



Review article

Socioeconomic impacts on e-learning accessibility and health literacy in underserved communities: A meta-synthesis

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Abstract

Introduction: Socioeconomic disparities continue to hinder full access to e-learning and digital health resources, making both educational and health equity elusive. This study addresses the research question: How do socioeconomic factors influence the accessibility and effectiveness of e-learning and consequently health literacy in underserved communities?

Methods: A systematic meta-synthesis of qualitative studies was conducted following the process by Noblit and Hare. Studies focusing on health inequalities without a connection to educational access or e-learning were excluded to maintain coherence with the research aim.

Results: The interpretation of the findings resulted in five themes: (1) digital divide, (2) technological and language barriers, (3) inadequate infrastructure, (4) economic constraints, (5) cultural and contextual adaptations.

Conclusion: The digital divide, along with technological proficiency and language barriers, exacerbates educational disparities by limiting access to technology and supportive resources, particularly for non-English speaking populations. The findings underscore the need for a more holistic examination of accessibility beyond educational outcomes, incorporating health literacy dimensions as well.

Keywords: Digital equity; Educational technology; Inclusivity; Multilingual education; Social justice

Introduction

The rapid proliferation of digital technologies and the widespread availability of the internet have revolutionized education, making e-learning a significant mode of learning across the globe. However, despite these technological advancements, the promise of educational equity remains largely unfulfilled. Socioeconomic disparities continue to present substantial barriers, particularly for underserved communities, limiting both access to and the effectiveness of e-learning. These inequalities not only hinder educational opportunities but also contribute to disparities in digital health literacy, an essential component of modern health equity (Azzopardi-Muscat and Sørensen, 2019). This study seeks to explore the complex relationship between socioeconomic factors and the accessibility and efficacy of e-learning in marginalized communities, with a particular focus on how these factors influence health literacy. Just as health inequalities are driven by the social determinants of health (Cuellar, 2021), educational disparities are similarly influenced by socioeconomic status, limiting digital inclusion and affecting digital health literacy.

Socioeconomic status plays a pivotal role in determining access to digital resources, which are crucial for successful participation in e-learning environments. Studies have shown that individuals from higher-income households typically

enjoy greater access to digital devices, reliable internet connections, and supportive home environments conducive to e-learning. In contrast, individuals from lower-income households frequently encounter barriers such as device shortages, high costs of internet access, and limited digital literacy, all of which impair their ability to engage effectively with online learning (Azubuike et al., 2021; Careemdeen, 2023). Furthermore, the digital divide exacerbated by socioeconomic disparities not only affects access to e-learning but also the quality of the learning experience itself, leading to widening gaps in educational outcomes between different socioeconomic groups (Careemdeen, 2023; Mahdavi Ardestani et al., 2023).

Beyond education, these limitations have profound consequences for digital health literacy, which refers to individuals' ability to access, comprehend, and apply online health-related information to make informed decisions (Berete et al., 2024). Research highlights that digital health literacy is strongly correlated with socioeconomic status, as lower-income populations often experience difficulties in navigating digital health resources, leading to poorer health outcomes and reduced engagement with preventive care services (Lastrucci et al., 2019).

The influence of parental income and educational attainment on e-learning experiences has been extensively documented. For example, research indicates that individuals from households with higher incomes and better-educated parents benefit from greater virtual support, which enhances their en-

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<http://doi.org/10.32725/kont.2025.017>

Submitted: 2025-02-03 • Accepted: 2025-04-16 • Prepublished online: 2025-04-22

KONTAKT 27/2: 150–157 • EISSN 1804-7122 • ISSN 1212-4117

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agement and academic performance (Chen et al., 2019). Conversely, those from less privileged backgrounds often struggle to keep pace with their peers due to the lack of necessary resources and support. This discrepancy points to the urgent need for targeted interventions to bridge the digital divide, such as providing digital resources to economically disadvantaged communities, promoting digital literacy among parents and teachers, and improving internet accessibility in underserved areas (Careemdeen, 2023; Chen et al., 2019; Mahdavi Ardestani et al., 2023).

