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Effectiveness of Telehealth Interventions in Reducing Health Disparities Among Vulnerable Populations: A Systematic Review.

Jeremiah Olaoluwa Akinlade, Morgan State University

Jeremiah Olaoluwa Akinlade is a Doctoral student in Civil Engineering at Morgan State University, with strong interests in structural and transportation engineering, data-driven analysis, and engineering education. His academic and research pursuits align closely with ASEE's mission of advancing excellence, innovation, and inclusivity in engineering education, with a focus on translating research into impactful teaching, workforce development, and real-world engineering practice.

Julius Ogaga Etuke, Morgan State University

Julius Ogaga Etuke is a seasoned civil engineer and Ph.D. Candidate in Civil Engineering at Morgan State University, where his research focuses on sustainable and resilient infrastructure engineering. With over 15 years of consulting and project leadership experience, primarily in Nigeria's infrastructure landscape, he brings a robust, practical perspective to academic inquiry. His doctoral research is at the cutting edge of transportation resilience, integrating virtual and augmented reality (VR/AR), climate adaptation modeling, and data-driven solutions to improve disaster preparedness and risk mitigation in complex transportation systems. As a COREN-registered engineer and member of the Nigerian Society of Engineers, his work emphasizes impactful research and consultancy that bridges structural design principles with urgent sustainability and resilience challenges.

Sarah Halleluyah Adeyemi, Morgan State University

Sarah Halleluyah Adeyemi is a Master student in the Department of Bioinformatics at Morgan State University. She holds a B.Sc. in Microbiology from Mountain Top University, Nigeria. Her research interests focus on gene expression analysis, cardiovascular genomics, antimicrobial resistance, and the application of computational tools in biomedical research. She is also currently working towards being a Data Scientist.

Sarah has research experience from the Nigerian Institute of Medical Research, where she contributed to infectious disease diagnostics and antimicrobial studies. She also worked in the R&D division at FrieslandCampina WAMCO, gaining insight into food safety, quality control, and process validation. Currently, she serves as a graduate assistant on interdisciplinary research projects funded by NASA and ETA-STEM, supporting data analysis and science education initiatives.

She is a member of ASEE, IEEE, passionate about STEM education and is passionate about integrating bioinformatics and molecular biology to solve health-related challenges and promote inclusive scientific research.

Olorunfunmi Samuel Shobowale, Morgan State University

Olorunfunmi Shobowale is a graduate research assistant at Morgan State University, Maryland, pursuing a Masters degree in Advanced Computing. He has over nine years of experience in IT, edtech and STEM education. His research focuses on equitable engagement strategies and the integration of AI in learning environments.

Dr. Olushola V. Emiola-Owolabi, Morgan State University

Olushola Emiola-Owolabi is an engineering pedagogy specialist, researching active learning in engineering classrooms and specializing in qualitative methods research on teaching and learning – particularly in remote synchronous learning environments.

Dr. Oludare Adegbola Owolabi P.E., Morgan State University

Dr. Oludare Owolabi, a professional engineer in Maryland, joined the Morgan State University faculty in 2010. He is the director of the Sustainable Infrastructure Development, Smart Innovation and Resilient Engineering Research Lab, Department of Civil Engineering at Morgan State University.

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Dr. Uttam Gaulee

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Abstract

The rapid digital transformation of healthcare is reshaping healthcare delivery, yet its benefits remain uneven across low income, rural, and racially and ethnically marginalized populations. Persistent gaps in broadband access, digital literacy, and culturally responsive care continue to limit equitable engagement, positioning telehealth as both an opportunity and a test of system design. This systematic review examines how telehealth interventions influence healthcare access, engagement, and clinical outcomes among vulnerable populations, and identifies the conditions under which they reduce or reinforce disparities. Guided by the Digital Divide Framework and conducted in accordance with PRISMA guidelines, a structured search of PubMed, Scopus, and CINAHL identified 821 records published between 2015 and 2025, from which 58 studies met inclusion criteria following a two stage screening process. Data extraction and quality appraisal were performed using the Mixed Methods Appraisal Tool, focusing on intervention modality, population characteristics, digital access constraints, literacy supports, and outcome domains. Telehealth consistently improved healthcare access, particularly through reduced missed appointments and expanded reach in underserved settings. Overall, 74% of studies reported effective or above average outcomes, though equity gains were not uniform. Interventions that incorporated flexible, low bandwidth modalities, digital literacy support, and integration within existing care systems demonstrated stronger and more consistent outcomes. In contrast, video dependent and standalone models showed greater variability and were more likely to exclude populations with limited digital capacity. These findings demonstrate that telehealth effectiveness is shaped by design choices, implementation context, and system integration rather than technology alone. By framing telehealth as a socio technical system, this review identifies key enablers and failure points and advances an engineering perspective that positions equity as a core design requirement for scalable and inclusive digital health systems.

Keywords: Telehealth, Health Disparities, Vulnerable Populations, Digital Divide, Systematic Review, Equity-Centered Design

1. Introduction

The rapid digital transformation of healthcare is reshaping how care is accessed, delivered, and experienced globally. Telehealth, including video visits, phone consultations, mobile health applications, and remote monitoring has evolved from a supplementary tool to a central component of healthcare delivery, particularly after the COVID-19 pandemic [1–3]. It is widely viewed as a means to improve access, efficiency, and continuity of care while reducing geographic and logistical barriers [4–6]. However, as telehealth becomes more embedded in routine care, concerns persist regarding the equitable distribution of its benefits.

For historically marginalized populations, such as low-income groups, rural communities, racial and ethnic minorities, older adults, and individuals with limited digital literacy telehealth adoption remains uneven due to persistent structural barriers [7–10]. Challenges including limited broadband access, inadequate devices, low digital literacy, language barriers, and inconsistent policy support continue to shape engagement with telehealth services [11–13]. Consequently, digital exclusion often mirrors or exacerbates existing health disparities rather than resolving them [14–16].

