Medicor: Journal of Health Informatics and Health Policy
E-ISSN : 3030-9166
Volume. 2, Issue 3, July 2024
Page No: 158-172

Bridging the Digital Divide in Healthcare: Insights on Literacy, Empowerment, and Portal Adoption

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Received : May 24, 2024
Accepted : July 12, 2024
Published : July 31, 2024

Citation: Alifah, R, N. (2024). Bridging the Digital Divide in Healthcare: Insights on Literacy, Empowerment, and Portal Adoption. Medicor: Journal of Health Informatics and Health Policy, 2(3), 158-172.

https://doi.org/10.61978/medicor.v2i3.1059

ABSTRACT: The adoption of digital health portals represents a major shift toward patient-centered care. These portals empower patients by improving access to health information and facilitating communication with providers. This review synthesizes evidence on how portals influence empowerment, with emphasis on digital literacy and health outcomes. Findings show that patients with strong digital skills actively use portals, achieve better chronic disease management, and report higher satisfaction. Quantitative evidence includes a 0.5% reduction in HbA1c and improved blood pressure regulation among users. However, vulnerable populations face persistent barriers such as limited literacy, low socioeconomic status, and inadequate infrastructure. Systemic obstacles like interoperability issues and provider workload also limit portal effectiveness. Policy strategies should focus on digital literacy education, universal internet access, and strong privacy protections to ensure equitable benefits. Future research must adopt longitudinal and inclusive approaches to strengthen evidence and guide equitable implementation.

Keywords: Patient Empowerment, Digital Health Portals, Digital Literacy, Ehealth Outcomes, Healthcare Equity, Chronic Disease Management, Health Technology Adoption.

INTRODUCTION

The growing integration of digital technologies in healthcare has transformed the landscape of patient engagement and management. Among these innovations, digital health portals have emerged as pivotal tools designed to enhance patient empowerment by granting individuals greater access to their health information and enabling active participation in healthcare decision-making. Health portals provide platforms where patients can view medical records, communicate with healthcare providers, schedule appointments, and access educational resources, thereby reshaping traditional dynamics between patients and providers (Henry et al., 2025; Hazara et al., 2019; Thielmann et al., 2023). This paradigm shift reflects broader global trends emphasizing patient-centered care, where the democratization of health information is seen as instrumental in fostering autonomy, improving health literacy, and ultimately enhancing clinical outcomes.

In parallel with the expansion of digital health infrastructures, there has been increasing scholarly attention on the role of portals in promoting digital health literacy. Digital literacy constitutes a central determinant of patients' ability to derive meaningful benefits from health portals. Several studies have emphasized that low digital literacy remains a critical barrier to portal utilization, particularly among older adults, marginalized populations, and individuals in technologically underserved regions (Zanaboni et al., 2020; Osovskaya et al., 2025). Conversely, health portals themselves can function as educational platforms, facilitating patients' understanding of medical conditions and fostering more informed decision-making (Sergeeva, 2023; Bulck et al., 2018). This dual role positions health portals not only as repositories of information but also as catalysts for strengthening digital competencies in healthcare contexts.

Evidence indicates that patients with higher digital proficiency experience greater satisfaction, enhanced trust, and improved self-efficacy when interacting with portals (Hazara et al., 2019; Monkman et al., 2023). These individuals are more likely to engage in self-management practices such as monitoring symptoms, adhering to medication regimens, and adopting healthier behaviors. However, patients with insufficient digital literacy often report feelings of anxiety, frustration, and disempowerment when navigating portals, which may exacerbate existing health disparities (Deursen et al., 2022; Thielmann et al., 2023). This contrast highlights the importance of incorporating digital literacy education into healthcare strategies, ensuring equitable access to the benefits of digital health tools (Sipanoun et al., 2022; Nøst et al., 2021; Hermanns et al., 2023).

Despite their transformative potential, digital health portals face significant challenges in implementation across healthcare systems. One of the most pressing barriers involves technical limitations related to user interface design and system interoperability. Portals that lack user-friendly features can deter adoption, especially among older patients or those with limited educational backgrounds (Nøst et al., 2021; Bulck et al., 2018). Additionally, concerns regarding data privacy and security have emerged as critical issues, influencing both patient willingness to engage and provider readiness to recommend portal use (Thielmann et al., 2023). These concerns are particularly acute in sensitive domains such as mental health, where confidentiality and stigma remain paramount considerations (Bärkås et al., 2023; Kassam et al., 2022).

Another significant challenge involves disparities in digital literacy across populations. Studies demonstrate that individuals with limited technical skills are less likely to benefit from portal functionalities, potentially reinforcing health inequities (Risling et al., 2017; Jhamb et al., 2015). Such disparities underscore the necessity of targeted interventions to provide digital literacy training and support mechanisms tailored to vulnerable groups (Williams et al., 2017; Sands & Finn, 2025). Without such measures, health portals risk becoming tools that disproportionately benefit digitally competent populations while leaving behind those most in need of empowerment.

