skills and abilities necessary for digital access and navigating technology ***Digital self-efficacy*** - an individual's self-efficacy with regard to effective and effortless utilisation of information technology and predicts proficiency ***Technology access*** - necessary technological equipment availability to an individual ***Attitude towards use*** - individual desire and willingness to use, trust in, and beliefs about their ability to use digital tools
Interpersonal Level Determinant	***Implicit tech bias*** - *the* impact that unconscious perceptions of an individual's digital literacy, technology access and attitudes towards use have on clinicians' willingness to enroll and engage individuals with digital healthcare tools ***Interdependence*** - positive adaptive mechanism serves as positive social capital and facilitates healthy behaviours for both individuals and larger group networks. ***Patient-tech-clinician relationship*** - complex interpersonal transformations encouraged by digital technologies, which impact power dynamics between individuals.
Community Level Determinant	***Community infrastructure*** - cellular wireless and broadband access, quality and affordability. Forms of e-Health availability are restricted with limited access to broadband services. ***Healthcare infrastructure*** - community access to the healthcare system with advanced digital capabilities. ***Community tech norms*** - community preference for particular tools such as high- vs low-tech solutions ***Community partners*** - contributors to the local digital equity ecosystem, the socio-technical systems that work to increase access
Societal Level Determinant	***Tech policy*** - national and local policies supporting healthcare technology adoption, development and innovation ***Data standards*** - created and maintained by professional organisations that impact the ability of organisations to measure and monitor progress towards equity ***Design standards*** - impact accessibility for those with disabilities and low digital health literacy ***Social norms and Ideologies*** - set of beliefs and philosophies that impact who develops digital tools, what is developed, how it is used and who it is used by ***Algorithmic bias*** - bias in the use of machine learning and artificial intelligence, as well as racial bias in health algorithms that do not use these advanced statistical and computational methodologies

Appendix 2 *PRISMA-E Checklist*

Section and Topic	Item #	Checklist item	Extension for Equity-Focused Reviews (PRISMA-E 2012 Checklist)	Page reported (PRISMA|PRISMA-E)
TITLE				
Title	1	Identify the report as a systematic review.	Identify equity as a focus of the review, if relevant, using the term equity	Cover Page
ABSTRACT				
Abstract	2	See the PRISMA 2020 for Abstracts checklist.		
	2A		Present results of health equity analyses (e.g. subgroup analyses or meta-regression).	Abstract
	2B		Describe extent and limits of applicability to disadvantaged populations of interest.	Abstract
INTRODUCTION				
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Describe assumptions about mechanism(s) by which the intervention is assumed to have an impact on health equity.	1,2 | 1
	3A		Provide the logic model/analytical framework, if done, to show the pathways through which the intervention is assumed to affect health equity and how it was developed.	| 4,5
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Describe how disadvantage was defined if used as criterion in the review (e.g. for selecting studies, conducting analyses or judging applicability).	2 | 2
	4A		State the research questions being addressed with reference to health equity	| 2
METHODS				
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Describe the rationale for including particular study designs related to equity research questions.	6,7 | 11
	5A		Describe the rationale for including the outcomes - e.g. how these are relevant to reducing inequity.	| 6
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Describe information sources (e.g. health, non-health, and grey literature sources) that were searched that are of specific relevance to address the equity questions of the review.	7 | 7

Section and Topic	Item #	Checklist item	Extension for Equity-Focused Reviews (PRISMA-E 2012 Checklist)	Page reported (PRISMA|PRISMA-E)
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Describe the broad search strategy and terms used to address equity questions of the review.	7,8 | 7,8
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.		8
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.		8
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.		10
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	List and define data items related to equity, where such data were sought (e.g. using PROGRESS-Plus or other criteria, context).	10|10
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.		13
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.		13
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).		13
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.		13
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.		13
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	Describe methods of synthesizing findings on health inequities (e.g. presenting both relative and absolute differences between groups).	13
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).		N/A