Telehealth therefore represents both an opportunity and a test of equity. When intentionally designed, it can improve access, engagement, and chronic disease management for underserved populations [17–19]. However, without attention to digital access, literacy, cultural responsiveness, and policy alignment, it risks reinforcing disparities by favoring already advantaged groups [20–22]. Identifying the conditions under which telehealth functions as an equity-enhancing intervention is thus essential. Evidence on telehealth effectiveness remains mixed and context-dependent. While many studies report improvements in access, adherence, patient satisfaction, and clinical outcomes across areas such as chronic disease, mental health, and preventive care [23–26], these benefits are not consistently observed. Outcomes vary by intervention modality, population characteristics, availability of digital literacy support, and broader infrastructural and policy conditions [27–30]. Importantly, increased access does not necessarily translate to equitable outcomes, as underserved populations often experience differential benefits [31–33].

The Digital Divide Framework helps explain these disparities by highlighting multiple layers of inequality, including access to technology, digital skills, meaningful use, and outcomes [34–36]. In telehealth contexts, disparities arise not only from access limitations but also from how interventions are designed and implemented within broader social, cultural, and economic environments. Thus, telehealth equity extends beyond utilization to encompass system-level design and implementation. Despite growing research, existing reviews often focus narrowly on utilization, satisfaction, or specific clinical domains, with limited attention to how effectiveness varies across vulnerable populations and contexts [37–39]. Many also emphasize technological feasibility while overlooking issues such as digital exclusion, literacy, and culturally responsive design. This creates a need for a comprehensive synthesis that integrates effectiveness, equity, and methodological rigor.

To address this gap, this systematic review examines how telehealth interventions influence access, engagement, and health outcomes among vulnerable populations, and identifies the conditions under which they reduce disparities. Guided by the Digital Divide Framework and PRISMA guidelines, it synthesizes evidence from 2015 to 2025, focusing on intervention modalities, population characteristics, digital access, literacy supports, and key outcome domains. From an engineering systems perspective, telehealth disparities reflect system-level performance failures rather than individual limitations. Telehealth operates as a socio-technical system involving infrastructure, interfaces, workflows, and users. When these systems fail to account for variability in connectivity, literacy, and context, inequities emerge as predictable outcomes.

Accordingly, this review reframes telehealth equity as a design and implementation challenge. It contributes an engineering-centered perspective by identifying system-level characteristics necessary for equitable, scalable, and human-centered telehealth solutions shifting the focus from access alone to intentional, equity-driven system design.

2. Research Questions

These research questions are examined not only to assess health outcomes, but to identify system-level design factors that influence the effectiveness and equity of telehealth technologies. Therefore, the review addresses the following research questions:

1. Among vulnerable populations, how effective are telehealth interventions compared with traditional in-person care in improving healthcare access and reducing health disparities?

2. What contextual, design, and implementation factors influence the effectiveness of telehealth interventions in reducing health disparities among vulnerable populations?

Where RQ1 examines the comparative effectiveness of telehealth interventions relative to traditional in-person care across vulnerable populations, with particular attention to outcome domains including healthcare access, patient engagement, adherence, and clinical improvement, this question explicitly considers equity-relevant differences in outcomes across population groups, highlighting where telehealth mitigates, reproduces, or exacerbates existing disparities. RQ2 focuses on identifying and synthesizing the contextual, design, and implementation conditions under which telehealth interventions are most effective in reducing health disparities. This includes variations in telehealth modality (e.g., video-based care, mobile health applications, remote patient monitoring), delivery context (e.g., rural, safety-net, or resource-constrained settings), and supportive features such as digital literacy assistance, connectivity support, and culturally responsive workflows. By examining these factors, RQ2 clarifies not only which telehealth approaches are commonly implemented but also why specific interventions succeed or fail in advancing equity.

The research questions were formulated using the SPIDER framework [81] (Sample, Phenomenon of Interest, Design, Evaluation, Research type), which is well-suited for systematic reviews integrating quantitative, qualitative, and mixed-methods evidence. This framework supports a comprehensive examination of both effectiveness and contextual mechanisms, enabling a systems-level understanding of telehealth equity across diverse populations and implementation environments.

3. Materials and Methods

This study adopts a systematic literature review approach following PRISMA guidelines to ensure transparency, reproducibility, and methodological rigor in assessing telehealth effectiveness across diverse populations and settings. To enable consistent comparison across varied study designs, outcomes were categorized using predefined criteria. Studies were classified as Effective or Above Average when they reported statistically significant improvements, meaningful clinical impact, or sustained outcomes. Those with non-significant, inconsistent, or minimal effects were classified as Less Effective, while studies without explicit outcome reporting were categorized as Not Reported.

A. Search Strategy

A comprehensive literature search was conducted across major electronic databases, including PubMed/MEDLINE, Scopus, and CINAHL. The search covered studies published between January 2015 and October 2025, reflecting the modern evolution of telehealth technologies and policies. These databases capture a broad spectrum of medical and social science literature, enabling a comprehensive understanding of the topic.

B. Search Strings

Search strings combined terms related to telehealth, telemedicine, digital health, remote care, effectiveness, health outcomes, access to care, utilization, health disparities, equity, underserved populations, safety net, rural, low-income, and ethnic minority groups. Boolean operators and truncation were applied to optimize sensitivity and specificity across databases. The same search strings were not used across the same databases because some were not recognized by the databases. These search terms were iteratively refined based on preliminary searches to improve both sensitivity and specificity. See Table 1 below:

Table 1.0 Database keyword search strings including criteria

S/N	Database	Search String/ Boolean Query	Date Search
1	Scopus	("telehealth" OR "telemedicine") AND ("effectiveness" OR "impact" OR "evaluation") AND ("reduce health disparity*" OR "reduce health inequality*" OR "improve health equity*") AND ("underserved community*" OR "low-income population*" OR "minority group*" OR "vulnerable population*")	October 27th, 2025
2	PubMed	(telehealth OR telemedicine OR "virtual care" OR "remote consultation" OR eHealth OR mHealth) AND ("health disparities" OR "health inequities" OR "health inequality" OR "healthcare access") AND ("vulnerable populations" OR "underserved communities" OR "low-income populations" OR "minority groups" OR "rural populations") AND ("2015"[Date - Publication] : "3000"[Date - Publication])	October 27th, 2025
3	CINAHL	(MH "Telehealth+" OR MH "Telemedicine+" OR "telehealth" OR "telemedicine" OR "digital health" OR "virtual care" OR "mobile health" OR "remote monitoring") AND (MH "Vulnerable Populations+" OR MH "Rural Population+" OR MH "Minority Groups+" OR MH "Low Income Population+" OR "underserved" OR "disadvantaged" OR "older adults" OR "disabled") AND (MH "Health Care Disparities+" OR MH "Health Equity" OR "health disparities" OR "health inequities" OR "healthcare access" OR "healthcare quality" OR "equity") AND ("effectiveness" OR "impact" OR "evaluation" OR "assessment" OR "intervention study" OR "program evaluation")	October 23rd, 2025

Boolean operators (AND/OR) were applied to refine results. Reference lists of included studies were manually screened to identify additional eligible articles.

C. Inclusion and Exclusion criteria

Inclusion and exclusion criteria were developed using established systematic review frameworks to ensure relevance, rigor, and alignment with the study objectives. Studies were included if they examined telehealth or digital health interventions implemented among vulnerable or underserved populations and reported outcomes related to healthcare access, engagement, adherence, or clinical improvement. Eligible study designs included quantitative, qualitative, mixed-methods, and systematic reviews published in peer-reviewed journals.

Studies were excluded if they lacked a telehealth component, focused solely on technical system development without outcome evaluation, examined general populations without an explicit equity or vulnerability focus, or consisted of editorials, commentaries, or non–peer-reviewed sources. Articles published outside the defined timeframe or not available in English were also excluded. These criteria were applied consistently during both title/abstract screening and full-text review to ensure the inclusion of studies that directly address telehealth effectiveness and health equity. See Table 2 below.

Table 2.0: Showing the Inclusion and Exclusion criteria

Inclusion	**Exclusion**
Evaluated a telehealth or telemedicine intervention delivering clinical care, monitoring, education, or screening.	Did not evaluate a telehealth or telemedicine intervention.
Examined outcomes relevant to health equity or disparity reduction (e.g., improved access for underserved groups, reduced care gaps).	Did not address health equity or disparities.
Employed quantitative, qualitative, or mixed-methods designs appropriate to the research question.	Insufficient methodological detail for quality appraisal.
Included empirical evaluation of outcomes.	Lacked measurable healthcare delivery or clinical outcomes.
Published between 2015 and 2025	Published before 2015
Published in English	Not published
Available in full text	Not accessible in full text

D. Study Selection and Data Extraction

All identified records were screened using a dual-review process. Titles and abstracts were independently reviewed by two reviewers, followed by full-text screening for eligibility. Discrepancies were resolved through discussion to ensure consistency. Data extraction captured study characteristics (telehealth effectiveness, health disparities, vulnerable populations, and methodological rigor). All records identified through database searches were first compiled and managed using the Microsoft Excel Tool, after which duplicate records were removed. Duplicate removal was conducted both automatically and through manual verification to ensure accuracy prior to screening. This template was used to collect data of:

1. Effectiveness of telehealth interventions
2. Geography and location
3. Methodological quality (MMAT-aligned)
4. Reduction in health disparities
5. Experience and health outcomes
6. Barriers and Enablers
7. Policy Intervention

3.1. Study inclusion thresholds:

1. High rigor: Studies that satisfied **(**all four eligibility domains**).**
2. Moderate rigor: Studies that satisfied **(**at least three of the four eligibility domains that were selected**)**.

3.2. Study Selection Process

A structured two stage screening approach was used to ensure rigor, transparency, and alignment with the review objectives. All records identified from database searches were compiled in Excel and duplicates were removed using both automated and manual checks.

In Level 1, titles and abstracts were screened against predefined inclusion criteria, focusing on telehealth effectiveness, relevance to vulnerable populations, contribution to health disparity reduction, and methodological suitability. Only studies meeting at least three of these domains progressed to the next stage.

Level 2 involved full text review and detailed coding in Excel. Each study was systematically evaluated based on design, population characteristics, telehealth modality, outcomes, equity considerations, and methodological quality. Studies meeting all four domains were classified as high rigor, while those meeting at least three were retained as moderate rigor. Screening and coding were conducted independently, with discrepancies resolved through consensus.

This process resulted in a final set of eligible studies, with the selection flow documented using a PRISMA 2020 diagram.

3.3. Studies Selected

As illustrated in Figure 1**,** a total of 821 records were identified through database searches, including Scopus (n = 277), PubMed (n = 230), and CINAHL (n = 314). Before screening, 737 records were removed, comprising records excluded by filtering (n = 716), duplicate records (n = 8), and articles that were not accessible or could not be retrieved in full text (n = 13).

The titles and abstracts of the remaining records were screened using the predefined inclusion criteria, resulting in 84 records advancing to further assessment. Following title and abstract screening**,** 2 records were excluded, and 82 articles were sought for full-text review. All 82 full-text articles were successfully retrieved and assessed for eligibility.

During full-text screening**,** 68 articles were excluded, including studies that did not meet all 4 inclusion criteria (n = 44) and those that failed to meet at least 3 of the eligibility domains (n =

24). Ultimately, 58 studies met the final 3 eligibility criteria and were included in the final systematic review.

The PRISMA 2020 flow diagram in Figure 1 provides a visual representation of the selection process in extracting the final set of 58 articles included in this review. As suggested by the PRISMA 2020 checklist, the summary of the main features of the selected individual studies is included in Table 1.

