REVIEW ARTICLE

The Impact of Digital Health Solutions on Bridging the Health Care Gap in Rural Areas: A Scoping Review

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Abstract

Digital health tools can improve health care access and outcomes for individuals with limited access to health care, particularly those residing in rural areas. This scoping review examines the existing literature on using digital tools in patients with limited access to health care in rural areas. It assesses their effectiveness in improving health outcomes. The review adopts a comprehensive search strategy to identify relevant studies from electronic databases, and the selected studies are analyzed descriptively. The findings highlight the advantages and barriers of digital health interventions in rural populations. The advantages include increased access to health care practitioners through teleconsultations, improved health care outcomes through remote monitoring, better disease management through mobile health applications and wearable devices, and enhanced access to specialized care and preventive programs. However, limited internet connectivity and a lack of familiarity with digital tools are barriers that must be addressed to ensure equitable access to digital health interventions in rural areas. Overall, digital tools improve health outcomes for individuals with limited health care access in rural areas.

Introduction

Digital health encompasses the utilization of technology, including digital devices, software, and communication tools, to enhance health and health care delivery.[1,2] Its applications range from monitoring and managing health to diagnosing and treating diseases and supporting health care practitioners and patients.[3-6] Various digital tools and services fall under the umbrella of digital health, such as mHealth, telehealth, electronic health records (EHRs), health IT, wearable devices, and remote monitoring systems. The primary goal of digital health is to enhance the efficiency, quality, and accessibility of health care services, empowering individuals to take an active role in managing their health and well-being.[7,8]

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Health determinants comprise the conditions that influence an individual's health. These determinants can stem from biological, environmental, behavioral, and socioeconomic factors; access to health care; and cultural beliefs.[9] They can impact a patient's well-being positively or negatively.[10] Access to health care is a crucial determinant of health that substantially affects the outcomes of individuals and populations. Therefore, insufficient access to health care services can result in delayed or missed diagnoses, inadequate treatment, and poorer health outcomes.[11,12] Furthermore, individuals without access to health care may miss out on preventive care, such as immunizations and cancer screenings, leading to the development of chronic diseases that are more challenging and expensive to treat in the long run.[13–15]

Digital health tools have played a pivotal role in enhancing health care access by offering patients new avenues to manage their health information, connect with health care practitioners, and receive remote care.[3,5,16] Through the use of teleconsultations, wearable devices, mobile applications, and social media platforms, these tools have helped overcome challenges such as transportation issues.[17] However, it is crucial to ensure that these digital tools be accessible and user-friendly for all patients to deliver high-quality and personalized health care services. This scoping review aims to examine the existing literature concerning the utilization of digital tools in patients with limited access to health care delivery, specifically those residing in rural areas, and assess their effectiveness in improving individuals' health outcomes.

Methods

This review aims to identify and synthesize the current evidence on the effectiveness of digital tools in improving individuals' health outcomes in the context of limited health care access.

SEARCH STRATEGY AND STUDY SELECTION

The authors conducted a comprehensive search on May 22, 2023, to identify relevant studies from electronic databases, including MEDLINE, Google Scholar, EMBASE, and Scopus. In the methodology section, the search strategy was designed to ensure a thorough inclusion of relevant studies. The selection of search terms was carefully based on examining keywords commonly found in related articles and reviews. This was done to ensure a comprehensive coverage of literature pertinent to the research topic. The search terms were "digital health," "health care access," "rural areas," "rural population," and "health outcomes." These terms were combined using Boolean operators, resulting in the following search query: "digital health" AND "health care access" AND ("rural areas" OR "rural population") AND "health outcomes." This combination of keywords and Boolean logic aimed to comprehensively gather studies directly related to the research focus, which was examining the impact of digital health on health care access in rural areas and its subsequent outcomes. Then, 2 reviewers independently screened the titles and abstracts of the identified studies for study selection to assess their eligibility for inclusion. Full-text articles of potentially relevant studies were obtained and assessed against the predetermined inclusion and exclusion criteria. Any reviewer disagreement was resolved by engaging in discussions or seeking input from a third reviewer. The inclusion criteria encompassed studies published in peer-reviewed journals examining the use of digital tools (eg, telehealth, mHealth, wearable devices) in individuals with limited access to health care in rural areas. The criteria also encompassed studies reporting on health outcomes, including but not limited to clinical outcomes, patient satisfaction, health care utilization, and cost-effectiveness, conducted in any country or setting. The authors excluded studies not published in English, case reports, and reviews focused on urban or nonrural populations and based on technical aspects of digital tools without assessing health outcomes.

DATA EXTRACTION AND ANALYSIS

Using a standardized data extraction form, the authors extracted data from relevant studies focusing on study characteristics (eg, authors, year of publication, study design), digital tools used, patient diagnosis, and reported health outcomes. The results of the included studies were analyzed descriptively, highlighting key findings and trends in the literature. To enhance clarity and readability, the synthesized findings were categorized into distinct sections, focusing on the advantages and barriers of digital health interventions in the rural population. This was done to provide an overview of the current evidence of digital tools in improving health

outcomes for individuals with limited health care access in rural areas.