Moreover, the broader social context in which individuals live significantly impacts their ability to benefit from e-learning (Prosen et al., 2022). Factors such as community support, the availability of educational resources, and the overall socioeconomic environment play crucial roles in shaping e-learning experiences. As Bronfenbrenner's socio-ecological theory suggests, a child's development is influenced by multiple layers of their environment, including the home, school, and community. Within digital education, these environmental factors either enable or hinder effective engagement with learning tools, with consequences that extend beyond education into digital health competencies (Berete et al., 2024). In the context of e-learning, these environmental factors can either facilitate or impede a student's ability to engage effectively with digital learning tools, thereby influencing their academic outcomes (Careemdeen, 2023).

While e-learning holds great potential for democratizing education, its benefits are unevenly distributed across socioeconomic lines. This study aims to explore how socioeconomic factors influence both the accessibility and effectiveness of e-learning, as well as their broader impact on digital health literacy. By addressing these disparities, we can work towards creating a more inclusive digital ecosystem that enables all individuals, regardless of their socioeconomic background, to succeed in an increasingly digital world.

Materials and methods

A meta-synthesis approach by Noblit and Hare (1988) was chosen to answer our research question. This approach allows for the integration of findings across multiple qualitative studies, providing a more comprehensive understanding of the phenomenon under investigation by moving beyond simple aggregation of data to generate new theoretical insights (Edwards and Kaimal, 2016; Thorne, 2022). Qualitative syntheses are therefore recognized as valuable tools for exploring participants' meanings, experiences, and perspectives in both depth (through a qualitative lens) and breadth (by integrating findings from various contexts and participant groups). These syntheses are particularly useful for identifying gaps in existing research, guiding the design of new studies, and providing evidence to support the development, implementation, and assessment of interventions (Lachal et al., 2017). In the context of this study, they are instrumental in examining how socioeconomic factors shape the effectiveness of e-learning and access to it, and how these factors, in turn, impact health literacy in underserved communities.

Literature review

A literature review was conducted in May 2024. The following search terms were selected to align with the dual focus on educational access and digital health literacy: "socioeconomic", "economic barriers", "Healthcare Disparities", "educational outcomes", "health literacy", "Education, Distance", "e-learning", "underserved", "Health Inequalities".

These terms were used to perform literature search in databases, including PubMed, ScienceDirect, and CINAHL/MEDLINE, covering publications from 2019 to 2024. The search was intentionally restricted to the past five years to ensure that the included studies reflect current trends in digital access, technological advancements, and policy interventions. The search was limited to qualitative studies published in English (dissertations and theses were excluded).

Initially, the search yielded a much larger pool of publications, but after refining the inclusion criteria based on thematic relevance and research quality, 74 articles were deemed potentially relevant. To clarify the scope of the review, studies were excluded if they focused solely on health inequalities without considering e-learning as a component of health literacy or educational access. The screening process was systematically recorded and justified in the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram 1.

For the purposes of this study and the identification of appropriate publications, we followed the definition of underserved populations put forward by Bantham et al. (2021), which states that underserved populations are "under-resourced", with limited access to services such as quality health-care, education, healthy food sources, safe spaces, and other social determinants of health. These populations often experience "physical, social, economic, and emotional vulnerability" when policies, systems, and institutions do not align with their needs. Scientific publications that addressed broader topics outside the scope of e-learning and socioeconomic factors and health disparities, or those that were not solely qualitative in nature, were excluded. Additionally, duplicate studies and articles focusing on health inequalities unrelated to educational outcomes were removed. Search results were exported and handled in EndNote 20 (Clarivate Analytics, PA, USA).

Following a rigorous selection and screening process conducted separately by both authors and finalized jointly, the review was narrowed down to three publications that were deemed most suitable for in-depth analysis. The rationale for selecting only three studies stems from the stringent inclusion criteria – ensuring that the selected studies explicitly addressed both e-learning accessibility and digital health literacy within underserved populations. This focus resulted in a narrower sample but provided a depth of thematic exploration that aligned with our study's objectives. Such focused inclusion is consistent with guidance on meta-ethnography, which is especially suited for synthesizing findings from a small number of high-quality qualitative studies (Edwards and Kaimal, 2016).

