



Addressing health service equity through telehealth: A systematic review of reviews

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Abstract

Objective: To synthesize existing reviews on the impact of telehealth programs on health service equity in non-urban areas, focusing on six dimensions of access: accessibility, availability, acceptability, affordability, adequacy, and awareness.

Methods: We included systematic and non-systematic reviews published from 2012 to 2023 on telehealth interventions in rural or remote settings. Content was mapped to the six dimensions, and coverage within each dimension was rated based on predefined criteria.

Results: A total of 42 reviews (43% systematic) were identified. Most reviews (90.5%) addressed at least one dimension, yet comprehensive coverage was rare. Acceptability had the highest number of “good” ratings (24%), while awareness was the least explored. Gaps included digital literacy, infrastructure challenges, and cultural barriers—factors critical to equitable telehealth access. Cost-effectiveness analyses were also limited, leaving affordability underexamined.

Conclusion: Telehealth shows promise for improving healthcare access in non-urban regions. However, existing reviews often provide incomplete assessments across the six dimensions. This suggests a need for clearer, more robust evaluation frameworks to ensure more comprehensive reporting of equity impacts in telehealth research.

Keywords

Telehealth, telemedicine, digital health, rural healthcare, health equity, healthcare disparities, review, accessibility

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Introduction

Although the quality and accessibility of healthcare has improved significantly over recent decades, there are still considerable regional differences in the utilization and outcomes of medical services.¹ These discrepancies are particularly pronounced in non-urban areas.² Residents in these areas often face many challenges in accessing high-quality medical services, including scarcity of medical facilities, lack of professional medical personnel, and heavier travel burden.³ As a result, their health outcomes are often poorer than residents in urban areas.

Telehealth provides a promising avenue for enhancing equity of access to healthcare services, especially for people living in non-urban settings. Ideally, telehealth utilizes cutting-edge information and communication technologies to provide cross-regional healthcare services, enabling patients to receive medical consultations and

services in their location from remote experienced healthcare professionals.⁴ Telehealth covers various forms, including teleconsultations, teleradiology, telepathology, and remote health education.⁵ With the advent of smartphones and high-speed internet, telehealth can further

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raise awareness of available healthcare options and accessibility of services for people in non-urban regions.^{6,7}

However, while the potential of telehealth is widely recognized, current research indicates mixed results on its actual impact and effectiveness.⁸ Some studies have found that telehealth can significantly improve patients' health outcomes and access to medical services,^{9–12} for example in chronic disease management or mental health support.^{11,13–15} Others, however, report limited or inconsistent effects.^{16–19} This discrepancy may be due to multiple factors, such as program design, patient demographics, digital literacy, technology infrastructure, cost and reimbursement policies, as well as cultural acceptance and privacy concerns—all of which may influence whether telehealth programs can be successfully implemented in real-world non-urban contexts.

Given these complexities, we focus on the multi-dimensional concept of healthcare access, which encompasses at least six interrelated dimensions: accessibility, availability, acceptability, affordability, adequacy, and awareness.^{20,21} Originally proposed by Penchansky and Thomas (1981),²² and later extended by Saurman (2016),²⁰ these dimensions provide a framework for examining why telehealth may or may not address the healthcare challenges faced by non-urban populations. For example, digital literacy directly affects the “awareness” dimension, since a lack of familiarity with technology can hinder patients from even attempting telehealth consultations.²³ Similarly, insufficient broadband infrastructure is related to “accessibility,”²⁴ while inadequate reimbursement mechanisms and technology maintenance costs are related to the “affordability” dimension.⁴ Moreover, cultural acceptance of telehealth, especially in communities with strong religious or traditional beliefs, falls under “acceptability.”²⁵

We selected these six dimensions for their relevance to telehealth, as they collectively address both systemic barriers (e.g., infrastructure, service capacity) and patient-centered challenges (e.g., affordability, cultural acceptability). We acknowledge, however, that these dimensions are neither perfectly mutually exclusive nor collectively exhaustive. For instance, both availability and adequacy may address service volume and operating hours. Moreover, supply- versus demand-side factors (providers vs. patients) are not uniformly separated within each dimension. Despite these overlaps, the 6A model remains widely recognized in health services research for systematically examining healthcare interventions. To minimize confusion and ensure a comprehensive but flexible analysis, we refined each dimension's definition (see Table 1) to emphasize its primary focus. For example, in our overview availability focuses on whether sufficient services/resources exist to meet anticipated demand, whereas Adequacy emphasizes how services are organized and structured (e.g., appointment systems, after-hours care) to effectively meet clinical needs.