Results and Discussion

The studies in this scoping review encompassed various settings, populations, and digital health interventions. The search strategy and study selection are presented in Figure 1. Furthermore, the studies were divided into 2 main categories, advantages and barriers, according to the trends identified in the analysis.

ADVANTAGES OF DIGITAL HEALTH IN RURAL AREAS

Increased access to health care practitioners

Different countries and contexts may define rural areas in different ways, especially considering the

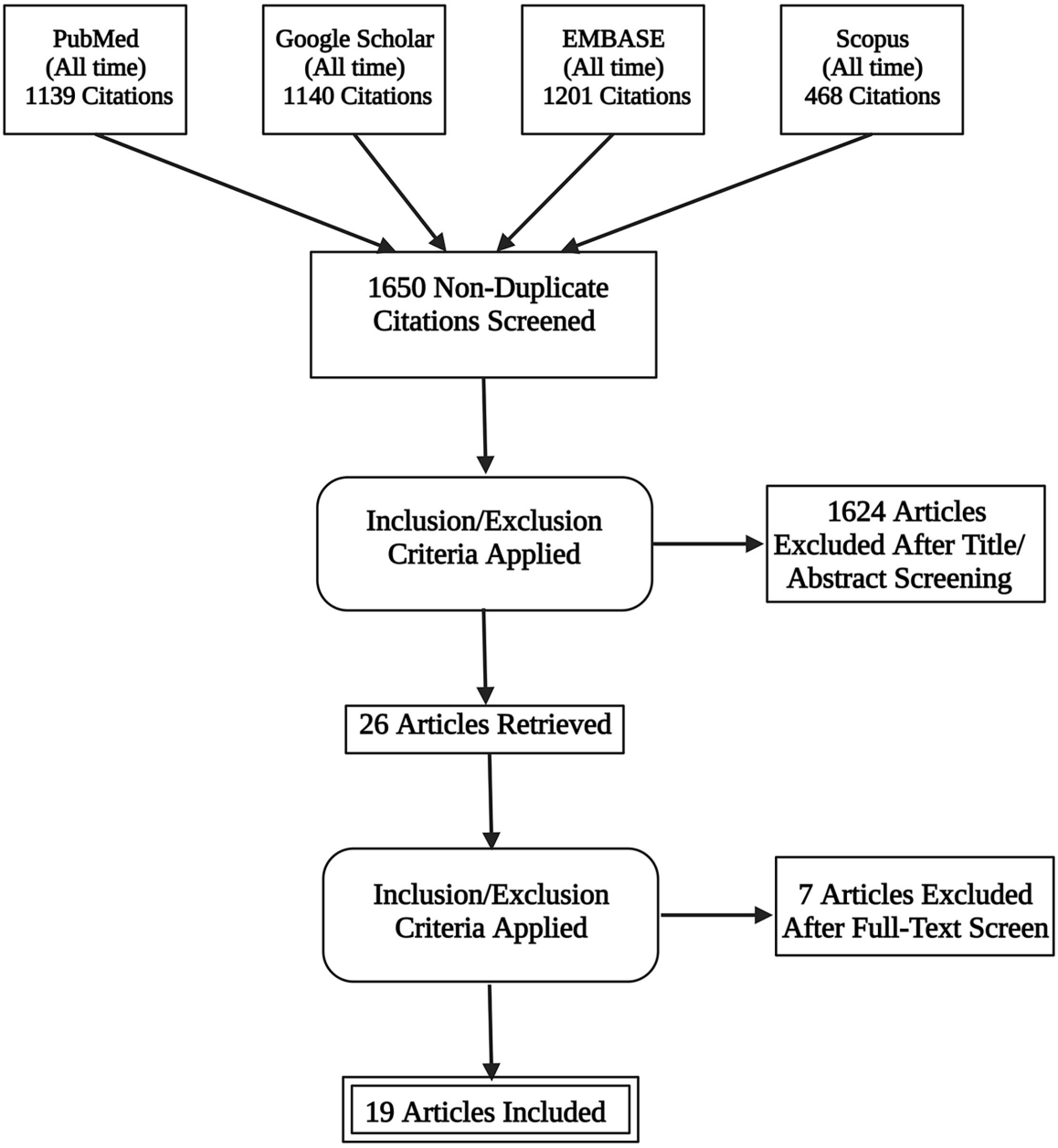

Figure 1: Flowchart created using PRISMA design from page MJ, McKenzie JE, Bossuyt PM, et al. Updating guidance for reporting systematic reviews: development of the PRISMA 2020 statement. J Clin Epidemiol. 2021;134:103–112. https://guides.lib.unc.edu/prisma#s-lg-box-26464651. Created with BioRender.

demographic, economic, and cultural variations that considerably influence health care systems and policies in these regions.[18,19] For example, a large rural town near a city may have more in common with urban areas than smaller, isolated towns. As there is no standard definition for rural and urban areas, researchers often characterize rural regions as those having smaller populations and lower density. They also often consider rural regions to be located further away from or less connected to urban centers.[19]