Sample

The three qualitative studies reviewed in this analysis focused on the impact of socioeconomic factors on educational outcomes and health literacy in virtual learning environments. These studies were conducted in diverse geographical contexts, including South Africa, the United States (New York), and Malawi (Table 1), providing a global perspective on the challenges faced by underserved populations in accessing and benefiting from e-learning. In all studies, data were collected using a focus group method. Age, gender, and socioeconomic background were reported differently across the studies, making direct comparisons difficult. However, it is noteworthy that the studies predominantly focused on low-income communities, highlighting the pervasive impact of economic barriers on educational access and outcomes.

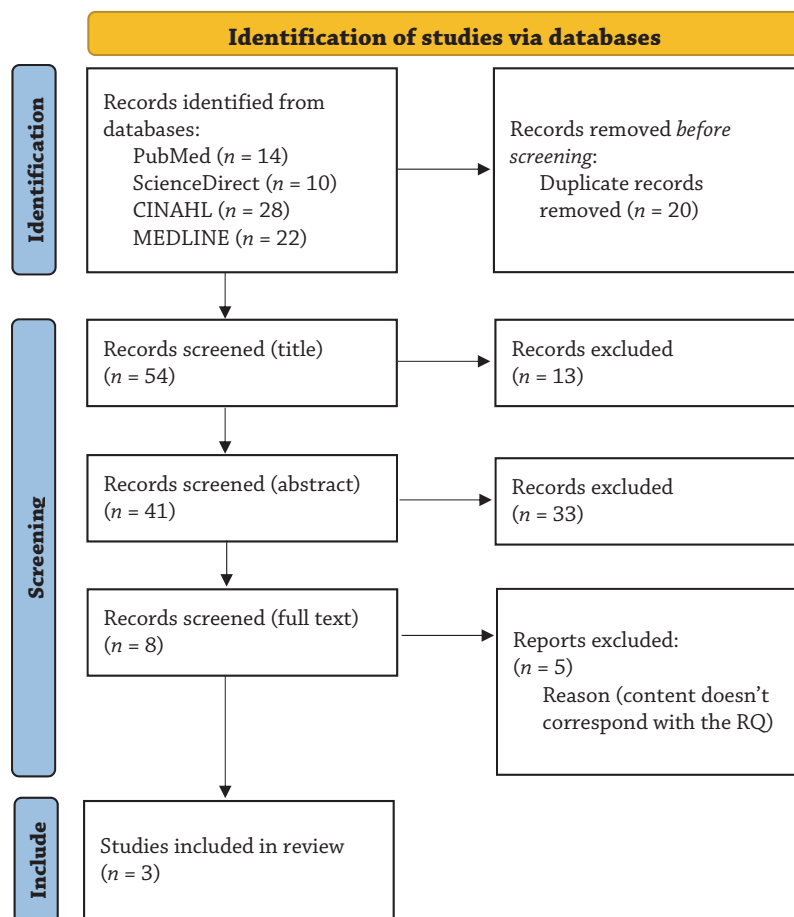


Diagram 1. PRISMA flow diagram

To assess the quality of these studies, the Critical Appraisal Skills Programme (CASP) checklist was employed (Critical Appraisal Skills Programme, 2023). The CASP analysis revealed that all studies provided a clear statement of their aims and used appropriate qualitative methods for exploring the subjective experiences of their participants (Table 1).

Data analysis

The data analysis in this study followed the seven-step meta-ethnographic process as outlined by Noblit and Hare (1988). This approach was selected specifically to synthesize qualitative evidence that explores the interrelation between

socioeconomic barriers, e-learning access, and health literacy rather than just aggregating general themes on digital learning. The process followed these seven phases: Phase 1: Getting started; Phase 2: Deciding what is relevant; Phase 3: Reading the studies; Phase 4: Determining how the studies are related; Phase 5: Translating the studies into one another; Phase 6: Synthesizing translations; and Phase 7: Expressing the synthesis (Noblit and Hare, 1988).