We recognize that further refinements could involve explicitly distinguishing supply-side (e.g., technical infrastructure, provider capacity) from demand-side (e.g., patient resources, acceptance) within each dimension. Indeed, additional dimensions—such as sustainability or cultural competency—could be considered as stand-alone dimensions in future frameworks. For now, we maintain that the 6A structure offers a pragmatic, well-established lens for identifying critical gaps and guiding policy and practice in telehealth access. By framing our analysis through these six dimensions, we aim to provide a more structured and nuanced perspective on telehealth's potential and limitations.

Objectives

This study aims to provide a comprehensive synthesis of existing reviews on the impact of telehealth programs on health service access in non-urban areas. By examining the multiple dimensions of access, our objective is to fully understand how telehealth can shape healthcare in non-urban areas and how the design and evaluation of telehealth services might be optimized to fully realize the potential of these approaches to healthcare delivery.

Our objective is to provide insights for health policy makers, healthcare providers, and researchers to improve the design and reporting of telehealth research, with the ultimate goal of maximizing the quality and outcomes of healthcare services in non-urban areas.

Methods

Search strategy and inclusion criteria

This systematic review adheres to the PRISMA guidelines and is registered in the PROSPERO (CRD42023448755). Literature searches were conducted in Medline, Embase, and CINAHL (EBSCO). The initial search was undertaken between May and July 2023, with an update in August 2023. Keywords used were “telehealth,” “telemedicine,” “health inequities,” “rural health services,” and “access”. Table 2 presents the inclusion and exclusion criteria. We included both synchronous (real-time) telehealth interventions (e.g., audio-only calls, interactive video consultations) and asynchronous (store-and-forward) modalities (e.g., remote patient monitoring, web-based platforms) to capture the diverse range of telehealth practices. Reviews focusing exclusively on telephone-based support or text messaging were included if they met our other eligibility criteria (i.e., addressing at least one dimension of access for non-urban populations). No limits were placed on the outcomes or access measures reported by the reviews. Full-text review of all candidate reviews was undertaken, and reviews were excluded if there was insufficient information to confirm the methods used. The reference lists

Table 1. Refined definitions and examples of the six dimensions of access.

Dimension of access	Definition	Core focus	Typical supply-side factors	Typical demand-side factors	Examples
Accessibility ^a	Location	Spatial & logistical proximity	<ul style="list-style-type: none"> Geographic location of service Adequate roads/telecom infrastructure to reach users 	<ul style="list-style-type: none"> Patient travel time/cost Patient capacity to use telehealth platforms (e.g., internet access, basic tech literacy) 	<ul style="list-style-type: none"> “Is there a clinic or telehealth hub within reasonable travel time?” “Are broadband speeds sufficient for video consultation at the patient’s home?”
Availability ^a	Supply and demand	Adequate capacity	<ul style="list-style-type: none"> Enough health professionals Sufficient equipment or technology for telehealth Service volume meets community needs 	<ul style="list-style-type: none"> Demand level for specific health services (e.g., specialized care, chronic disease management) Timing of demand (peak vs. off-peak) 	<ul style="list-style-type: none"> “Does the telehealth service have enough professionals or equipment to handle the number of potential users?” “Are consult slots available at needed times?”
Acceptability ^a	Consumer perception	Cultural & social fit	<ul style="list-style-type: none"> Provider willingness to offer telehealth Provider attitudes toward cultural/religious practices 	<ul style="list-style-type: none"> Patient cultural/religious beliefs Personal preferences or comfort with technology or care mode 	<ul style="list-style-type: none"> “Do patients feel comfortable receiving care via telehealth given their cultural or religious practices?” “Do providers trust telehealth’s clinical effectiveness?”
Affordability ^a	Financial and incidental costs	Economic feasibility	<ul style="list-style-type: none"> Costs for providers to implement/maintain telehealth Insurance coverage/reimbursement models 	<ul style="list-style-type: none"> Out-of-pocket costs for patients Hidden costs (e.g., internet data plans, equipment) 	<ul style="list-style-type: none"> “Can low-income households afford the broadband or devices needed for telehealth?” “Are telehealth services reimbursed at parity with in-person visits?”
Adequacy ^a	Organization	Service design & organization	<ul style="list-style-type: none"> Operational workflows (referral, after-hours, appointment systems) Facility readiness (e.g., telehealth equipment) 	<ul style="list-style-type: none"> Patient ability to navigate appointments and schedules Suitability of the service for diverse clinical needs 	<ul style="list-style-type: none"> “Are after-hours telehealth services available for urgent consultations?” “Do patients with complex conditions receive adequate follow-up via telehealth?”
Awareness ^b	Communication and information	Knowledge & information exchange	<ul style="list-style-type: none"> Provider outreach efforts Public health campaigns 	<ul style="list-style-type: none"> Patient familiarity with telehealth Community education 	<ul style="list-style-type: none"> “Do patients know telehealth options exist in their region?” “Do healthcare

(continued)

Table 1. Continued.