In recent years, digital health tools have been instrumental in bridging the gap in access to health care practitioners in rural areas [20–22]. With the aid of technology, patients living in remote locations can now easily access consultations, diagnoses, and treatment plans from health care professionals without the need to travel long distances to a medical facility.[23] Mathew et al[23] reported that some patients in remote areas preferred telemedicine, as it allowed them to remain in their community and fulfill their family and cultural obligations. Moreover, the COVID-19 pandemic helped to highlight the importance of digital health instruments in the rural population. Considering the constant changes in the rules for traveling from a remote community to a regional center of care, teleconsultations became an excellent alternative for community members who felt hesitant to travel for medical appointments, as they were concerned about being allowed to return home.[23]

Telehealth substantially increased during the COVID-19 pandemic, leading patients to maintain contact with their primary care practitioners.[16,24] This helped to overcome the disadvantages associated with rural areas, such as lack of road infrastructure (unsealed and unfenced), limited public transportation availability, and expensive travel costs.[25] For instance, patient costs have increased due to limitations on buses that transport people between regional centers and remote communities. Costs of flights to some irregularly serviced communities have also increased.[25] Moreover, access to subspecialty care in rural areas has enabled more effective care management and prevented treatment disruption, particularly in patients with chronic diseases.[26–28]

Improved health care outcomes

Technology has enabled patients to manage their health conditions better and receive timely medical care from the comfort of their own homes.[16,29] With the help of digital tools, patients can easily track their vital signs, monitor their symptoms, and communicate with their health care practitioners in real time; this has created improved disease management, faster diagnoses, and timely interventions.[4] This technology has the advantages of reducing hospital readmissions, improving medication adherence, and increasing patient engagement in their care.[30–32]

In addition, mobile health applications have made it easier for patients to monitor their health conditions, track their symptoms, and receive personalized health recommendations.[33] Mobile applications help people manage diabetes by tracking their blood glucose levels, food intake, and medication schedules.[34] Similarly, wearable devices, such as smartwatches and fitness trackers, have also become increasingly popular, allowing patients to track their physical activity levels, heart rates, and sleep patterns.[2,35] These devices can provide insights into a patient's overall health and help identify potential health problems before they become serious.[36]

Remote monitoring systems enable health care practitioners to track patients' vital signs and symptoms in real time, contributing to patient medication adherence risk factor control and early intervention in medical emergencies.[35] A recently published article by the authors of this study confirmed the reliability of remote patient imaging through telemedicine as a diagnostic tool. A comprehensive analysis of 1095 studies determined that remote patient imaging evaluation exhibited a high or moderate level of reliability in accurately diagnosing and screening conditions compared with the gold standard of care. The utilization of telemedicine platforms, such as smartphones, medical devices, and tablets, facilitates sharing and evaluating photographs, videos, and diagnostic tests, including radiographs, ultrasounds, CT scans, and biopsy results. This enables efficient patient follow-up for chronic diseases and postoperative care. This approach considerably enhances patient access to highly qualified and specialized care globally.[5]

In the particular case of hypertensive patients, nonpharmacological treatment can be facilitated using digital health.[37] A randomized, controlled study included 390 participants and investigated the efficacy of the HERB system. This study demonstrated that a digital therapeutic was superior to standard lifestyle modification in reducing 24-hour ambulatory, home, and office blood pressures (BPs).

This interactive smartphone application helped users incorporate lifestyle modifications to reduce their BP readings through salt restriction, weight control, exercise, and alcohol restriction. In addition, the high engagement rate (< 95%) showed that the participants responded positively to the digital therapeutic program, evidenced by 90% of participants completing all of the recommendations. By contrast, the use of mobile phones to deliver active (hypertension-specific management) or passive (health behavior alone) short message services in a rural community with hypertension did not significantly reduce BP[27] Despite a reduction in BP overall, BP control was similar between groups at 37.5% and 32.8%, respectively. Therefore, a more dynamic intervention, such as teletransmitting BP devices, might improve hypertension management in remote and vulnerable populations.

In the United States, the continuous increase in diabetes incidence has been a challenge. Therefore, the National Diabetes Prevention Program (DPP) has focused on prevention and education strategies.[38] As a way to increase access to the DPP, especially for people living in rural areas, a fully digital artificial intelligence–powered DPP called Lark's DPP was launched.[39] To evaluate the extent of the platform's coverage, the geographic and demographic attributes of Lark's DPP commercial health plan members were compared to a comprehensive composite sample of members enrolled in DPP throughout the country. The findings indicated that 24.4% of the members resided in rural areas, while 7.6% were located in areas with zip codes where in-person DPPs were available.