Section and Topic	Item #	Checklist item	Extension for Equity-Focused Reviews (PRISMA-E 2012 Checklist)	Page reported (PRISMA|PRISMA-E)
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	Describe methods of additional synthesis approaches related to equity questions, if done, indicating which were pre-specified	N/A
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).		N/A
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.		13
RESULTS				
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.		14
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.		14
Study characteristics	17	Cite each included study and present its characteristics.	Present the population characteristics that relate to the equity questions across the relevant PROGRESS-Plus or other factors of interest.	17|17
Risk of bias in studies	18	Present assessments of risk of bias for each included study.		N/A
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.		19,25
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Present the results of synthesizing findings on inequities (See 13d)	20,26
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.		20,26
	20c	Present results of all investigations of possible causes of heterogeneity among study results.		N/A
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	Give the results of additional synthesis approaches related to equity objectives, if done, (see 13f).	N/A
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.		N/A
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.		N/A
DISCUSSION				

Section and Topic	Item #	Checklist item	Extension for Equity-Focused Reviews (PRISMA-E 2012 Checklist)	Page reported (PRISMA|PRISMA-E)
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.		29
	23b	Discuss any limitations of the evidence included in the review.	Present extent and limits of applicability to disadvantaged populations of interest and describe the evidence and logic underlying those judgments.	31,32|31,32
	23c	Discuss any limitations of the review processes used.		32
	23d	Discuss implications of the results for practice, policy, and future research.	Provide implications for research, practice or policy related to equity where relevant (e.g. types of research needed to address unanswered questions).	29,30,31|32
OTHER INFORMATION				
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.		N/A
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.		N/A
	24c	Describe and explain any amendments to information provided at registration or in the protocol.		N/A
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.		N/A
Competing interests	26	Declare any competing interests of review authors.		N/A
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.		N/A

Appendix 3 Full Code Book

Study	Paper No.	Factor	Domain of Influence	Level of Influence	Effect on Equity	Mechanism
Udenigwe et al. (2022)	1	Family/Peer Norms	Sociocultural Environment	Interpersonal	Negative	Women in the household are less likely to own a mobile phone, limiting their access to maternal mHealth programmes.
Udenigwe et al. (2022)	1	Sociodemographics	Sociocultural Environment	Individual	Negative	The compounded accessibility challenges for rural women residing in more remote areas are closely linked to socioeconomic status.
Udenigwe et al. (2022)	1	Social Norms	Sociocultural Environment	Societal	Positive	Program to empower women in making healthcare-seeking decisions and promoting access to healthcare services.
Udenigwe et al. (2022)	1	Availability of Services	Health Care System	Community	Positive	Low-cost integrated programmes allow participants to access free pregnancy care and emergency transportation.
Udenigwe et al. (2022)	1	Design Standards	Digital Environment	Societal	Positive	The design of the integrated programme allows participants to access comprehensive maternal care.
Udenigwe et al. (2022)	1	Community Infrastructure	Digital Environment	Community	Negative	A poor supply of electricity and inadequate network coverage hindered the functioning of mobile phones and the utilisation of mHealth.
Udenigwe et al. (2022)	1	Community Partners	Digital Environment	Community	Positive	Community health workers with a higher level of digital literacy provide training to local women for the effective use of the mHealth programme.
Udenigwe et al. (2022)	1	Interdependence	Digital Environment	Interpersonal	Negative	Women rely on their spouses to gain access to mHealth programmes
Udenigwe et al. (2022)	1	Community Norms	Sociocultural Environment	Community	Negative	Concerns about interaction with the community driver (non-spouse man) raise suspicion in the community.
Laar et al. (2019)	2	Availability of Services	Health Care System	Community	Positive	Mobile calls enable midwives to conduct remote consultations, thereby reducing geographical barriers.
Laar et al. (2019)	2	Sociodemographics	Sociocultural Environment	Individual	Negative	The lack of access to mobile devices due to cost prevents access to the programme.
Laar et al. (2019)	2	Community Infrastructure	Digital Environment	Community	Negative	Insufficient mobile network coverage and electricity hinder access to the programme.
Laar et al. (2019)	2	Digital Literacy	Digital Environment	Individual	Negative	Individuals, including participants and health workers, lack technical know-how to benefit from the programme.