As outlined in the introduction, the focus of this meta-synthesis (step 1 of Noblit and Hare, 1988) was chosen due to the global significance of understanding how socioeconomic factors influence e-learning accessibility and effectiveness, and its

Table 1. Quality appraisal of included publications

Author (year)	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Total 'yes' votes/10
Arcia et al. (2019)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	10
Mash and Cairncross (2023)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	10
Rosenberg et al. (2022)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	8
Total 'yes' votes/10	3	3	3	3	3	3	3	2	2	3	

Note: Q – Question; Q1 – Was there a clear statement of the aims of the research?; Q2 – Is a qualitative methodology appropriate?; Q3 – Was the research design appropriate to address the aims of the research?; Q4 – Was the recruitment strategy appropriate to the aims of the research?; Q5 – Was the data collected in a way that addressed the research issue?; Q6 – Has the relationship between researcher and participants been adequately considered?; Q7 – Have ethical issues been taken into consideration?; Q8 – Was the data analysis sufficiently rigorous?; Q9 – Is there a clear statement of findings?; Q10 – How valuable is the research?

impact on health literacy in marginalized communities. Three qualitative studies were carefully chosen (step 2 of Noblit and Hare, 1988) based on their relevance to the research questions (Table 2). The CASP checklist was used to assess the quality of individual studies and ensure that only high-quality research was included. Each selected study was thoroughly reviewed multiple times to ensure a deep understanding of its content (step 3 of Noblit and Hare, 1988).

As the analysis progressed, it became evident that the concepts and themes identified in the different studies were largely aligned, indicating a reciprocal relationship despite being conducted in different geographical settings (step 4 of Noblit and Hare, 1988). The next step involved translating the findings from each study into a common conceptual framework. To ensure consistency and coherence, thematic categories were created based on the overlaps in the study results. This step was crucial to ensure that key themes such as the digital divide and technological literacy were presented consistently across the studies. The way in which each theme was identified and interpreted was systematically cross-checked by the authors to enhance credibility and confirmability (step 5 of Noblit and Hare, 1988). To ensure additional trustworthiness and rigor of the thematic synthesis, intercoder reliability was assessed. Two independent researchers coded the same dataset, and agreement was calculated based on percentage agreement, which is a commonly used method in qualitative research to assess coding consistency (Cheung and Tai, 2023; O'Connor and Joffe, 2020). Although the exact agreement percentage

was not recorded during coding, the observed consistency was high and reached an estimated agreement rate of approximately 85–90%, which is widely accepted as satisfactory in qualitative studies (Cheung and Tai, 2023). Coding discrepancies were discussed and resolved through consensus, and adjustments to the coding scheme were made where necessary to ensure clarity and conceptual alignment.

Reflexivity was maintained throughout the process to acknowledge the role of researcher subjectivity in thematic synthesis. Additionally, discussions among the authors helped refine interpretations and ensure that the synthesis accurately represented the data without imposing pre-existing assumptions. In the final synthesis stage (step 6 of Noblit and Hare, 1988), the translated themes were integrated into a broader narrative that went beyond the individual studies. Five main themes emerged from this synthesis: the digital divide, technological and language barriers, inadequate infrastructure, economic constraints, and cultural and contextual adaptations. These themes provided a holistic overview of how socio-economic factors relate to the accessibility of e-learning and health literacy. The final synthesis was framed in the form of a narrative that followed our research objective and integrates findings of the studies within a broad context that can serve as a basis for future research and policy development (step 7 of Noblit and Hare, 1988). The data were analysed using the qualitative data analysis software NVivo ver. 1.7.2. (QRS International).