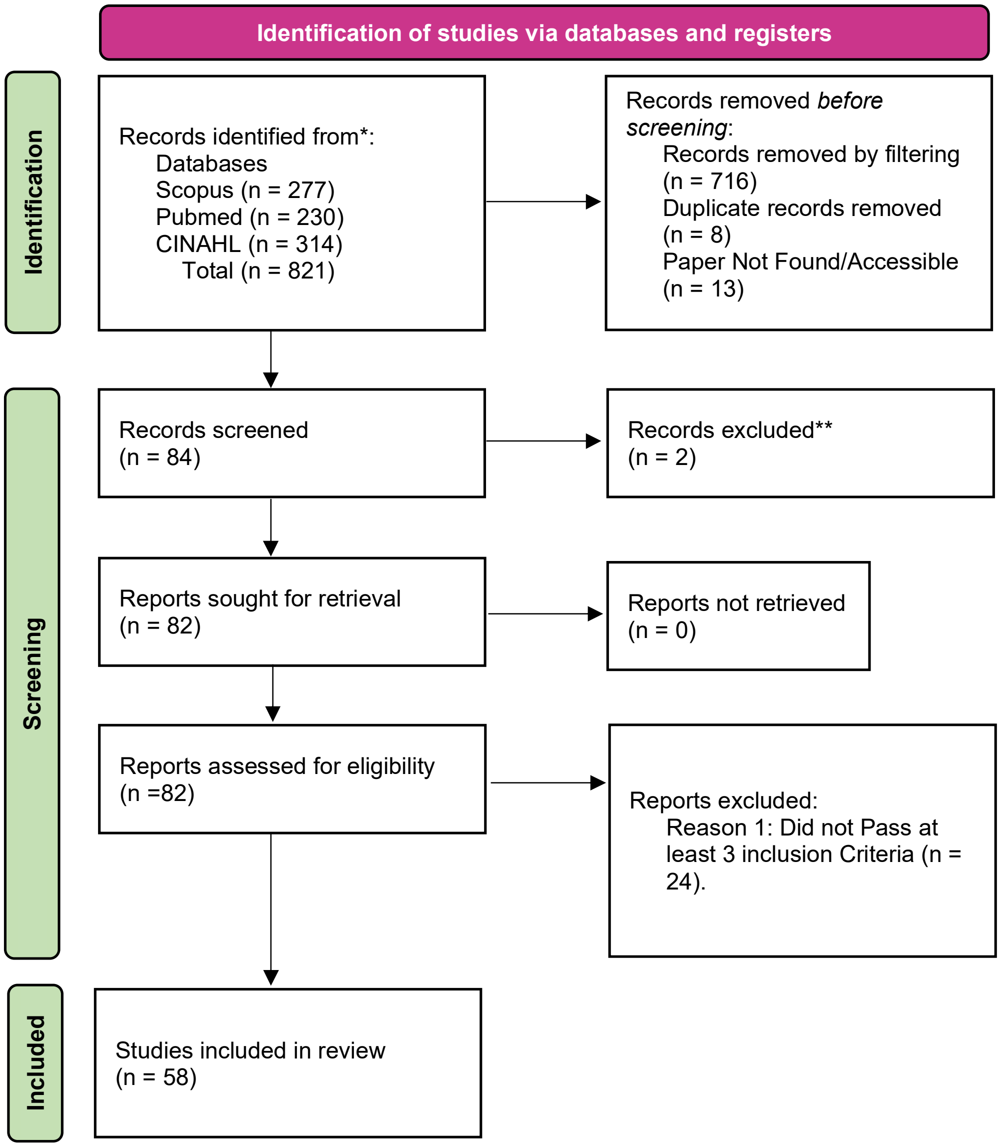

Figure 1. PRISMA flowchart of literature review process.

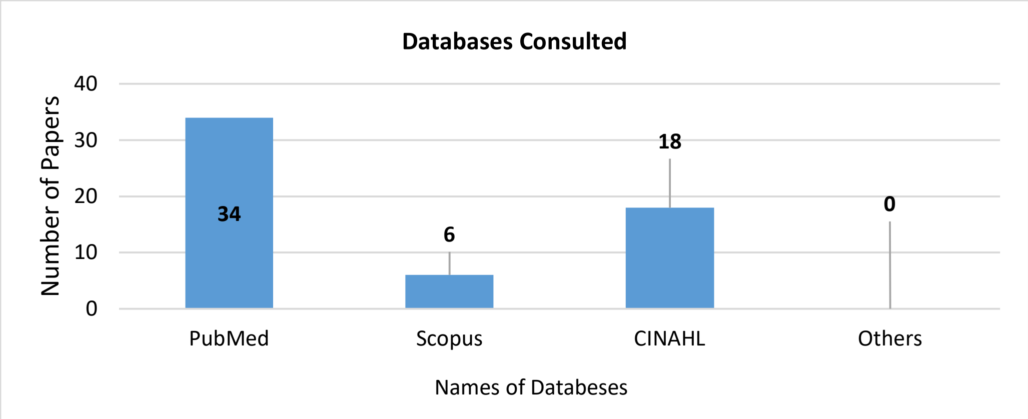

Figure 2. Bar Chart Showing the Final Number of Papers from Databases after screening

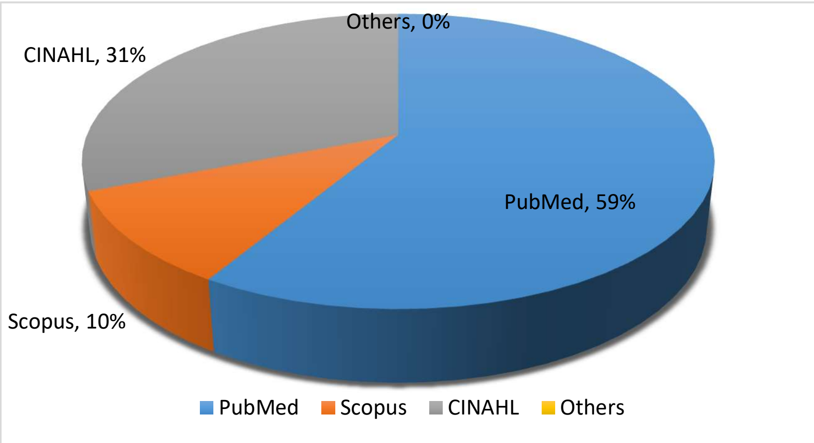

Figure 3. Pie Chart Percentage Representation of the Papers

The Figure 2. and Figure 3. above illustrates the distribution of included studies by database source. The majority of studies were identified through PubMed (n = 34(59%)), reflecting the strong representation of clinical and public health–focused telehealth research within the reviewed literature. CINAHL contributed a substantial portion of the included studies (n = 18(31%)), highlighting the relevance of nursing and allied health perspectives in telehealth equity research. Scopus accounted for a smaller number of studies (n = 6 (10%)), while no eligible studies were retained from other sources following screening. This distribution indicates that the evidence base for telehealth interventions targeting vulnerable populations is primarily concentrated within health sciences–oriented databases.