Study	Paper No.	Factor	Domain of Influence	Level of Influence	Effect on Equity	Mechanism
Laar et al. (2019)	2	Limited English	Sociocultural Environment	Individual	Negative	A low level of education hindered the ability to obtain information from text messages.
Laar et al. (2019)	2	Patient-tech-clinician Relationship	Digital Environment	Interpersonal	Positive	The programme promotes a closer relationship by enabling more frequent communication through mobile calls regarding health status and appointment reminders.
Laar et al. (2019)	2	Interdependence	Digital Environment	Interpersonal	Negative	Women rely on their spouses to gain access to the mHealth programme
Sneha et al. (2023)	3	Availability of Services	Health Care System	Community	Positive	Bring specialist eye care to households' doors
Sneha et al. (2023)	3	Societal structure	Physical/Built Environment	Societal	Negative	Transportation infrastructure limits access by restricting the movement of heavy equipment.
Ye et al. (2019)	4	Patient-tech-clinician Relationship	Digital Environment	Interpersonal	Positive	Enhanced communication and relationships between clinicians and rural populations through improved health information exchange
Ye et al. (2019)	4	Attitudes Towards Use	Digital Environment	Individual	Positive	Rural patients leverage IT more to access medical services.
Irani et al. (2022)	5	Social Norms	Sociocultural Environment	Societal	Negative	Social distrust regarding the credibility of free digital health services
Irani et al. (2022)	5	Health Literacy	Health Care System	Individual	Negative	Lower educational levels limit the ability to comprehend health content.
Irani et al. (2022)	5	Limited English	Sociocultural Environment	Individual	Negative	Language barrier limiting the acceptability of health content
Irani et al. (2022)	5	Community Functioning	Behavioral	Community	Positive	Health information sharing and community support fostered by the use of Mobile Vaani.
Irani et al. (2022)	5	Attitudes Towards Use	Digital Environment	Individual	Positive	Positive attitude towards freely accessible health content
Irani et al. (2022)	5	Sociodemographics	Sociocultural Environment	Individual	Negative	Younger, more educated women exhibit higher levels of engagement with e-health interventions than their less educated elderly counterparts.
Irani et al. (2022)	5	Health Behaviours	Behavioral	Individual	Positive	Improved health behaviour resulting from sharing health information within the family
Irani et al. (2022)	5	Family/Peer Norms	Sociocultural Environment	Interpersonal	Negative	Access to the mobile device is restricted by the partner due to gendered family expectations and fear of domestic conflict.

Study	Paper No.	Factor	Domain of Influence	Level of Influence	Effect on Equity	Mechanism
Irani et al. (2022)	5	Design Standards	Digital Environment	Societal	Positive	The inclusion of a call-back system improves user engagement.
Sosanya et al. (2024)	6	Design Standards	Digital Environment	Societal	Positive	App design aligns with the digital literacy of the target population to promote engagement.
Sosanya et al. (2024)	6	Design Standards	Digital Environment	Societal	Positive	The gamification of apps yields better knowledge enhancement and behavioural change than verbal training for teenage mothers.
Choudhury and Choudhury (2022)	7	Social Norms	Sociocultural Environment	Societal	Negative	Women in tribal societies exhibit resistance to learning through technology.
Choudhury and Choudhury (2022)	7	Design Standards	Digital Environment	Societal	Positive	App design aligns with the digital literacy of the targeted population to promote engagement.
Johri et al. (2020)	8	Community Infrastructure	Digital Environment	Community	Negative	Poor mobile network infrastructure limits programme reach
Johri et al. (2020)	8	Social Norms	Sociocultural Environment	Societal	Negative	The low level of women's empowerment has limited uptake due to gender norms.
Johri et al. (2020)	8	Technology Access	Digital Environment	Individual	Negative	Ownership of a mobile device is essential for mHealth engagement.
Johri et al. (2020)	8	Family Functioning	Behavioral	Interpersonal	Negative	Intra-household dynamics limit mobile access and affect adoption among mothers.
Johri et al. (2020)	8	Design Standards	Digital Environment	Societal	Positive	Appropriate implementation strategies such as a call-back system promote reach.
Capasso et al. (2024)	9	Community Infrastructure	Digital Environment	Community	Negative	Communities without adequate mobile network coverage are prevented from accessing the programme.
Ji et al. (2024)	10	Digital Literacy	Digital Environment	Individual	Negative	The level of digital literacy influences the engagement level and benefits gained from digital health behaviour.
Ji et al. (2024)	10	Health Literacy	Health Care System	Individual	Negative	Health literacy positively correlates with the diversity of digital behaviour and the range of health information absorbed.
Yankappa et al. (2024)	11	Patient-tech-clinician Relationship	Digital Environment	Interpersonal	Positive	Mobile applications improve communication between patients and clinicians, ensuring continuity of care.
Yankappa et al. (2024)	11	Healthcare Infrastructure	Digital Environment	Community	Positive	Previously underserved rural patients gained access to healthcare services through telemedicine.