Table 2. Methodological characteristics

Authors (year), country	Method	Study purpose	Sample	Data collection
Arcia et al. (2019) USA	Qualitative descriptive study	To elucidate how low-income pregnant women, characterize their digital information needs and seeking processes, and to identify barriers and facilitators to meeting these needs.	16 low-income pregnant women in New York City	Focus group interview
Mash and Cairncross (2023) South Africa	Exploratory, descriptive qualitative study	To evaluate the feasibility of virtual group education for diabetes in low-income communities using tablets and Zoom.	5 patients with type-2 diabetes and 3 dieticians	Focus group interview
Rosenberg et al. (2022) Malawi	Qualitative study (unspecified)	To develop and digitize an implementation package for HIV-assisted contact tracing (ACT) in Malawi.	11 key informants (district-level supervisors, facility-level supervisors, healthcare workers)	Focus group interview and semi-structured in-depth interview

Results

The findings of the meta-synthesis are organized into five main themes: (1) Digital divide, (2) Technological and language barriers, (3) Inadequate infrastructure, (4) Economic constraints, and (5) Cultural and contextual adaptations (Table 3).

Theme 1: Digital divide

The digital divide encompasses disparities in device functionality, internet reliability, digital literacy, and the ability to fully engage with e-learning and digital health tools. In low-income communities, while smartphones are prevalent, they are often insufficient substitutes for laptops or tablets, particularly for educational and healthcare applications that require larger screens, advanced software, or multitasking capabilities. Mash and Cairncross (2023) found that while smartphones were widely used in low-income communities in Cape Town, limited access to computers and tablets hindered meaningful partici-

pation in virtual education, access to advanced health portals, and engagement in skill-building tasks such as typing, coding, or design work. This limitation made it difficult for patients to engage fully in virtual education programs, as noted by one facilitator: *"Smartphones were commonly used in the community, but access to laptops or tablets was thought to be much less common"* (Mash and Cairncross, 2023). Similarly, Rosenberg et al. (2022) found that in rural Malawi, disparities in access to digital tools were not just a function of economic limitations but also infrastructural inadequacies, with rural areas lacking sufficient broadband infrastructure to support equitable access to digital education and health services.

Theme 2: Technological and language barriers

Technological proficiency and language barriers, while interconnected, are distinct challenges that independently contribute to digital exclusion. Initially, these barriers were categorized together; however, a deeper analysis revealed key differences. Some individuals struggle with using digital tools

Table 3. Meta-synthesis themes

Author (year)	Theme 1: Digital divide	Theme 2: Technological and language barriers	Theme 3: Inadequate infrastructure	Theme 4: Economic constraints	Theme 5: Cultural and contextual adaptations
Arcia et al. (2019)	Low-income pregnant women in New York City face significant challenges in accessing necessary digital information	Language barriers in accessing online resources for non-English speaking pregnant women	Limited availability of high-speed internet in certain low-income neighbourhoods, restricting access to vital prenatal information	Economic challenges in affording ongoing costs like internet and device maintenance	Need for culturally relevant digital content that aligns with the experiences and realities of low-income pregnant women in NYC
	Disparity in access to prenatal digital resources compared to higher-income groups	Inadequate translation services for digital health platforms	Dependence on outdated technology due to financial constraints	Difficulty in sustaining digital engagement due to recurring costs	Incorporation of culturally sensitive material to ensure better understanding and engagement
	Limited digital literacy among low-income pregnant women impacting their ability to use available resources	Lack of bilingual support in mobile health applications	Digital divide between public and private healthcare settings in terms of access to technology	Affordability issues related to the purchase of newer, more efficient digital devices	Engagement of community-based organizations to co-create content that resonates with the target population
Mash and Cairncross (2023)	Limited access to tablets and laptops among low-income communities in Cape Town	Challenges in using Zoom due to language barriers and low technological literacy among patients	Inconsistent internet connectivity in low-income areas, impacting the feasibility of virtual group education	Cost concerns related to data usage and potential theft of tablets provided to patients	Need for adaptation of educational content to local cultural contexts in Cape Town
	Dependence on smartphones with limited functionality	Lack of multilingual support in virtual learning platforms	Lack of technical support for troubleshooting in virtual sessions	Inability to afford personal internet connectivity and reliance on public Wi-Fi services	Customization of materials to be more visually accessible to users with limited literacy skills
	High turnover of technological devices due to crime in the community	Difficulty in engaging participants in a virtual setting due to unfamiliarity with technology	Unreliable power supply affecting the continuity of virtual sessions	Inadequate financial resources to replace or repair damaged digital devices	Incorporation of local idioms and expressions to make content more relatable to participants
Rosenberg et al. (2022)	Disparities in access to digital health tools between urban and rural areas in Malawi	Language barriers faced by healthcare workers in translating ACT content into local dialects	Limited broadband infrastructure in rural areas affecting the efficacy of digital health interventions	Financial burden on healthcare workers and patients for maintaining internet connectivity	Adaptation of ACT tools to local cultural practices and norms in Malawi
	Inequitable distribution of digital resources within healthcare settings	Difficulty in training healthcare workers on new digital tools due to language and literacy barriers	Inadequate infrastructure to support remote health monitoring in rural communities	High costs of digital devices compared to average income levels in rural areas	Adjustment of health communication strategies to reflect traditional beliefs and practices
	Over-reliance on SMS-based health communication due to lack of smartphones in rural areas	Lack of local language options in health information platforms	Inconsistent electricity supply limiting the usage of electronic devices	Expenses related to the procurement and maintenance of solar-powered solutions to mitigate electricity issues	Integration of community leaders and traditional healers in the digital health strategy to enhance acceptance and effectiveness