This systematic literature review methodology is well-suited for engineering and systems research because it enables structured synthesis of evidence across heterogeneous implementations, contexts, and system configurations. In this study, the review approach supports identification of recurring design patterns, constraints, and failure modes in telehealth systems, providing evidence-based inputs for engineering design, optimization, and educational curricula.

4. Results and Findings

The systematic search strategy across PubMed, Scopus, and CINAHL yielded 821 records, from which 58 studies met the inclusion criteria following PRISMA guided screening [40]. Sample sizes ranged from 18 to 8,445,720 participants, with a combined total of approximately 9,117,783 records, reflecting a mix of small scale interventions and large population level analyses. After removing 126 duplicates and exclusions, 82 articles underwent full text review, resulting in a final set of 58 studies examining telehealth and social vulnerability. Most studies were conducted in the United States, accounting for 43 articles or 74.1 percent, while a smaller number originated from the United Kingdom, Canada, India, and multinational settings. This distribution indicates a strong concentration of evidence within Western healthcare systems, with limited but important contributions from lower resource contexts [41-43].

Publication trends show a clear increase in recent years, with 2024 and 2025 contributing over 62.1 percent of the included studies, indicating a shift toward post pandemic evaluation of telehealth and its impact on disparities. Methodologically, 65.5 percent of studies employed empirical designs, while the remainder consisted of policy analyses and conceptual work that support understanding of digital determinants of health [44-45].

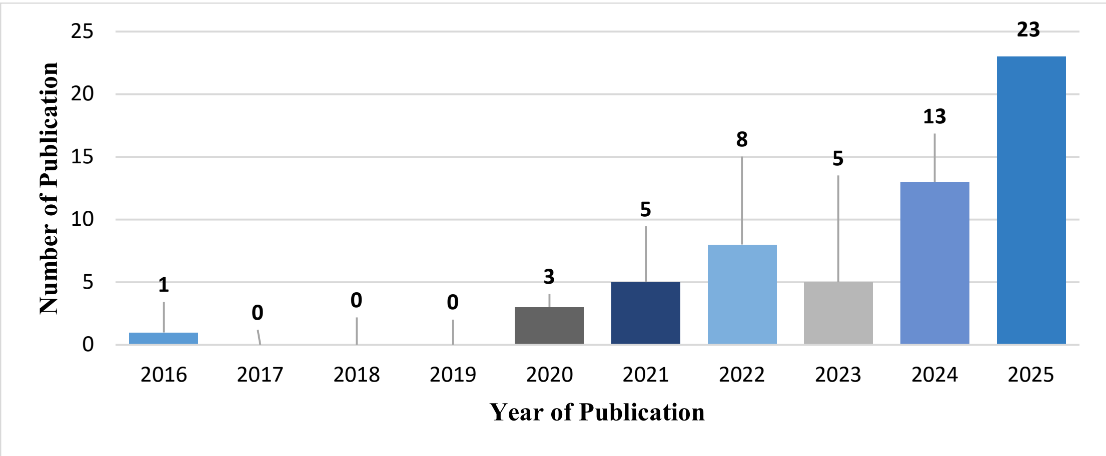

Figure 4. Bar Chart of Publication Trends (2015-2025) showing the spike in [2024/2025]

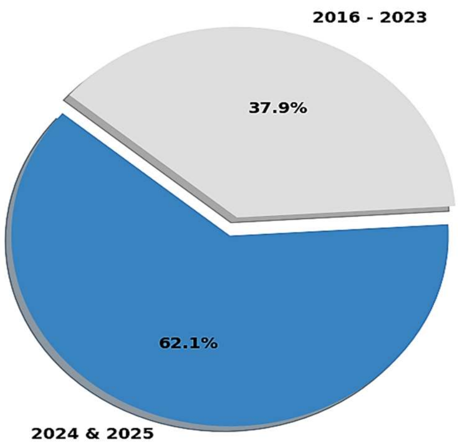

Figure 5. Pie Chart showing Proportion of Studies Published in (2024-2025 vs. Others)

Geographically, the evidence base is heavily concentrated in high-income countries, with studies conducted in the United States accounting for the majority of included articles. Additional contributions originate from Europe, parts of Asia, and a limited number of studies from low- and middle-income countries. This concentration underscores both the maturity of telehealth infrastructure in high-income settings and the relative scarcity of rigorous evaluations in regions where digital access constraints are most severe. The dominance of U.S.-based studies also reflects the particular relevance of telehealth in fragmented healthcare systems characterized by insurance disparities, safety-net providers, and uneven broadband coverage [46–47].