Study	Paper No.	Factor	Domain of Influence	Level of Influence	Effect on Equity	Mechanism
Hampshire et al. (2016)	12	Community Environment	Physical/Built Environment	Community	Negative	Unevenly distributed phone credit shops in rural areas create structural barriers for healthcare workers to access mobile services equitably in urgent situations.
Hampshire et al. (2016)	12	Community Infrastructure	Digital Environment	Community	Negative	Mobile network coverage differentiates access to remote health services.
Hampshire et al. (2016)	12	Technology Access	Digital Environment	Individual	Negative	Mobile ownership for CHWs is essential for providing access to medical emergency services for populations in remote areas.
Hampshire et al. (2016)	12	Patient-tech-clinician Relationship	Digital Environment	Interpersonal	Positive	CHWs can easily provide general health information through improved communication.
Hampshire et al. (2016)	12	Cultural Identity	Sociocultural Environment	Individual	Positive	Healthcare workers who are willing to sacrifice their personal time to provide counselling services, influenced by both professional and religious factors.
Hampshire et al. (2016)	12	Community Partners	Digital Environment	Community	Positive	Enhanced access to emergency services through better communication with local volunteers
Zhou et al. (2024)	13	Community Infrastructure	Digital Environment	Community	Negative	Unstable mobile network coverage discourages adoption.
Zhou et al. (2024)	13	Patient-clinician Relationship	Health Care System	Interpersonal	Negative	Lack of access to qualified clinicians in remote conditions reduces trust and the effectiveness of care.
Zhou et al. (2024)	13	Digital Literacy	Digital Environment	Individual	Negative	A lower level of digital literacy creates functional barriers.
Zhou et al. (2024)	13	Digital Self-efficacy	Digital Environment	Individual	Negative	Variations in perceived confidence regarding use result in inconsistent adoption.
Zhou et al. (2024)	13	Attitudes Towards Use	Digital Environment	Individual	Positive	The perceived ease of accessing health information encourages engagement.
Zhou et al. (2024)	13	Treatment Preferences	Health Care System	Individual	Negative	The severity of a disease creates differing willingness to adopt telehealth platforms.
Zhou et al. (2024)	13	Tech Policy	Digital Environment	Societal	Negative	Insufficient promotion of e-Health services restricted awareness.
Zhou et al. (2024)	13	Insurance Coverage	Health Care System	Individual	Negative	The exclusion of telehealth from insurance coverage has limited its adoption due to financial burdens.
Zhou et al. (2024)	13	Healthcare Infrastructure	Digital Environment	Community	Positive	Telehealth enables access to consultations and health advice remotely.
Zhou et al. (2024)	13	Availability of Services	Health Care System	Community	Positive	Facilitates remote follow-up consultations to ensure an expanded level of continuity of care.

Study	Paper No.	Factor	Domain of Influence	Level of Influence	Effect on Equity	Mechanism
Haenssgen et al. (2020)	14	Technology Access	Digital Environment	Individual	Negative	The advantage of quicker access to formal care depends on ownership of the device.
Haenssgen et al. (2020)	14	Sociodemographics	Sociocultural Environment	Individual	Positive	The marginalised group shows improved access to healthcare services through phone use, compared to the non-marginalised group.
Li et al. (2019)	15	Sociodemographics	Sociocultural Environment	Individual	Negative	The use of web-based healthcare services is more concentrated in urban populations with higher socioeconomic status.
Li et al. (2019)	15	Health Literacy	Health Care System	Individual	Negative	Higher health literacy is associated with a greater willingness to engage in web-based communication and consultation with healthcare professionals.
Li et al. (2019)	15	Societal structure	Physical/Built Environment	Societal	Positive	Greater distance to hospitals motivates the rural population to use the internet to access health information online.
Chib et al. (2012)	16	Health Literacy	Health Care System	Individual	Negative	Health education programmes could reinforce the health literacy gap.
Chib et al. (2012)	16	Design Standards	Digital Environment	Societal	Negative	Poor programme design exacerbated health inequity.
Wahedi et al. (2018)	17	Community Infrastructure	Digital Environment	Community	Negative	Inadequate local mobile network coverage created a barrier to usage for poorer communities.
Wahedi et al. (2018)	17	Digital Literacy	Digital Environment	Individual	Negative	The use of the platform requires adequate digital skills for navigation, such as code identification.
Wahedi et al. (2018)	17	Societal structure	Physical/Built Environment	Societal	Positive	Existing spatial and physical barriers for health complaints, such as travel costs and time, are alleviated by SMS and online platforms.
Wahedi et al. (2018)	17	Sociodemographics	Sociocultural Environment	Individual	Negative	A younger age was found to be associated with learning capabilities, affecting the ability to use interventions.
Wahedi et al. (2018)	17	Technology Access	Digital Environment	Individual	Negative	Less advanced mobile devices created barriers to typing and writing code, hindering engagement.
Dev et al. (2023)	18	Healthcare Infrastructure	Digital Environment	Community	Positive	The availability of telemedicine through personal devices or community kiosks has reduced travel costs compared to in-person visits, including time lost at work and travel expenses.