even when content is in their native language, while others are technologically skilled but face challenges due to language limitations.

In the study conducted by Rosenberg et al. (2022), healthcare workers in Malawi faced difficulties in translating Assisted Contact Tracing (ACT) content into local dialects, which hindered the effective implementation of the program. As the study notes, language barriers faced by healthcare workers in

translating ACT content into local dialects presented a significant challenge in the execution of the program (Rosenberg et al., 2022). Similarly, Mash and Cairncross (2023) observed that in Cape Town, the use of Zoom for virtual education was complicated by language barriers and the low technological literacy of patients. This challenge was captured by one patient who explained, “I switch between languages when I see that they’re getting lost if I speak English” (Mash and Cairncross, 2023).

Theme 3: Inadequate infrastructure

Inadequate infrastructure is another major obstacle to the successful implementation of e-learning and digital health programs, especially in underserved areas. Mash and Cairncross (2023) found that in Cape Town, the feasibility of conducting virtual group education for diabetes was limited by inconsistent internet connectivity, which disrupted the delivery of educational content. They reported inconsistent internet connectivity in low-income areas, impacting the feasibility of virtual group education as a key challenge (Mash and Cairncross, 2023). Likewise, Rosenberg et al. (2022) highlighted similar infrastructural challenges in Malawi, where limited broadband infrastructure in rural areas affected the efficacy of digital health interventions.

Theme 4: Economic constraints

Economic barriers extend beyond the initial cost of acquiring digital devices and encompass ongoing costs such as internet subscriptions, maintenance of devices, and other related expenses. These financial constraints place a significant burden on low-income families and hinder their ability to fully participate in e-learning and digital health programs. In the study by Arcia et al. (2019), low-income pregnant women in New York City faced substantial challenges in affording ongoing costs like internet and device maintenance, which limited their access to crucial prenatal digital information. The study emphasized the economic challenges in affording ongoing costs like internet and device maintenance as a major barrier (Arcia et al., 2019). Similarly, Mash and Cairncross (2023) identified cost concerns related to data usage as a significant issue for patients participating in virtual education sessions in Cape Town. Patients voiced worries that the tablets might be lost or stolen, or that some individuals might enroll in the program with the intent of taking the tablet rather than genuinely participating in the education. Additionally, patients were concerned about the cost of data if they had to provide it themselves. Even when data was provided on the tablets, there was a risk that family and friends would use it if there were no restrictions in place (Mash and Cairncross, 2023).