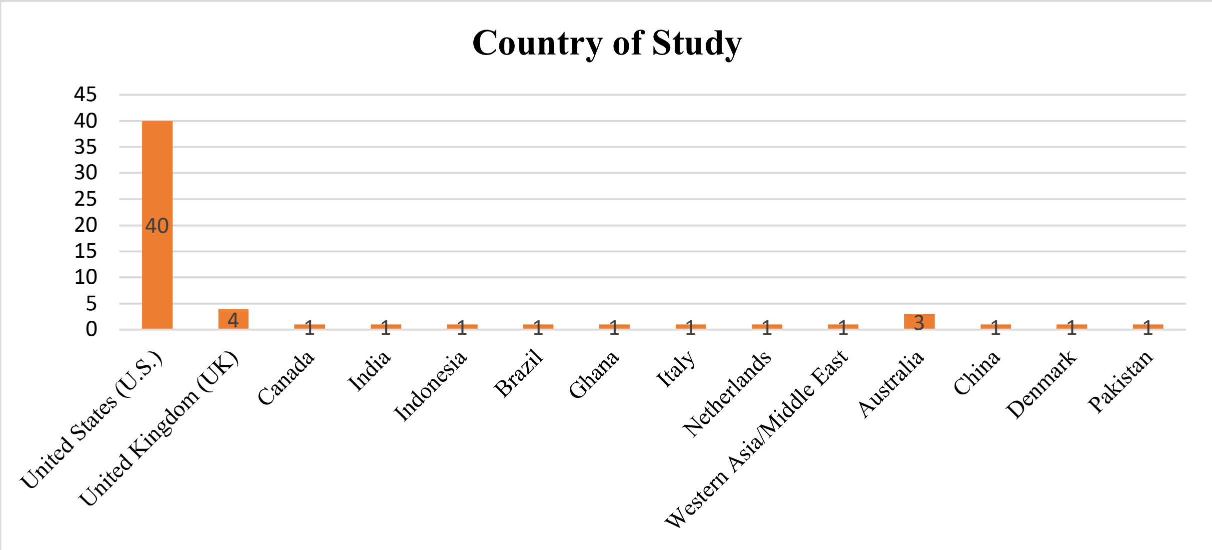

Figure 6. Geographic distribution of included studies

Across the included literature, a range of vulnerable populations are represented. Studies frequently focus on rural residents, low-income individuals, older adults, racial and ethnic minority groups, Medicaid recipients, and patients receiving care in safety-net or community health settings. Several studies examine overlapping vulnerabilities, such as older adults in rural areas or low-income minority populations with chronic disease, reinforcing the intersectional nature of health disparities addressed by telehealth interventions [48–49].

Methodologically, the reviewed studies encompass quantitative, qualitative, and mixed-methods designs as shown in Figure 7. Quantitative studies commonly employ retrospective cohort analyses, cross-sectional surveys, or quasi-experimental comparisons between telehealth and in-person care. Qualitative studies provide detailed insight into patient experiences, perceived barriers, and implementation challenges, while mixed-methods designs integrate outcome measurement with contextual explanation. This methodological diversity strengthens the review's capacity to assess both effectiveness and underlying mechanisms.

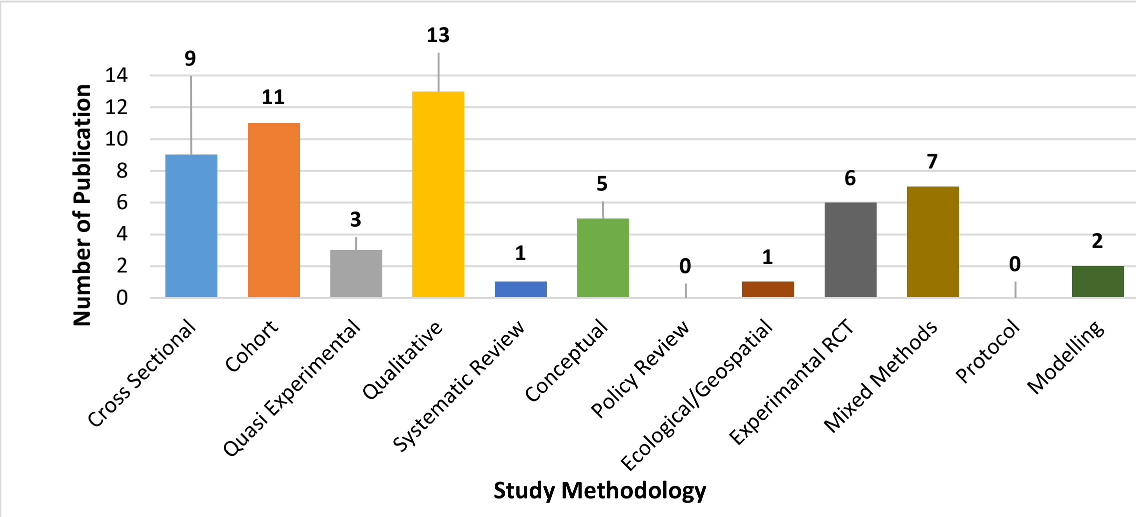

Figure 7. Distribution of study methodologies and designs

Telehealth interventions examined across the studies include video consultations, telephone-based care, mobile health applications, and remote patient monitoring, often implemented in combination rather than isolation. Notably, the descriptive analysis shows that interventions vary not only in modality but also in the degree of support provided to users, such as digital literacy training, connectivity assistance, or culturally tailored delivery. These variations are central to interpreting effectiveness and equity outcomes [50–51].

Research Question 1: Among vulnerable populations, how effective are telehealth interventions compared with traditional in-person care in improving healthcare access and reducing health disparities?

This research question examines the effectiveness of telehealth interventions relating to traditional in-person care in improving healthcare access and reducing health disparities among vulnerable populations. Across the included studies, telehealth demonstrates consistent benefits in improving access to care, with more variable effects on engagement, adherence, and clinical outcomes.