Dimension of access	Definition	Core focus	Typical supply-side factors	Typical demand-side factors	Examples
			<ul style="list-style-type: none"> • Clear communication channels to reach communities 	about benefits/limitations	professionals understand cultural factors that might influence patient uptake?"

aThe five dimensions of access identified by Penchansky and Thomas (1981).

bA sixth dimension added by Saurman (2016) to emphasize the role of communication and information.

Table 2. Summary of the inclusion and exclusion criteria applied to published review articles.

	Inclusion criteria	Exclusion criteria
Study Type	Peer-reviewed systematic or non-systematic review article.	Primary research studies, case reports, conference abstracts, editorials.
Publication Time span	January 2012–August 2023	Prior to 2012
Research Content	Studies focusing on telehealth in non-urban settings, addressing at least one dimension of access: availability, accessibility, acceptability, affordability, adequacy, and awareness. Studies that address telehealth in both urban and non-urban settings are included if they provide substantial content and relevant findings concerning non-urban environments related to at least one of these dimensions of access.	Studies addressing telehealth in non-urban settings but failing to engage with any of the following dimensions of access: availability, accessibility, acceptability, affordability, adequacy, and awareness. Studies focusing solely on urban telehealth without substantive data or findings related to non-urban settings.
Outcome variable	Articles discussing or mentioning the actual impact of telehealth programs on healthcare service access, whether they have been directly studied or merely mentioned.	Articles that do not discuss or mention the impact of telehealth on healthcare service access.
Language	English	Non-English articles

of included papers were hand-searched for any additional papers not identified via the electronic literature searches. Details of the search strategy are in Additional file 1 and a PRISMA (2020) flowchart is shown in Figure 1. This study is a systematic review of reviews and did not require human research ethics approval, as it does not directly involve human participants or primary data collection.

Data extraction

After de-duplication, two authors (SW, AW) independently screened article titles, abstracts, and full texts for inclusion, with adjudication by a third author (SN or AvH) if discrepancies arose, with final decisions resolved by consensus. The following information was extracted using pre-agreed data extraction tables: first author, publication year,

keywords, review type, corresponding author's country, countries or regions of interest, study aim, setting, diseases of interest, search details (databases searched, search span, number of included studies), and the Population Intervention Comparator Outcome (PICO) elements of their research question(s).

In addition to the details mentioned, we also extracted data related to the dimensions of healthcare access as defined by our study's conceptual framework. This included whether and how each review addressed the issues of availability, accessibility, affordability, acceptability, adequacy, and awareness of health services. During data extraction, if elements overlapped, we categorized them according to their predominant dimension (e.g., if a review discussed after-hours service, we coded that under Adequacy rather than Availability). To identify and assess