Theme 5: Cultural and contextual adaptations

Cultural and contextual adaptations are essential to the success of e-learning and digital health programs, particularly in diverse and underserved communities. The study by Rosenberg et al. (2022) in Malawi emphasized the need to adapt Assisted Contact Tracing (ACT) tools to local cultural practices and norms to ensure their effectiveness. The researchers found that adaptation of ACT tools to local cultural practices and norms was crucial for the program's success (Rosenberg et al., 2022). Similarly, Mash and Cairncross (2023) highlighted the importance of culturally relevant content in virtual diabetes education in Cape Town. They observed that participants benefited more when the educational materials were adapted to their cultural context, with one facilitator suggesting "*the need for adaptation of educational content to local cultural contexts in Cape Town*" (Mash and Cairncross, 2023).

disparities in access to technology and internet connectivity severely limiting the educational opportunities available to low-income populations. The lack of access to appropriate technology not only hampers participation in digital initiatives but also deepens existing social inequalities by restricting opportunities for those who are already disadvantaged. This divide is exacerbated by technological and language barriers that prevent non-English-speaking and technologically inexperienced individuals from fully engaging with digital learning platforms (Chen et al., 2019; 2024; Mash and Cairncross, 2023; Rosenberg et al., 2022).

Moreover, inadequate infrastructure, particularly in rural and low-income urban areas, further hinders the delivery of online education and health services (Chen et al., 2019; Rosenberg et al., 2022). These infrastructural deficiencies emphasize the need for investment in digital infrastructure to ensure that e-learning and digital health services can reach and benefit all communities, particularly those who are marginalized. The economic constraints faced by these communities compound these challenges, making it difficult for households to sustain the necessary investments in technology and internet services (Arcia et al., 2019; Chen et al., 2019; Mash and Cairncross, 2023; Rosenberg et al., 2022). Public policy interventions and support systems need to be implemented to alleviate the financial burden on low-income households and ensure equitable access to digital services. As highlighted by Notley and Aziz (2024), low-income households often face significant financial stress, having to make difficult sacrifices, such as choosing between essential household needs and maintaining digital connectivity for their children's education. Without targeted interventions, the unjust burden of digital inclusion disproportionately affects those already marginalized, further deepening socioeconomic disparities.

In addition to limiting e-learning access, economic constraints also play a critical role in shaping digital health literacy. Individuals facing financial hardships often have restricted access to digital health resources, such as telehealth platforms, online health education programs, and e-health applications that require reliable internet connections (Lastrucci et al., 2019). As a result, lower-income populations are less likely to engage with preventive health information or develop the necessary digital skills to navigate health-related content effectively, which further exacerbates health disparities (Berete et al., 2024). Addressing economic barriers through subsidized internet programs and community-based digital literacy training could mitigate these disparities and enhance both educational and health outcomes.

Finally, the lack of culturally and contextually adapted content means that even when access to digital resources is available, the material may not resonate with or be relevant to the learners' lived experiences, thereby reducing its impact (Chen et al., 2019; Rosenberg et al., 2022). Buliva (2020) points out that educational technology must not only provide access but also align with the cultural beliefs, values, and practices of the learners for it to be effective. Without such alignment, even the most advanced educational technologies can fail to engage learners meaningfully, reducing both learning outcomes and persistence in interaction with these resources. A deeper analysis of cultural barriers reveals that digital literacy challenges are not uniform across communities but are shaped by specific socio-cultural factors. For instance, research highlights that digital education programs that do not align with local cultural norms may face resistance or limited engagement (Kim and Padilla, 2020). In some communities, particularly those with lower formal education levels, there is a reliance on oral tra-

Discussion

The findings from this meta-synthesis demonstrate the persistent and multidimensional barriers that socioeconomic factors impose on the accessibility and effectiveness of e-learning in underserved communities. Upon reflecting on the identified themes, the digital divide remains a significant issue, with

ditions, making text-heavy digital content less accessible and effective (Careemdeen, 2023). Furthermore, gender norms in certain societies influence access to and control over digital resources, as seen in studies indicating lower internet usage among women in some socioeconomically disadvantaged regions (Chen et al., 2019). Integrating culture-specific learning designs and ensuring that the content is culturally inclusive and adaptable to the learners' unique contexts, becomes an important issue in contemporary educational technology development.