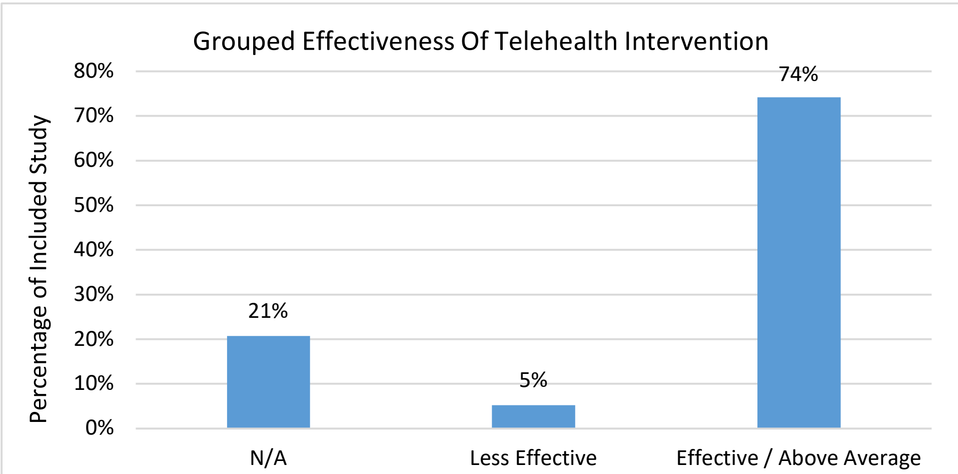

Figure 8. Bar chart showing the grouped distribution of reported telehealth effectiveness relative to traditional in-person care across included studies.

The Figure 8 presents the grouped distribution of telehealth effectiveness outcomes across included studies. A substantial majority (74%) of studies were classified as “Effective / Above Average,” demonstrating statistically significant or clinically meaningful improvements. A smaller proportion (5%) reported limited or non-significant outcomes and were categorized as “Less Effective.” In 21% of studies, effectiveness outcomes were not explicitly reported. This grouped synthesis enhances interpretability by consolidating heterogeneous outcome labels into standardized analytical categories. Taken together, this distribution suggests that telehealth generally performs at least comparably to in-person care, with effectiveness contingent on implementation context and intervention design, an observation explored in greater detail in subsequent analyses addressing equity mechanisms and enabling conditions [52–54].

Healthcare access emerges as the outcome domain with the strongest and most consistent evidence of telehealth effectiveness. Studies comparing telehealth with in-person care frequently report reduced missed appointments, shorter wait times, and increased visit completion rates, particularly among populations facing transportation, mobility, or geographic barriers. In several studies, telehealth not only matched but exceeded in-person care in appointment attendance, suggesting that remote modalities can mitigate structural barriers that disproportionately affect vulnerable groups [55–56].

However, access gains are not uniform across all telehealth formats. The descriptive coding indicates that interventions offering telephone-based options alongside video consultations are more likely to demonstrate equitable access outcomes. In contrast, video-only models frequently exclude individuals without reliable broadband access, appropriate devices, or digital literacy, resulting in differential use across socioeconomic and racial groups. These findings suggest that modality flexibility is a key determinant of whether telehealth improves or undermines equity of access [57–58]. The Table 3 below summarizes the comparative equity performance of major telehealth modalities across vulnerable populations

Table 3: Comparative Economic Outcomes of Telehealth Interventions.

Modality	**Target Population**	**Key Equity Finding**	**Representative Study Examples**
Video Visits	General/ Veterans	Decrease in Equity: Significant "Video Gap" observed. Older, rural, and minority patients use video less than audio-only.	S004, S010
Audio-Only (Phone)	Safety-Net/ Rural	Increase in Access: Vital safety net. Preferred by patients with low digital literacy or poor broadband.	S002, S005, S008
Remote Monitoring	Heart Failure/ Maternal	Mixed: Clinically effective (reduced readmissions), but enrollment processes may exclude minorities.	S002, S005
mHealth/ Text	Hypertension/ Stroke	Increase in Access: High feasibility in low-resource settings (Ghana, US safety net) due to low bandwidth requirements.	S003, S009, S012

Table 4: Comparative effectiveness of telehealth versus in-person care by outcome domain and population group.

Outcome Domain	**Population Group**	**Telehealth is More Effective than In-Person**	**Comparable Effectiveness**	**Less Effective /Mixed Evidence**	**Representative Study Examples**
Healthcare Access	Rural populations	✓			S002, S006, S011
Healthcare Access	Low-income populations	✓			S003, S009, S012
Healthcare Access	Older adults	✓			S005, S008
Patient Engagement	Rural populations		✓		S004, S010
Patient Engagement	Low-income populations	✓			S002, S006
Patient Engagement	Racial/ethnic minority populations		✓		S007, S011
Clinical Outcomes	Chronic disease populations		✓		S002, S005
Clinical Outcomes	Older adults			✓	S008
Disparity Reduction	Rural and low-income populations	✓			S003, S009
Disparity Reduction	Racial/ethnic minority populations		✓		S007, S012

The Table 4 above presents the effectiveness of telehealth relative to in person care across major outcome domains, taken together, the findings addressing RQ1 indicate that telehealth is generally effective in improving healthcare access for vulnerable populations and can support engagement and clinical outcomes comparable to those of in-person care. However, its capacity to reduce health disparities is conditional rather than automatic, dependent on how interventions are designed and implemented [59–60].

Research Question 2: What contextual, design, and implementation factors influence the effectiveness of telehealth interventions in reducing health disparities among vulnerable populations?

This Second research question addresses the contextual, design, and implementation features that influence whether telehealth interventions effectively reduce health disparities among vulnerable populations. Based on the descriptive synthesis of the 58 included studies coded in the Excel dataset, telehealth effectiveness is strongly associated with a combination of contextual readiness, equity-oriented design choices, and supportive implementation strategies. From a contextual perspective, connectivity conditions and care settings play a defining role. Studies implemented in rural, safety-net, and community-based environments where baseline access to in-person care is limited are disproportionately represented among interventions rated as Effective, Very Effective, or Highly Effective. Conversely, studies conducted in settings with persistent broadband limitations but without alternative low-bandwidth options are more likely to fall within the Less Effective or N/A categories [61–62]. This pattern aligns with the overall effectiveness distribution, in which 74% of studies were rated as Effective or higher. In comparison, 21% did not report conclusive effectiveness, often due to contextual access constraints, as shown in Figure 9 below.