Additionally, the geographic assessments of Lark's DPP revealed its ability to extend its services to individuals in high-risk regions across the United States, ensuring access to primary care and lifestyle interventions. Approximately half of the Lark members were situated in southern and select midwestern states, and 24% of the sample population resided in rural areas known for their increased diabetes risk. Notably, 93.3% of Lark members were located in either partial or whole county health professional shortage areas, showcasing the platform's convenient and practical approach to mitigating diabetes risk for individuals.[39] Therefore, this digital solution provided individuals residing in remote locations, where traditional in-person or telephonic DPP may present challenges, with convenient access to a DPP. Moreover, it catered to younger individuals and those with a higher BMI, who required more substantial intervention.

In addition, Scheer et al[40] developed a completely remote digital care program for patients suffering from musculoskeletal conditions. Telerehabilitation interventions, including exercises, education, and cognitive behavioral therapies, achieved a similar engagement level between rural and urban areas. However, rural participants showed higher completion rates, which was attributed to limited alternative health care resources and the provision of Wi-Fi hotspots to ensure internet access. Despite worse baseline clinical outcomes in rural areas, improvements in pain, mental health, and productivity impairment were observed in both groups. The prevalence of depression was higher in rural areas, reflecting the scarcity of mental health services. Nonetheless, comparable enhancements in mental health scores were noted among participants from both rural and urban areas. This indicated that the scarcity of mental health resources played a role in the elevated disease burden that was experienced in rural regions.[40]

A cross-sectional survey study conducted in the United Kingdom exploring the perceptions of mental health professionals delivering rural psychological therapies via telehealth during the COVID-19 pandemic reported a important increase in telephone and online video conferencing consultations.[41] Telehealth was found to improve patient access and attendance, with the majority of respondents preferring to continue delivering psychological therapies mostly or entirely via telehealth. This indicated a preference for telehealth over fully face-to-face service delivery.[41]

Similarly, implementing a table-based screening system that integrated EHRs in a rural primary care setting for screen patients with behavioral issues positively impacted primary care operations and practitioner ability to address behavioral health needs.[42] Patients were given a mini-screen assessment every 30 days to evaluate their mental health and substance use. The system allowed clinicians to identify and address behavioral health issues that might have otherwise gone unnoticed in primary care, increasing the efficiency and effectiveness of the clinic.[42] This study emphasized the importance of incorporating such technology into workflows to improve patient access to behavioral health treatments, especially in rural areas.

The emergence of digital psychotherapy as an alternative delivery method has presented an opportunity to bridge this health care gap and overcome workforce distribution challenges.[43] Various

randomized, controlled trials and comprehensive meta-analyses have consistently shown that digital psychotherapy, specifically cognitive behavioral therapy, is equally effective as traditional face-to-face therapy. As a result, international clinical practice guidelines have officially recommended and supported its use as a viable and convenient method for delivering mental health care.[43,44]

Mobile phone technology has ensured access to skilled pregnancy care in rural Nigeria.[45] The TXT4Life initiative has utilized mobile phones as a means for pregnant women to send concise messages to a central server, which has been connected to primary health care (PHC) facilities and preregistered transport owners. Participants were instructed to text the server in the event of pregnancy complications, allowing them to request emergency transportation and access to health care practitioners. Among the 1620 registered women, 56 (3.5%) of them sent text messages seeking emergency transportation, resulting in 51 women reaching PHC facilities. At these facilities, 46 received successful treatment, while 5 were referred to higher-level care facilities. Notably, no maternal deaths were reported during the study period, although 4 perinatal deaths were recorded. This study underscored the effectiveness of mobile phone technology in facilitating prompt communication and enabling access to emergency obstetric care in remote areas. By addressing transportation barriers, this approach contributed to improved maternal and perinatal outcomes.[45]

Concerning skin diseases, a systematic review centered on the advantages of digital health for posttreatment care of melanoma in rural and remote regions of Australia. It demonstrated that the utilization of technology could help mitigate the disparity in melanoma incidence, mortality rates, and access to posttreatment care between urban areas and rural/remote populations.[20] Therefore, using digital health initiatives to deliver support care services at a lower cost, along with the decreased expenses related to early detection efforts, could enhance health care access and address the disparities between urban and rural areas.[20]

A randomized, controlled trial involving patients referred to a regional hospital in Northern Ireland evaluated the cost-effectiveness of real-time teledermatology compared to traditional outpatient dermatology care in urban and rural areas.[46] The study's findings indicated comparable clinical outcomes between telemedicine and conventional consultations, with nearly half of the patients being effectively managed after a single consultation. Although teledermatology showed slightly higher costs per patient due to fixed equipment expenses, sensitivity analysis demonstrated that telemedicine consultations were more cost-effective in rural areas than conventional consultations.[46]

The development of an application providing real-time monitoring of solar radiation doses and offering personalized recommendations for sun exposure and sunscreen use has reduced erythema compared to baseline. The effectiveness and safety of the mobile application Sun4Health in reducing sunburn while maintaining vitamin D levels has represented an excellent option for skin cancer prevention.[47] Silveira et al[48] created a mobile application and website that allowed patients to capture high-quality digital images of suspicious skin lesions. These images and information were then analyzed remotely by skin cancer professionals. The diagnostic efficiency of teledermatology was compared to standard face-to-face dermatology evaluations, with histopathological findings serving as the gold standard. The results showed that teledermatology had similar sensitivities, accuracies, specificities, and predictive values compared to face-to-face evaluations. These findings suggested that the mobile application has great potential and reliability, making it a valuable ancillary option, especially in isolated communities with limited access to dermatology clinics.[48]