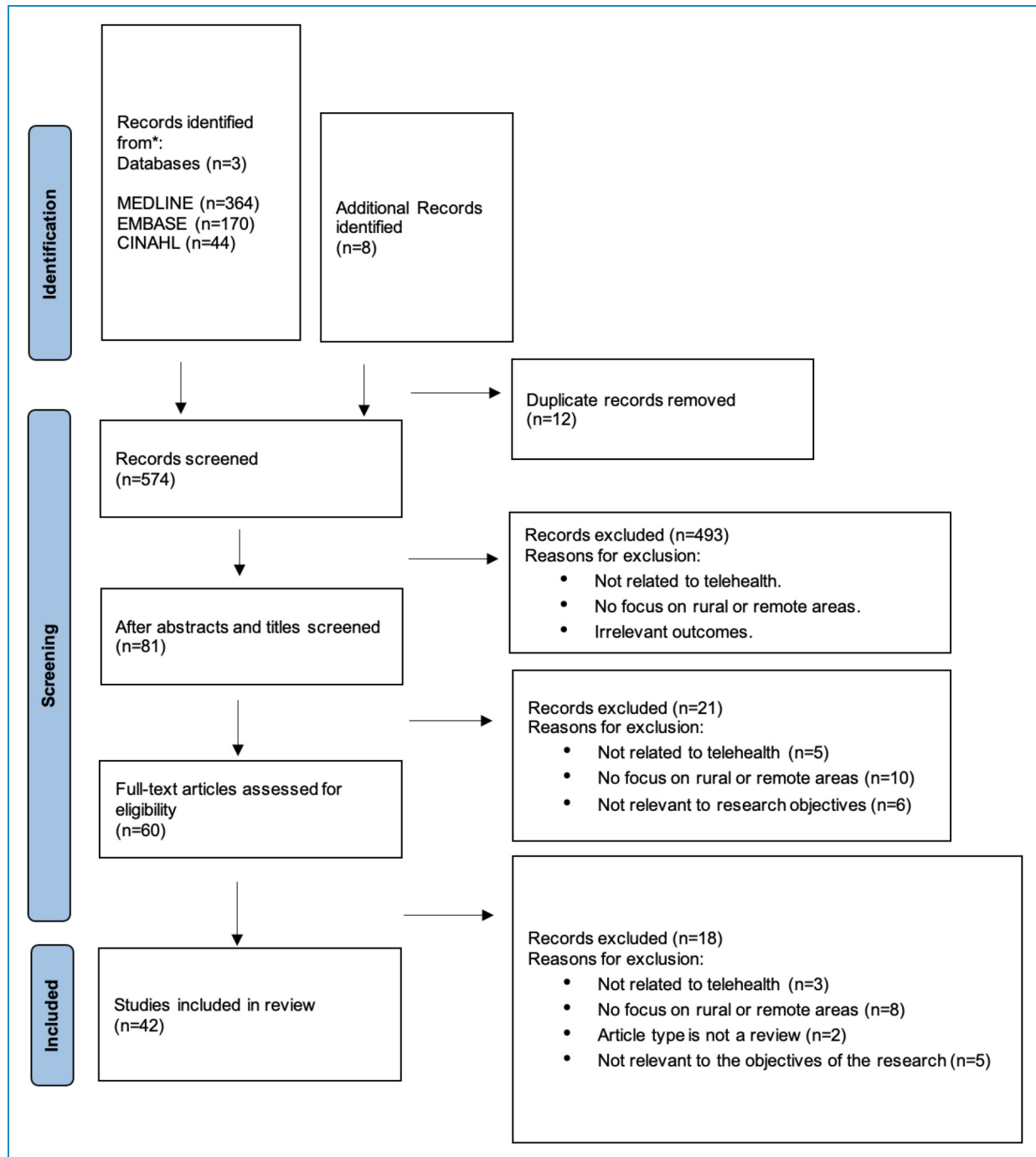


Figure 1. PRISMA flowchart of article review and selection.

these dimensions, we employed a structured data extraction form that included specific fields for each dimension. This form was developed based on the review's initial aims and objectives. The dimensions of healthcare access were then systematically analyzed for each review during the data extraction phase. This analysis informed the subsequent synthesis and discussion of how well the included studies addressed each dimension of access within their respective scopes and contexts.

Assessment of included studies

There was no single quality assessment tool that could be applied across the range of review types included in our umbrella review. Instead, we inferred quality based on their reporting against the following minimum information: key details of their search strategy (databases searched, search dates, and search span) and whether quality assessment was undertaken of included primary studies. Quality

was determined as follows: Good, details provided for all minimum information; Fair, details provided for either the search strategy or quality assessment of primary studies; Poor, no details provided for any of the minimum information set (Additional file 2).

Analysis of included studies

Judgments were made by the authors regarding the extent to which each included review addressed each of the six dimensions of access. To systematically assess the coverage of each dimension of access, we developed four levels of evaluation criteria (Table 3). These criteria emphasize specific indicators and the extent to which all indicators were addressed by the included reviews. For example, a “Good” rating required the article to: (1) address the dimension as a primary focus or one of the key components; (2) provide data and/or detailed analysis related to the dimension; and (3) offer actionable conclusions or recommendations. In contrast, a “Fair” rating required the article to address the dimension with some depth but without meeting all the criteria for a “Good” rating. Examples of how these ratings were applied during the evaluation process are included in Table 3. For instance, articles rated as “Good” for affordability provided detailed cost-effectiveness analyses, while those rated as “Poor” merely mentioned affordability as a limitation or area for future study without supporting data. Importantly, these ratings provided a consistent framework for us to judge the depth of coverage for each dimension of access within each review, but they do not necessarily reflect the methodological quality of the included reviews.

Additionally, we have constructed a heatmap (Table 4) to visualize these ratings, where color intensity corresponds to the percentage of reviews in each rating category. The heatmap was created using Excel, applying a gradient from light blue to dark blue to indicate increasing coverage percentages.

The ratings were developed using an initial sample of 42 reviews, with detailed co-review by all authors to define, expand, and then refine the criteria before application of the final criteria to the full set of included reviews by one author (SW). To ensure the reliability and consistency of the ratings, a second reviewer (PS) conducted blinded judgments on a random 20% of the sample. Instances where the two reviewers’ assessments differed by more than one level on the rating scale were flagged for further discussion. In cases where a consensus could not be reached through discussion, a third reviewer (AW) was brought in to arbitrate. This reviewer independently assessed the contested dimension(s) and facilitated a final decision.

Meta-analyses were not conducted because of the wide variety of outcomes reported across the reviews, and because of the potential for individual primary research studies to be included in multiple reviews.