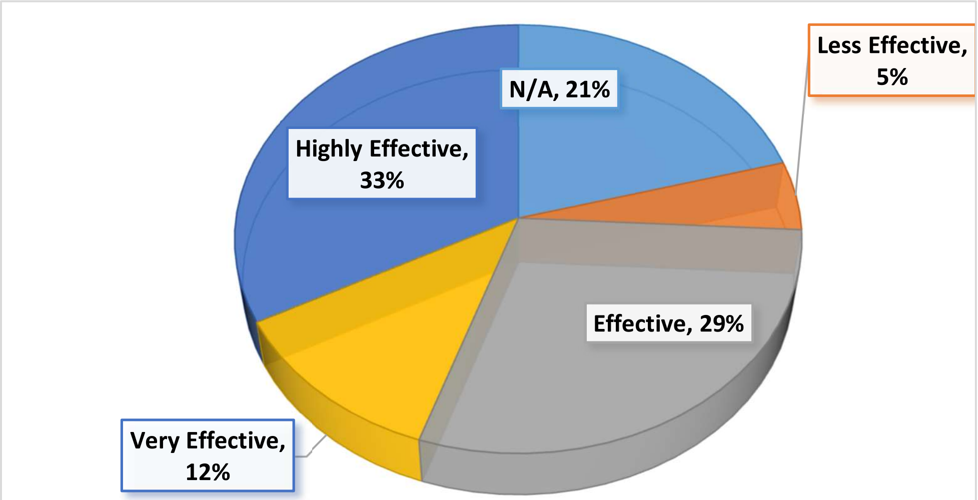

Figure 9. Pie Chart Showing the Telehealth modality by effectiveness category

Modality flexibility strongly influences telehealth effectiveness. Interventions that include audio or text based options alongside video are more often rated effective, while video only models show more mixed outcomes. About 33% of highly effective studies used low bandwidth approaches [63–64].

User support further differentiates outcomes. Interventions with onboarding or technical assistance perform more consistently, whereas those requiring independent use show greater variability, especially among vulnerable groups. This also explains why 21% of studies were classified as not reported, reflecting implementation challenges rather than clinical failure [65–66]. The Table 5 below synthesizes the contextual, design, and implementation factors associated with higher telehealth effectiveness.

Table 5. Contextual, Design, and Implementation Factors Associated with Higher Telehealth Effectiveness (n = 58)

Factor Domain	**Factor Observed in Coding**	**Association With Effectiveness**
Contextual	Rural or safety-net setting	More common in Effective–Highly Effective studies
Contextual	Connectivity barriers unaddressed	More common in Less Effective / N/A studies
Design	Low-bandwidth or flexible modality	Concentrated on highly effective studies
Design	Digital literacy or onboarding support	Linked to higher engagement
Implementation	Workflow integration	Associated with continuity and follow-up
Implementation	Stand-alone digital delivery	Linked to mixed effectiveness

Implementation characteristics also shape effectiveness. Telehealth interventions integrated into existing care workflows, such as primary care systems, community health programs, or coordinated service models, are more consistently effective than stand-alone digital deployments. Studies reporting structured follow-up, care coordination, or linkage to in-person services show stronger continuity of care and fewer disparities in participation [67–68].

Overall, the Excel-based coding evidence indicates that telehealth interventions are most effective in reducing health disparities when implemented in access-limited contexts, designed with flexible, low-barrier modalities, and supported by literacy assistance and integrated delivery structures. Interventions lacking these characteristics demonstrate greater variability or less consistent effectiveness, despite using similar technologies [69–70].

5. Discussion

This systematic review shows that telehealth can reduce health disparities among vulnerable populations, but its effectiveness is shaped by context, design, and implementation rather than technology alone. Although most studies were rated effective or highly effective, outcomes varied based on how well interventions aligned with the realities of underserved groups. Stronger gains were observed in rural, safety net, and community based settings where baseline access gaps are greatest, while interventions that failed to address connectivity or population specific barriers often produced mixed results [71–72].

Design choices are central to equitable outcomes. Flexible, low bandwidth modalities such as audio or text based care consistently perform better than video dependent models, emphasizing accessibility and usability over technological sophistication [73–74]. Interventions that assume independent digital competence show lower and less equitable uptake.

Implementation further differentiates effectiveness. Programs embedded within existing care systems or community based structures demonstrate better continuity and follow up than stand alone digital models. This reinforces the view of telehealth as a socio technical system where human support, organizational integration, and contextual fit are as critical as the technology itself [75–76]. Supportive policies that enable modality flexibility and community integration enhance equity, while rigid regulatory structures may constrain reach [77–78].

Across studies, disparities in effectiveness were consistently linked to system level constraints such as bandwidth, device access, and interface complexity. These patterns indicate that inequities arise not only from user limitations but from mismatches between system design and real world conditions, leading to reduced performance in resource constrained settings.

6. Conclusion and Engineering Recommendations

This review contributes to telehealth research by shedding more lights on the conditions under which interventions can help reduce disparities, moving beyond broad claims of effectiveness. While prior studies highlight improvements in access, they often treat telehealth as a uniform approach, with less attention to how context, design, and implementation influence equity outcomes. By synthesizing evidence from 58 studies and examining modality, user support, and delivery characteristics, this review offers a more grounded understanding of telehealth equity [79].

The findings suggest that more consistent outcomes are observed when interventions incorporate flexible, low barrier modalities, include digital literacy and navigation support, and are integrated within existing care systems. In contrast, approaches that rely heavily on high bandwidth requirements, assume independent digital competence, or operate in isolation tend to show more variable results. Viewing telehealth through a systems perspective helps highlight how these design and implementation choices influence outcomes and can inform more balanced decision making for researchers, practitioners, engineers, and policymakers.

This review has limitations. The evidence base is largely concentrated in high income settings, particularly the United States, which may affect generalizability. Variations in study design, outcome measures, and reporting standards limited direct comparison across studies, and reliance on published English language literature introduces potential bias. Future research should further examine long term effectiveness, scalability, and the policy conditions that support equitable outcomes across diverse contexts [80].

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