Over the past decade, digital technologies (such as telemedicine, phone calls, internet, and mobile phone interventions) have been reported to support rural oncology care and address the disparities in cancer incidence and mortality rates that rural residents face.[49] Telemedicine interventions have therefore demonstrated improved patient outcomes and increased access to care in rural settings. Phone-based interventions have also showed promise in supporting weight loss, improving palliative care, and enhancing patients' feelings of connectedness. Still, internet-based approaches may pose challenges in rural populations due to limited access, device requirements, and less comfort with technology. Finally, rural cancer survivors' positive attitudes toward digital strategies support the importance of considering these tools to enhance health care access, ensuring equitable care for rural populations (Table 1).[49]

Author Year of study	Setting	Participants	Technology used	Research methodology	Main outcomes
Loane, M et al 2001[46]	Northern Ireland	Urban and rural dermatology patients	Real-time teledermatology	Randomized, controlled trial	Cost-effective, especially in rural areas.
Artuso, S et al 2013[25]	Central Australia	Aboriginal cardiac patients	Qualitative methods	Qualitative study	Barriers to health care utilization; need for culturally sensitive health care.
Silveira, C et al 2019[48]	Brazil	39 individuals	Mobile application, website	Prospective	High accuracy of cell phone application for skin cancer diagnosis, similar to clinic assessments.
Shenoy, P et al 2020[26]	Kerala, India	Rheumatology patients	WhatsApp	Practical approach	High feasibility and satisfaction with teleconsultation.
Weightman, M et al 2020[43]	Rural and remote areas	N/A	Digital psychotherapy	Narrative review	Effective for treating depression and anxiety disorders.
Chang, YP et al 2020[42]	New York, United States	Rural primary care clinic patients	Tablet-based system, EHR	Mixed methods	Improved behavioral health screening in rural areas.
Auster-Gussman, L et al 2022[39]	United States	Members of Lark's digital DPP	Digital, artificial intelligence–powered diabetes prevention	Retrospective analysis	Effective in reaching high-risk individuals in underserved areas.
Buyting, R et al 2022[27]	Canada	Rural Canadians with cardiovascular disease	Digital virtual care technologies	Scoping review	Potential of virtual care to improve access and outcomes.
Morris, B et al 2022[49]	Rural areas	N/A	Various digital technologies	Systematic review	Potential improvement in rural oncology care.
Harder, JL et al 2022[22]	Lennestadt, Germany	General practitioners, citizens	Telemedicine	Mixed methods	Openness to telemedicine, with concerns about implementation.
Young, AR et al 2022[47]	Brazil	59 healthy volunteers	Sun4Health® app	3-d clinical field study	Effective in reducing sunburn while maintaining vitamin D status.
Mathew, S et al 2023[23]	Remote Australia	Clinic staff	Telehealth	Interviews, group discussions	Effective as a supplementary tool, not a replacement for face-to-face care.
Nelson, D et al 2023[41]	Rural United Kingdom	Mental health professionals	Telehealth	Cross-sectional survey	Increased usage, but challenges in nonverbal communication.
Okonofua, F et al 2023[45]	Rural Nigeria	Pregnant women	Mobile phone application	Quasiexperimental	Improved emergency obstetric services access.
Scheer, J et al 2023[40]	United States	Urban and rural participants	DCP	Longitudinal cohort study	High engagement and satisfaction in managing musculoskeletal pain.

Table 1: Summary of included studies on the advantages of digital health in rural areas

DCP = digital care program; DPP = Diabetes Prevention Program; EHR = electronic health record.

BARRIERS TO DIGITAL HEALTH IN RURAL AREAS

Lack of access to technology and high-speed internet

In many rural communities, the necessary infrastructure for reliable internet access is either absent or inadequate.[50] As a result, accessing digital health services, such as telemedicine and remote patient monitoring, is difficult or impossible.[51,52] Without access to these services, residents in rural areas are at a disadvantage when it comes to managing their health, receiving timely medical care, and accessing the latest medical information.[53] This digital divide highlights the need for investment in rural broadband infrastructure to ensure that all individuals

have equal access to digital health services, regardless of their geographic location (Figure 2).[50]

An increasing body of evidence substantiates the belief that the limited availability of technology and high-speed internet is a substantial obstacle in implementing digital health initiatives in rural areas.[7,51,54–56] Data from the American Telemedicine Association's 2019 state telehealth analysis, the American Hospital Association's 2018 annual survey of acute care hospitals, and its Information Technology Supplement all have shown that 73% of US hospitals have telehealth capabilities.[57] Conversely, the National Rural Health Association found that only 14% of rural hospitals had a fully implemented telehealth program. This disparity was primarily attributed to the limited access to reliable internet services in rural areas. Furthermore, a report by the Federal Communications Commission indicated that 35% of US citizens living in rural areas lacked access to high-speed internet.[50] The report also found that nearly 39% of rural health care facilities did not have broadband services, limiting their ability to provide telehealth services to their patients.[51]