Results

Characteristics of the included reviews

The electronic and manual searches yielded 574 unique articles for title and abstract review, 81 underwent full-text screening, and 42 met the inclusion criteria (Figure 1).

Additional file 3 provides an overview of the 42 reviews. Between 2012 and 2023, the frequency of publication of reviews on this topic has increased, with 50% ($n = 21$) published in the last 2 years of the search span. The most common type of review was systematic (43%, $n = 18$), followed by literature (24%, $n = 10$), scoping (12%, $n = 5$), rapid (9%, $n = 4$), narrative (7%, $n = 3$), and “comprehensive” (5%, $n = 2$). Most reviews focused on peer-reviewed literature (93%, $n = 39$), 3 (7.1%) included gray literature, and 13 (31%) undertook quality assessment of the primary studies included in their review. Of the included reviews, 12 (28.6%) were judged to be of good quality, indicating a comprehensive reporting of both their search strategy and the quality assessment of primary studies, 23 (54.8%) were fair quality, suggesting that while they provided some necessary information there was room for improvement in their reporting, and 7 (16.7%) were poor quality, lacking in detail for what we judged to be the minimum reporting criteria.

The top three countries for the corresponding author were the United States (50%, $n = 21$), Australia (19%, $n = 8$), and Canada (14.3%, $n = 6$). Half the reviews (50%, $n = 21$) did not specify any limits or focus by country or region. The most common types of condition studied were chronic diseases (31%, $n = 13$), although, the majority ($n = 20$, 48%) had no focus on specific diseases or symptoms. The PICO elements in the majority of reviews (95.2%, $n = 40$) were aligned with our PICO criteria.

Analysis of findings from the included reviews

Each of the 42 included reviews described at least one of the six dimensions of access, with many reviews addressing multiple dimensions (see Additional file 4). To illustrate this variation in coverage, Table 4 presents a heatmap showing the frequency of “Not Covered,” “Poor,” “Fair,” and “Good” ratings for each dimension across all reviews. As the table shows, coverage is unevenly distributed among the six dimensions.

While all included reviews addressed at least one dimension of access, the coverage of each dimension was generally low. The most frequent assessment of dimension coverage was “poor” (66.8% overall, 139/208; where the denominator is the total number of reviews (42) multiplied by the number of dimensions (6), minus the number of Not Covered results (44)). No review was judged to have “good” coverage for all six dimensions. The dimension with the highest number of reviews with a “good” rating

Table 3. Evaluation criteria of the coverage of dimensions of access.

Rating	Description	Examples
Not Covered	The dimension of access is not mentioned at all within the article.	The review does not refer to any element related to the dimension (e.g., no mention of accessibility or availability).
Poor	The dimension is acknowledged, but only briefly, often in the discussion as a direction for future research or as a limitation of the current study. This rating also applies if data regarding the topic were collected by primary study authors, but findings were not discussed in the review article.	The review mentions affordability in the discussion section but does not delve into its details or implications.
Fair	The dimension is addressed more extensively than in “Poor” articles, but not as thoroughly as in “Good” articles. Coverage goes beyond a mere mention but lacks sufficient detail, examples, or robust analysis.	The review discusses awareness and provides some relevant data, but does not provide an exhaustive analysis.
Good	The article comprehensively addresses the dimension, presenting relevant data, critical insights, and/or contextual analysis that illustrates how this dimension influences telehealth access. The review may also suggest evidence-based strategies or best practices. This represents the gold standard of coverage within the context of the article’s topic.	A review devoted a large amount of content to the acceptability, including qualitative and quantitative data, and offered strategies for improvement.

was Acceptability (24%), but for the other dimensions, the number of reviews with a “good” rating was lower (2–14%) (Table 4). This pattern is also evident in the heatmap, where cells corresponding to “poor” ratings dominate most dimensions except Acceptability.

There was no significant association between the quality of the reviews and the extent of coverage of the access dimensions. This suggests that while quality assessment is crucial for evaluating the methodological soundness of a review, it may not fully capture the review’s comprehensiveness in addressing the multifaceted issue of access to telehealth service. Accordingly, narrower coverage of certain dimensions should not be interpreted as an inherent shortcoming of the review itself, but may instead reflect differences in scope, intervention stages, or study objectives.

Overall, Table 4 highlights substantial gaps in how existing telehealth reviews address the six dimensions of access, indicating opportunities for more holistic evaluations in future research.