Study	Paper No.	Factor	Domain of Influence	Level of Influence	Effect on Equity	Mechanism
Dev et al. (2023)	18	Sociodemographics	Sociocultural Environment	Individual	Positive	Relative cost savings were more significant for families living further away from urban areas with high transportation costs.
Zhang et al. (2022)	19	Social Norms	Sociocultural Environment	Societal	Negative	mHealth utilisation reflected gender inequality, as females show less willingness to adopt.
Zhang et al. (2022)	19	Sociodemographics	Sociocultural Environment	Individual	Negative	Unequal uptake of e-Health based on socioeconomic status and age
Zhang et al. (2022)	19	Treatment Preferences	Health Care System	Individual	Negative	Patients with poorer health status preferred to use e-health less frequently.
Zhang et al. (2022)	19	Health Literacy	Health Care System	Individual	Negative	Patients with higher health literacy exhibit greater engagement, highlighting barriers faced by those with limited literacy.
Zhang et al. (2022)	19	Health Behaviours	Behavioral	Individual	Positive	Patients with lower emotional well-being show higher engagement in online health information-seeking behaviour to address unmet needs.
Zhang et al. (2022)	19	Digital Literacy	Digital Environment	Individual	Negative	Patients with improved digital literacy demonstrated greater engagement.
Zhang et al. (2022)	19	Technology Access	Digital Environment	Individual	Negative	Prerequisites of advanced mobile device ownership exclude those without access to mHealth
Modi et al. (2019)	20	Availability of Services	Health Care System	Community	Positive	Intervention has shown effectiveness in encouraging health workers to adhere to protocols, leading to better quality and frequency of health services.