These findings have underscored the critical need for investment in rural broadband infrastructure to bridge the digital divide and provide equal access to digital health services. In recent years, policymakers and health care practitioners have recognized the importance of addressing this issue, with federal and state governments investing billions of dollars in rural broadband initiatives.[50,58,59] However, more work is needed to ensure that all residents in rural areas have access to reliable, high-speed internet

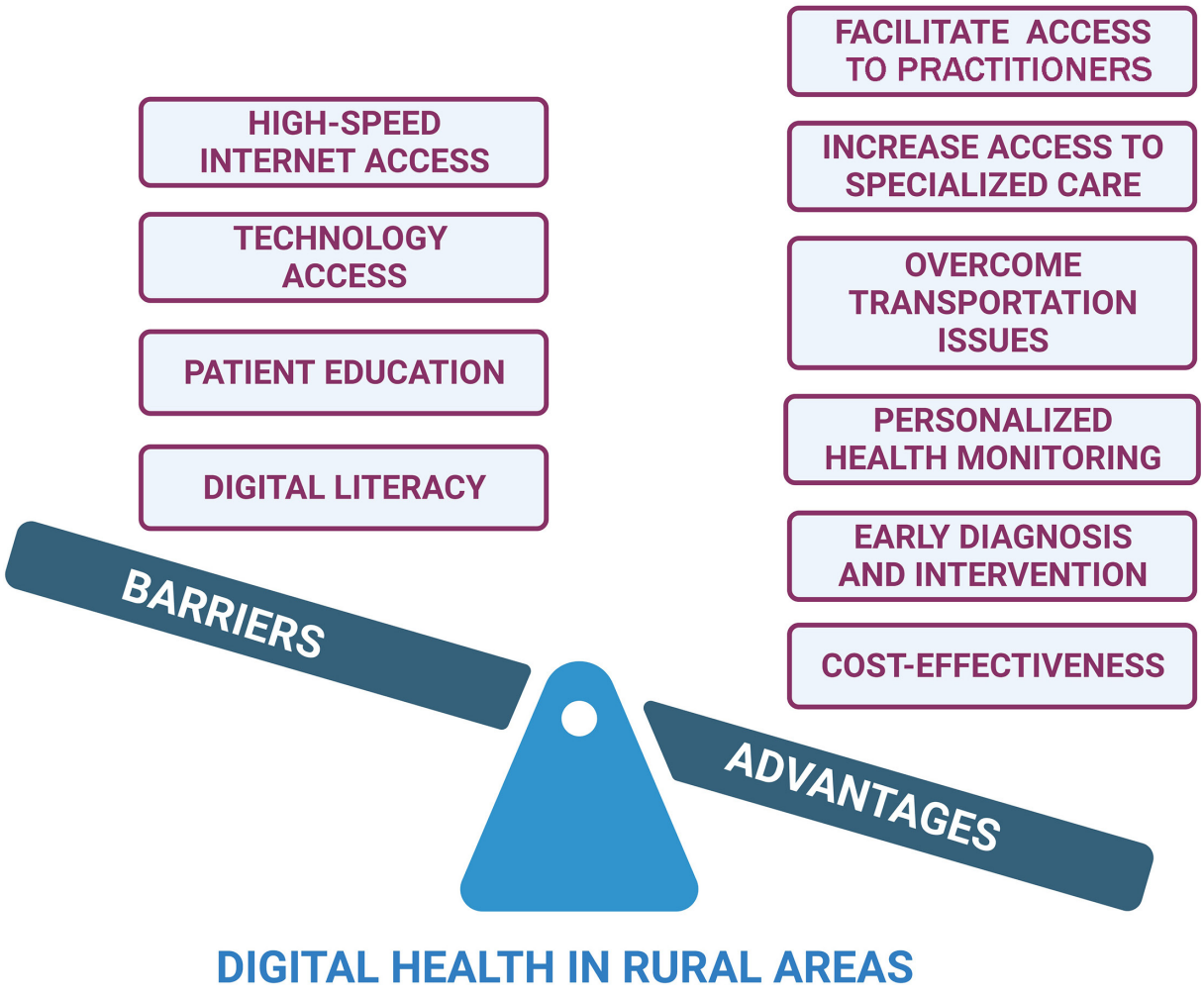

Figure 2: Advantages and barriers to the application of digital health in rural areas. When considering the balance, the number of advantages in implementing digital health tools outweighs the challenges or barriers faced in adopting this mode of care in rural health care settings. Created with BioRender.

services, which are essential for digital health adoption and overall health care equity.[53]

Limited digital literacy and patient education

Another major limitation of digital health implementation is patients' lack of digital literacy.[60] Many individuals in rural communities might not be familiar with using technology, which can hinder their ability to access and benefit from digital health services.[60,61] Without proper education and training, patients may struggle to navigate digital health platforms or understand how to use them effectively.[62]