Accessibility

Out of 42 reviewed articles, 90.4% (38/42) addressed accessibility issues in telehealth, but the majority of these ($n = 30$) had “Poor” coverage. Reviews rated as having “Good” coverage of this dimension (7.1%) discussed important factors, such as the ease of use of technology (digital literacy), having a stable and reliable internet connection (telecommunications infrastructure), and user-

friendly platforms (e.g., tailored for the elderly or disabled). Additionally, the reviews with “good” coverage of this dimension highlighted how concerns about patient data privacy and environmental privacy may limit the accessibility of virtual care.^{26–28}

Availability

Availability was covered by 81% (34/42) of the reviews, but the majority of these reviews ($n = 28$) had “Poor” coverage. Reviews that had “Good” (2.4%) or “Fair” (11.9%) coverage included comprehensive discussion on aspects including the scope of service provided by telehealth, the technological infrastructure required to support these services, financial constraints, cultural barriers and regional disparities in the provision of services (such as the availability of sufficiently trained professionals to interpret results).^{18,26,29–32}

Acceptability

Thirty-eight reviews (90.4%) covered issues related to acceptability. There was better coverage of this dimension overall; 21 reviews rated “good” or “fair” and 17 rated “poor.” Reviews with “Good” coverage delved into the attitudes and perceptions of both patients and providers toward telehealth. From the patient’s perspective, common barriers to acceptability included factors such as age, education

Table 4. The number (percentage) of reviews that covered or did not cover each dimension of healthcare access.

Dimension of access	Covered				Not covered <i>n</i> (%)
	Good <i>n</i> (%)	Fair <i>n</i> (%)	Poor <i>n</i> (%)	Total <i>n</i> (%)	
Accessibility	3 (7.1%)	5 (12.0%)	30 (71.4%)	38 (90.5%)	4 (9.5%)
Availability	1 (2.4%)	5 (11.9%)	28 (66.7%)	34 (81.0%)	8 (19.0%)
Acceptability	10 (23.8%)	11 (26.2%)	17 (40.5%)	38 (90.5%)	4 (9.5%)
Affordability	6 (14.3%)	10 (23.8%)	19 (45.2%)	35 (83.3%)	7 (16.7%)
Adequacy	2 (4.8%)	7 (16.7%)	29 (69.0%)	38 (90.5%)	4 (9.5%)
Awareness	2 (4.8%)	1 (2.4%)	23 (54.8%)	26 (62.0%)	16 (38.0%)

level, digital literacy, insurance coverage, cultural sensitivity, and a lack of understanding about, or familiarity with, the services. On the provider side, challenges included concerns related to cost, reimbursement, legal liabilities, privacy, data security, and the efficiency of telehealth services. Authors noted that these factors could make providers hesitant to fully embrace telehealth, thereby impacting its overall acceptability.^{17,26,28,29,32–34}

Affordability

Costs and economic issues were covered by 35/42 reviews (83.3%); 19 reviews had “poor” coverage of this dimension. The six reviews with “Good” coverage discussed technology costs, equipment costs, and insurance coverage as major barriers.^{11,26,27,35,36} Although affordability was considered in 35 reviews, only six undertook a specific cost-effectiveness analysis.^{26,32,37–40} Ten reviews mentioned potential cost savings but lacked any formal type of economic analysis.^{10–13,17,18,27,29,34,41}

Adequacy

Adequacy was mentioned in 38 (90.4%) reviews, 29 of which had “Poor” coverage. In the two reviews rated as having “good” coverage, there was discussion around whether telehealth services can meet patients’ clinical needs, and whether patients could effectively utilize these services. These concepts included the ability of the service to accommodate patients (especially after-hours), the efficiency of the appointment system, and the suitability of facility structures, particularly for individuals with

auditory, visual, or cognitive impairments, and the elderly.^{11,16,26,27,29,32}

Awareness

Awareness had the lowest coverage of the six dimensions with only 26 reviews addressing it, and only three of these reviews rated as “Good” or “Fair.” Awareness relates to the perception and understanding of telehealth services by patients, providers, and the community. Reviews mentioned barriers to awareness of telehealth services such as older age, lower educational levels, and digital literacy. These factors contribute to a lack of understanding among patients, which refers to their limited knowledge or recognition of the availability, functionality, or potential benefits of telehealth services. This lack of understanding can hinder patients’ ability to effectively access and utilize telehealth services.^{17,31}

Discussion

Telehealth continues to show promise in bridging healthcare gaps for non-urban populations. Our review highlights notable strengths and weaknesses in telehealth research across the six dimensions of access. While telehealth improves Availability by extending specialist care to remote regions,^{34,42} Accessibility remains constrained by infrastructure deficits, such as inadequate broadband and limited access to smartphones, which hinder large-scale telehealth implementation.^{13,16,27,31,43} Additionally, digital literacy challenges hinder effective use of telehealth platforms,^{19,31,43} particularly among elderly or low-literacy

groups.³¹ Ensuring connectivity, user-friendly technologies, and ongoing support for digital skills will be crucial for improving the Accessibility and Availability of telehealth. Addressing these issues requires targeted investments in broadband infrastructure and community-based digital literacy training programs.