Appendix 4 Full Search Terms for Low- and Lower-Middle-Income Countries Category

Category	Search Terms	Source
Low- and lower-middle-income countries	"developing country" OR "developing countries" OR "developing nation" OR "developing nations" OR "developing population" OR "developing populations" OR "developing world" OR "less developed country" OR "less developed countries" OR "less developed nation" OR "less developed nations" OR "less developed population" OR "less developed populations" OR "less developed world" OR "lesser developed country" OR "lesser developed countries" OR "lesser developed nation" OR "lesser developed nations" OR "lesser developed population" OR "lesser developed populations" OR "lesser developed world" OR "under developed country" OR "under developed countries" OR "under developed nation" OR "under developed nations" OR "under developed population" OR "under developed populations" OR "under developed world" OR "underdeveloped country" OR "underdeveloped countries" OR "underdeveloped nation" OR "underdeveloped nations" OR "underdeveloped population" OR "underdeveloped populations" OR "underdeveloped world" OR "middle income country" OR "middle income countries" OR "middle income nation" OR "middle income nations" OR "middle income population" OR "middle income populations" OR "low income country" OR "low income countries" OR "low income nation" OR "low income nations" OR "low income population" OR "low income populations" OR "lower income country" OR "lower income countries" OR "lower income nation" OR "lower income nations" OR "lower income population" OR "lower income populations" OR "underserved country" OR "underserved countries" OR "underserved nation" OR "underserved nations" OR "underserved population" OR "underserved populations" OR "underserved world" OR "under served country" OR "under served countries" OR "under served nation" OR "under served nations" OR "under served population" OR "under served populations" OR "under served world" OR "deprived country" OR "deprived countries" OR "deprived nation" OR "deprived nations" OR "deprived population" OR "deprived populations" OR "deprived world" OR "poor country" OR "poor countries" OR "poor nation" OR "poor nations" OR "poor population" OR "poor populations" OR "poor world" OR "poorer country" OR "poorer countries" OR "poorer nation" OR "poorer nations" OR "poorer population" OR "poorer populations" OR "poorer world" OR "developing economy" OR "developing economies" OR "less developed economy" OR "less developed economies" OR "lesser developed economy" OR "lesser developed economies" OR "under developed economy" OR "under developed economies" OR "underdeveloped economy" OR "underdeveloped economies" OR "middle income economy" OR "middle income economies" OR "low income economy" OR "low income economies" OR "lower income economy" OR "lower income economies" OR "low gdp" OR "low gnp" OR "low gross domestic" OR "low gross national" OR "lower gdp" OR "lower gnp" OR "lower gross domestic" OR "lower gross national" OR "lmic" OR "lmics" OR "third world" OR "lami country" OR "lami countries" OR "transitional country" OR "transitional countries" OR "Afghanistan" OR "Albania" OR "Algeria" OR "Angola" OR "Argentina" OR "Armenia" OR "Azerbaijan" OR "Bangladesh" OR "Belarus" OR "Belize" OR "Benin" OR "Bhutan" OR "Bolivia" OR "Bosnia and Herzegovina" OR "Botswana" OR "Brazil" OR "Burkina Faso" OR "Burundi" OR "Cabo Verde" OR "Cambodia" OR "Cameroon" OR "Central African Republic" OR "Chad" OR "China" OR "Colombia" OR "Comoros" OR "Congo*" OR "Costa Rica" OR "Côte d'Ivoire" OR "Cuba" OR "Djibouti" OR "Dominica" OR "Dominican Republic" OR "Ecuador" OR "Egypt*" OR "El Salvador" OR "Equatorial Guinea" OR "Eritrea" OR "Eswatini" OR "Ethiopia" OR "Fiji" OR "Gabon" OR "Gambia*" OR "Georgia" OR "Ghana" OR "Grenada" OR "Guatemala" OR "Guinea" OR "Guinea-Bissau" OR "Haiti" OR "Honduras" OR "India" OR "Indonesia" OR "Iran, Islamic Rep." OR "Iraq" OR "Jamaica" OR "Jordan" OR "Kazakhstan" OR "Kenya" OR "Kiribati" OR "Korea, Dem. People's Rep." OR "Kosovo" OR	Bohren et al. (2014); World Bank Group (2025)

"Kyrgyz Republic" OR "Lao PDR" OR "Lebanon" OR "Lesotho" OR "Liberia" OR "Libya" OR "Madagascar" OR "Malawi" OR "Malaysia" OR "Maldives" OR "Mali" OR "Marshall Islands" OR "Mauritania" OR "Mauritius" OR "Mexico" OR "Micronesia, Fed. Sts." OR "Moldova" OR "Mongolia" OR "Montenegro" OR "Morocco" OR "Mozambique" OR "Myanmar" OR "Namibia" OR "Nepal" OR "Nicaragua" OR "Niger" OR "Nigeria" OR "North Macedonia" OR "Pakistan" OR "Papua New Guinea" OR "Paraguay" OR "Peru" OR "Philippines" OR "Rwanda" OR "Samoa" OR "São Tomé and Príncipe" OR "Senegal" OR "Serbia" OR "Sierra Leone" OR "Solomon Islands" OR "Somalia" OR "South Africa" OR "South Sudan" OR "Sri Lanka" OR "St. Lucia" OR "St. Vincent and the grenadines" OR "Sudan" OR "Suriname" OR "Syrian Arab Republic" OR "Tajikistan" OR "Tanzania" OR "Thailand" OR "Timor-Leste" OR "Togo" OR "Tonga" OR "Tunisia" OR "Turkey" OR "Turkmenistan" OR "Tuvalu" OR "Uganda" OR "Ukraine" OR "Uzbekistan" OR "Vanuatu" OR "Vietnam" OR "West Bank and Gaza" OR "Yemen" OR "Zambia" OR "Zimbabwe”