Older adults in rural India had low digital and health literacy levels.[63] Only 11% of participants had digital literacy, and 3% to 27% had health literacy across different domains. Mobile phone ownership was relatively high at 50%, but smartphone usage and internet access for health care were minimal. The digital health tools implemented and the primary patients' diagnoses are graphically represented in Figure 3. The qualitative analysis highlighted limited exposure and confidence in using digital devices, barriers to traditional literacy, and physical challenges associated with aging. Social support from neighbors, family members, and local health care practitioners was crucial in facilitating the adoption of digital health solutions. Therefore, efforts to improve access to health care for older adults in rural India should address the low levels of digital and health literacy and harness the support of family and PHC practitioners.[63]

Patient education and digital health literacy programs are crucial to addressing this challenge. By providing patients with the necessary skills and knowledge to use digital health tools, health care practitioners can empower them to control their health and improve health outcomes. Therefore, the authors of this study proposed a pilot trial to assess the efficacy of 3 digital access and literacy interventions in promoting engagement with an online smoking cessation program among rural adults. The study employed a randomized, 3-arm design and recruited participants from a community-based health system in the Midwest. The 3 study groups that were evaluated included a control group without additional intervention, a group provided with a loaner digital device (a Bluetooth-enabled

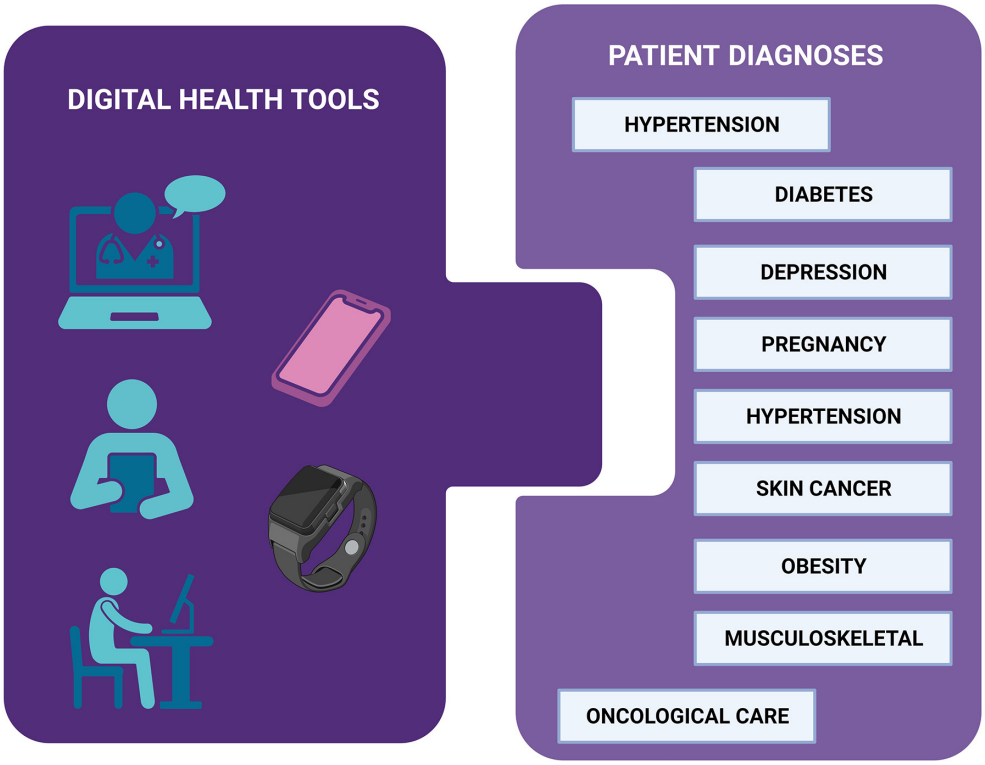

Figure 3: Implementation of digital health in rural areas. Summary of digital tools (telehealth, remote monitoring, smartwatch, cellphone, tablet) and the primary patient diagnoses identified in this scoping review. Created with BioRender.

iPad) for the duration of the study, and a group provided with a loaner digital device along with coaching support. The study measured program engagement, smoking abstinence, and patient experience as primary outcomes of interest. By shedding light on digital inclusion strategies for smoking cessation programs and clinical trials in rural communities, this study aimed to provide valuable insights and resources.[64]

Several initiatives have been launched to address the lack of digital literacy in underserved populations and rural areas. For example, the National Digital Equity Center supplies free digital literacy training to individuals in rural areas to help them access and use digital health services. Similarly, the Health Literacy Media project provides online resources and tools to help patients better understand and manage their health (Table 2).