Overall, patients report satisfaction with telehealth when it saves time and effort.^{10,26,37,39,42,44} However, cultural acceptability remains underexplored in certain contexts.^{13,19,33,45–47} Strict religious practices, traditional health beliefs, or mistrust of technology can limit telehealth adoption.^{19,33} Designing culturally sensitive telehealth platforms, incorporating translation services and respectful engagement with community-specific values is critical to overcoming these barriers. For instance, involving local leaders can build trust and improve acceptability among hesitant populations.^{19,31} Additionally, providers' willingness to adopt telehealth may be tempered by concerns about effectiveness, legal liability, and technical limitations.^{26,28,48} Efforts to develop culturally adaptable telehealth solutions and offer targeted educational initiatives can increase confidence among both patients and providers, expanding telehealth's reach in diverse communities.

Although telehealth can reduce patient-related costs like transportation,^{13–15,17,34,37,40} affordability remains a concern for both providers and users. Only a few reviews reported formal cost-effectiveness studies,^{26,32,37–40} and it is acknowledged that reimbursement models often lag behind technological innovations.^{34,35,47,49} But initial hardware expenses, maintenance costs, and lower reimbursement rates for telehealth services may undermine its economic viability.^{34,35,47} Several strategies can address affordability challenges: First, subsidy programs and grants could help low-income households overcome initial setup costs.⁴³ Second, Policymakers and insurers could collaborate to establish standardized reimbursement rates for telehealth services, thus improving financial predictability for providers and patients.³⁵ Third, investment in cost-efficient technologies and partnerships with internet providers can lower the overall cost of telehealth delivery.²⁹ Future research should prioritize economic evaluations to identify sustainable models for telehealth implementation.

Adequacy reflects whether telehealth services are organized to meet patients' clinical needs. While telehealth shows promise in managing chronic conditions, such as Type 2 diabetes and mental health counseling,^{10,14,26,38,47} gaps remain in ensuring its adequacy for complex or specialized care.^{19,27,31,37} Many reviews noted a lack of clinical outcome measurements and relied instead on process-focused metrics.^{36,37,50–52} As telehealth increasingly becomes a mainstream mode of medical service delivery, more rigorous, outcome-based evaluations are needed to ensure that all patients benefit from telehealth in both routine and specialized contexts.

Many reviews highlight that telehealth's success depends as much on awareness as on technical delivery.^{11,15,26,28,31,34,50} Knowledge gaps persist among patients and healthcare providers, particularly in low-literacy or low-resource environments.^{14,17,27,32,53} At least four strategies have been identified to address these gaps.: First, engagement with local leaders, community health workers, and patient advocacy groups to design culturally tailored campaigns that highlight telehealth's benefits.^{19,31} Second, creating comprehensive training modules for healthcare professionals, focusing on culturally appropriate communication strategies and a nuanced understanding of community needs.^{33,39,46} Third, collaborating with technology developers to simplify interfaces, prioritize language-accessible features, and incorporate assistive technologies for users with low digital literacy.⁴⁵ Fourth, developing and administering regular surveys to measure public knowledge about telehealth, identifying misconceptions or barriers that can be addressed through targeted interventions.¹⁶ Future research is needed to evaluate the impact of these strategies on telehealth adoption and equity.

Throughout the 6A dimensions, key barriers—namely digital literacy deficits, infrastructure shortcomings, and cultural factors—frequently intersect and amplify one another. For instance, limited infrastructure hinders both Availability and Accessibility, while cultural acceptability affects community readiness (under Acceptability) and communication strategies (under Awareness). Addressing these barriers systematically and contextually is essential for truly equitable telehealth.

We acknowledge that many of the reviews we included focused on specific intervention stages (e.g., early feasibility vs. larger-scale implementation) and thus naturally emphasized one or two dimensions. For instance, reviews centered on pilot studies often highlighted Acceptability and Awareness, whereas reviews on more mature telehealth programs paid closer attention to Affordability or Adequacy. In Table 4, we provide an overview of how many reviews covered each dimension at various levels (Not Covered, Poor, Fair, Good). This distribution indicates that although most reviews did not address all six dimensions comprehensively, many offered in-depth insights into particular aspects of telehealth access. We do not interpret such narrower scope as an inherent shortcoming in a review, but rather a reflection of each review's objectives and the maturity stage of the telehealth interventions being evaluated.