These findings have important implications for future research. Firstly, there is a need for more in-depth studies that examine the long-term impacts of e-learning initiatives in underserved communities, particularly through comparative studies that explore different socioeconomic and cultural contexts. Such research could help identify which interventions – such as the provision of multilingual content, subsidized technology access, and enhanced parental involvement – are most effective in overcoming the barriers to digital education (Chen et al., 2019). Future research should also focus on the role of public-private partnerships in expanding digital infrastructure and affordability, particularly in rural and low-income urban areas, where access remains limited. Additionally, future studies could explore the role of policy in bridging the digital divide, particularly by evaluating the effectiveness of government and community-led initiatives aimed at improving access to digital resources in low-income areas. Specifically, studies should assess the impact of subsidized technology programs, targeted digital literacy training, and parental engagement initiatives to enhance digital skills within households. Examining culturally responsive e-learning strategies – such as localized content adaptation and the integration of community support networks – could also provide valuable insights into improving digital education equity.

While this study provides valuable insights, it is not without limitations. The meta-synthesis was based on a relatively small number of qualitative studies, which may limit a broader contextual understanding of the findings. However, meta-syntheses, particularly those following the meta-ethnographic approach by Noblit and Hare (1988), emphasize depth and conceptual translation over sheer quantity. The inclusion of only three studies was a result of stringent selection criteria ensuring that each study explicitly addressed both e-learning accessibility and digital health literacy within underserved populations. This focused approach allows for a more in-depth and contextually rich synthesis, aligning with established qualitative synthesis methodologies (2016).

Despite efforts to identify relevant articles, there is a possibility that some studies were missed, leading to potential gaps in the overall analysis. Moreover, the studies included were from diverse geographical contexts, which, while providing a broad perspective, might also introduce variability that complicates the synthesis of findings. Nonetheless, such diversity is also a recognized strength in qualitative meta-syntheses, as it enables the identification of shared themes and universal barriers across different socioeconomic and cultural settings (Lachal et al., 2017).

While this study effectively applies existing theoretical frameworks related to digital equity and health literacy, a key direction for further theoretical contribution lies in establishing a conceptual model that explicitly links these domains. The synthesis of findings suggests that digital access, technological proficiency, and health literacy should not be viewed as isolated constructs but rather as interdependent dimensions within a broader digital equity framework. Future research

should build upon this study's findings to develop an integrative theoretical model that illustrates how socioeconomic barriers influence both e-learning accessibility and health literacy outcomes, highlighting key mediators such as cultural adaptability, policy interventions, and digital infrastructure investments. Such a model could serve as a foundation for designing targeted interventions and evaluating the long-term impact of digital education policies on health literacy and social inclusion.

Conclusion

This meta-synthesis highlights the significant challenges that socioeconomic factors pose to the accessibility and effectiveness of e-learning in underserved communities, with particular emphasis on the impact these challenges have on health literacy. Key barriers such as the digital divide, technological and language obstacles, inadequate infrastructure, and economic constraints were identified as primary factors that limit equitable access to e-learning. The lack of culturally relevant educational content further impedes the success of digital learning in marginalized populations. Addressing these interconnected challenges requires a comprehensive, multi-faceted approach, including investments in digital infrastructure, provision of economic support, and the development of multilingual, culturally sensitive learning resources. Policymakers and educators must collaborate to ensure that e-learning initiatives not only bridge the technological gap but also promote inclusivity and equity in educational outcomes, ultimately improving health literacy and access to opportunities in these communities. Future research should continue to explore targeted interventions and the long-term effects of e-learning on marginalized groups, contributing to more sustainable solutions for digital (health) equity.

Funding

The study was conducted as part of the project "Development of a Digital Education Standard in Higher Education for Ensuring Equity and Accessibility in Digital Education" (J5-4572), co-financed by the Slovenian Research and Innovation Agency.

Ethics approval and conflict of interest

No ethical statement has been made for this literature review. The authors have no conflict of interest to declare.

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