Future of Digital Health in Rural Areas

The future of digital health in rural populations holds substantial potential for improving health care access and outcomes. Research studies, such as the digital preventive measures for arterial hypertension study in Germany, have explored various aspects of digital health literacy, motivation for action, medication adherence, and usability perception among rural populations.[66] By investigating attitudes, barriers, advantages, and disadvantages, these studies have aimed to identify factors influencing the adoption and effectiveness of digital preventive measures. The findings from such projects can inform the development of patient-oriented and demand-based improvement strategies for preventive services, ultimately enhancing cardiovascular outcomes in rural areas. Similarly, in China, the Digital Health Kiosk program implemented by Guangdong Second Provincial General Hospital has aimed to increase health care utilization and patient satisfaction while reducing out-of-pocket costs through artificial intelligence–enabled diagnostic support and telemedicine platforms.[65] The ongoing cluster randomized, controlled trial in rural areas of China will provide valuable insights into the effectiveness of telemedicine approaches and has the potential to address health care access disparities. These studies have highlighted the ongoing efforts to harness the power of digital health technologies and address the specific needs of rural populations, paving the way for a future where digital health is crucial in providing equitable health care services.

Conclusion

This scoping review demonstrated the transformative impact of digital health tools on health care in rural areas. These tools have become critical in addressing the challenges faced by patients in remote locations and providing timely, cost-effective, and high-quality care. Telehealth, mHealth applications, wearable devices, and remote monitoring systems have substantially increased access to health care practitioners, leading to improved outcomes and reduced hospital readmissions. Digital health interventions have shown promise across various health care areas, including chronic disease management, mental health, prenatal care, and preventive care. Despite barriers such as limited internet access and technological literacy, the cost-effectiveness and convenience of digital health tools make them valuable resources for individuals in rural areas. Addressing these barriers and embracing digital innovation can bridge the health care gap, empowering individuals and creating a more patient-centered and inclusive health care system in rural communities.

Limitations

Although this scoping review provided valuable insights into the advantages and potential of digital health tools in improving health care outcomes in rural areas, it is essential to acknowledge its limitations. First, the review relied on existing literature and may not have captured the full extent of ongoing developments in the field. Newer studies or emerging technologies may not have been included in the analysis; this means that recent advancements have potentially been missed. Additionally, the review primarily focused on the positive aspects of digital health interventions, which may have introduced a bias and overlooked potential drawbacks or limitations. Furthermore, the generalizability of the findings may have been limited due to variations in health care systems, infrastructure, and socioeconomic factors across different rural areas. Finally, the review did not delve into the specific barriers and challenges faced by marginalized populations within rural

Author Year of study	Setting	Participants	Technology used	Research methodology	Main outcomes
Shiferaw, K et al 2020[62]	Northwest Ethiopia	Internet-using chronic patients	eHEALS	Cross-sectional	Factors influencing eHealth literacy; need for improvement in eHealth literacy among chronic patients in low-income settings.
Cortelyou-Ward, K et al 2020[56]	Rural areas	N/A	Telehealth services	Review	Structural barriers in adopting telehealth; issues like broadband access, interstate licensing, reimbursement, policy recommendations for improving rural telehealth access.
Patten, C et al 2022[64]	Rural areas of Minnesota, Wisconsin, Iowa	Rural adult smokers	Online smoking cessation program	3-arm randomized parallel-group design	Feasibility and effectiveness in engaging participants with smoking cessation; impact of technology access and coaching on program participation.
Cheng, W et al 2022[65]	Guangdong Province, China	Village doctors, rural residents	"Dingbei Doctor" telemedicine platform	Cluster randomized, controlled trial	Impact on health care quality and access in rural areas; effectiveness of telemedicine in improving health care utilization, patient satisfaction, and outcomes.
Holst, C et al 2022[61]	Rural Iringa, Tanzania	Residents aged 15–45 y	Digital health education platforms	Nonrandomized intervention	Improvement in health knowledge about HIV/AIDS, tuberculosis, etc; effectiveness of digital health education in rural areas.
Du, Y et al 2022[52]	Rural areas of Guangdong Province, China	Rural residents	Telemedicine services	Mixed methods (cross-sectional survey, interviews)	Low use of telemedicine; barriers like lack of knowledge, trust, digital literacy, strategies for enhancing telemedicine engagement.
Rasekaba, T et al 2022[63]	Rural areas of Mysore and Suttur, India	Older adults	Cartelli digital literacy framework	Mixed methods cross-sectional focus group, survey	Low technology usage, limited digital and health literacy, role of social support in enabling technology use for health care.
Bruch, D et al 2023[66]	Germany	Patients with arterial hypertension, physicians	Telemonitoring systems, E-learning platforms and educational materials, mHealth applications, digital questionnaires and interviews	Mixed methods (quantitative and qualitative)	Factors influencing use of digital measures for hypertension, impact on health literacy, improving hypertension prevention services.
Udegbe, B et al 2023[55]	N/A	N/A	N/A	Review	Challenges and disparities in telemedicine in obstetrics, impact of the digital divide on health equity, necessity to overcome barriers for equitable access.

Table 2: Summary of studies on barriers to digital health in rural areas

eHEALS = eHealth Literacy Scale.

communities, such as those belonging to indigenous or low-income groups. These limitations have highlighted the need for further research and a more comprehensive examination of the implementation and impact of digital health tools in diverse rural settings.

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