Each dimension of access offers a unique lens through which equity of telehealth services can be evaluated. Each dimension dynamically interacts with the others, allowing us to understand the barriers and facilitators to telehealth at the system level, providing a holistic view for policymakers, practitioners, and stakeholders aiming to fully harness the potential of telehealth. Going forward, we encourage future reviews to adopt a more holistic

framework where feasible, exploring multiple dimensions simultaneously. Future research should aim to fill the gaps identified in our discussion, particularly by conducting rigorous, outcome-based studies that provide a deeper understanding of how these dimensions affect real-world telehealth implementation. To support such activity, we aim to contribute a framework that is not only theoretically robust but also pragmatically informative, to guide the evolution of telehealth in a way that maximizes benefits for all users across diverse settings.

Limitations

This systematic review of reviews focused primarily on telehealth interventions in non-urban areas, so the findings might not be generalizable to urban settings or other health-care delivery models. The studies included in the review varied in terms of study design, intervention, and outcomes. This heterogeneity could influence the synthesis of results and the conclusions drawn, but simultaneously highlights the breadth of applications for telehealth and the need for consistency in assessment.

The field of telehealth is rapidly evolving with technological advancements, and some of the reviews included in this overview might not reflect the current state of telehealth technology and its capabilities. Nonetheless, 50% of the included studies were published recently, between 2021 and 2023. Even though older articles may have studied telehealth technologies that have been superseded, we cannot assume that their overall findings and insights are no longer relevant. Indeed, such studies are likely to offer longer-term insights into the evolution of telehealth practices and provide valuable context for relevant, current applications of the technology.

Potentially relevant research published in a language other than English, or not indexed in the search database may have been missed.

A further potential limitation of our study is the potential overlap of primary studies across the multiple reviews included in the synthesis. Such overlap could result in certain studies being overrepresented, potentially introducing bias in the findings. While this is a common challenge in umbrella reviews, we attempted to mitigate its impact by including a diverse range of reviews spanning different regions and timeframes. Furthermore, the broad trends and gaps identified in our analysis are unlikely to be substantially affected by this limitation, given the large number and variety of studies included.

Future research recommendations

There is a critical need for detailed economic analyses that explore the cost-effectiveness of telehealth technologies. This includes analyzing the setup, operational, and maintenance costs versus the economic benefits, such as

reduced hospitalization rates and transportation costs. There is also a need to examine the impact of different reimbursement models on the sustainability of telehealth services, particularly how these models influence provider adoption rates, patient access, and overall financial viability of telehealth solutions. In parallel, research should be directed toward improving patient-centric technology infrastructure necessary for delivering efficient telehealth services.

Studies should also focus on understanding cultural barriers to telehealth adoption and developing strategies to overcome these barriers. Developing and testing user-friendly telehealth platforms that are easily accessible to various user groups, including the elderly, disabled, and those with limited digital literacy, would not only improve patient engagement, but also increase the overall effectiveness of telehealth services. This also involves training providers to be culturally competent and incorporating patient-centered designs that respect diverse cultural backgrounds. Engaging with communities to raise awareness about the benefits of telehealth can ensure that telehealth initiatives are adapted to meet the specific needs of different groups. There is a particular need for more detailed investigations into the adequacy of telehealth services. Future research should assess the efficacy of telehealth across a wider range of clinical conditions and explore its long-term effectiveness in managing chronic diseases. Studies should also evaluate the capabilities of telehealth systems to meet diverse patient needs, including those of vulnerable populations.

As telehealth continues to grow, the importance of ensuring data security and protecting patient privacy becomes paramount. Research should focus on developing and testing robust cybersecurity measures and governance frameworks that can safeguard patient information while maintaining the functionality and accessibility of telehealth services. Research must also consider the impact of current telehealth policies and identify potential policy changes that could promote the wider adoption and equitable distribution of telehealth services.

Conclusion

This systematic review underscores the significant potential of telehealth to enhance healthcare access, particularly in non-urban areas, by bridging critical gaps in service delivery. Despite its promise, our analysis identifies persistent challenges across various dimensions of access—availability, accessibility, adequacy, affordability, acceptability, and awareness—each presenting unique obstacles and opportunities.

Key findings reveal that while telehealth is becoming more widely available, substantial barriers remain in ensuring equitable service distribution and accommodating the diverse needs of different populations. Challenges such as limited digital literacy, inadequate infrastructure, and

cultural barriers need focused attention to make telehealth truly inclusive and effective. Moreover, while telehealth can offer cost savings, the financial implications of technology setup and maintenance, alongside disparities in insurance coverage, demand more robust economic research to fully understand and address these economic barriers.

It is crucial that future telehealth initiatives and policies focus on enhancing service adequacy, improving affordability, and expanding awareness to ensure that all segments of the population can benefit equally from telehealth technologies. By addressing these critical dimensions, telehealth can fulfill its potential as a transformative healthcare delivery model, providing high-quality, accessible, and equitable care.

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