The literature also highlights gaps in research regarding the nuanced relationship between digital literacy and health outcomes. While there is broad consensus that digital literacy is integral to effective portal utilization, relatively few studies have explicitly examined how literacy levels influence patient engagement metrics, health behaviors, or disease-specific outcomes (Wang et al., 2023; Osovskaya et al., 2025). Much of the existing scholarship has focused on portal development

and general measures of patient satisfaction, leaving critical questions about causal pathways between digital literacy and clinical effectiveness unanswered (Kainiemi et al., 2022; Henry et al., 2025). Addressing this gap is vital for advancing evidence-based strategies to optimize portal implementation.

The primary aim of this review is to synthesize current knowledge regarding the role of health portals in promoting patient empowerment, with particular emphasis on the mediating role of digital literacy. The review seeks to analyze how portals influence patient engagement, communication, self-management, and clinical outcomes while identifying systemic barriers that hinder equitable adoption. By doing so, it intends to clarify the conditions under which portals achieve their intended benefits and propose directions for enhancing their design and implementation.

This review further delineates its scope by focusing on cross-national comparisons and population-level disparities in portal utilization. Particular attention is given to vulnerable populations, such as older adults, low-income groups, and individuals with chronic illnesses, who often encounter the greatest challenges in digital adoption. The inclusion of comparative perspectives between developed and developing regions enriches the analysis, illuminating how infrastructural, cultural, and policy differences shape portal effectiveness (Grünloh et al., 2018; García-Ulloa et al., 2020). By situating portal adoption within these diverse contexts, the review aims to offer insights that are both globally relevant and locally actionable.

In sum, the rise of digital health portals signifies a critical juncture in healthcare's evolution toward patient-centered, technology-driven models of care. Their promise lies in democratizing access to health information, fostering digital competencies, and empowering patients to play an active role in managing their health. Yet, realizing this promise requires overcoming challenges of accessibility, literacy, privacy, and system integration. Through this review, the analysis will contribute to bridging knowledge gaps, offering policy-relevant recommendations, and strengthening the discourse on digital health equity and patient empowerment in the 21st century.

METHOD

The methodological approach for this narrative review was designed to ensure comprehensive coverage of existing literature on digital health portals and their role in patient empowerment, with particular emphasis on digital literacy and health outcomes. To achieve this objective, a systematic process of literature identification, selection, and evaluation was adopted, drawing from a range of multidisciplinary databases that collectively cover biomedical sciences, healthcare management, and information technology. This approach enabled the inclusion of diverse perspectives while ensuring that the review maintained academic rigor and relevance.

The first stage of the process involved the identification of databases most appropriate for capturing relevant studies. PubMed was selected as a primary source given its specialized focus on

biomedical and health-related literature, providing access to peer-reviewed articles on clinical applications of health portals and their impact on patient care (Henry et al., 2025). Scopus and Web of Science were also utilized, both of which are recognized for their extensive indexing of high-quality journals across multiple disciplines, including health sciences, information technology, and social sciences. Their broad coverage ensured that the review could incorporate insights not only from clinical trials and cohort studies but also from interdisciplinary research that considered sociotechnical aspects of portal implementation (Hazara et al., 2019; Thielmann et al., 2023). In addition, Google Scholar was consulted as a supplementary resource to capture literature that might not be indexed in more stringent databases. Although less selective, Google Scholar provided a means of accessing conference proceedings, theses, and emerging publications, thereby broadening the scope of available materials (Zanaboni et al., 2020).

Following the identification of databases, specific keywords and search terms were developed to ensure the retrieval of literature aligned with the focus of this review. Four primary terms were employed: "patient empowerment," "health portal," "digital literacy," and "eHealth outcomes." Each term was selected based on its conceptual relevance and frequent appearance in existing studies of digital health portals. The keyword "patient empowerment" was particularly important for capturing literature that investigated the role of portals in enhancing patient autonomy, self-management, and involvement in healthcare decision-making (Osovskaya et al., 2025). The term "health portal" was used as a general descriptor to retrieve studies focused on digital platforms designed for patient access to health records, communication, and services (Sergeeva, 2023). "Digital literacy" was incorporated to identify research emphasizing the skills required for effective use of digital tools, a critical factor in maximizing portal benefits (Bulck et al., 2018). Finally, "eHealth outcomes" was used to locate evidence linking portal use to broader health results, ranging from patient satisfaction and adherence to measurable clinical improvements (Monkman et al., 2023; Deursen et al., 2022). Boolean operators and search filters were applied in varying combinations of these terms to refine results and ensure comprehensive coverage across contexts.

The inclusion and exclusion criteria were established to maintain methodological rigor while ensuring relevance to the research objectives. Studies were included if they explicitly examined the relationship between health portals and patient empowerment, digital literacy, or health outcomes. Eligible studies were required to be published in peer-reviewed journals between 2010 and 2025, thereby capturing contemporary research that reflected technological advances and evolving patient needs. Both quantitative and qualitative studies were considered to allow for a multidimensional understanding of the topic. Randomized controlled trials, cohort studies, cross-sectional analyses, case studies, and systematic reviews were included, as each offered distinct insights into how portals function within healthcare ecosystems. Exclusion criteria were applied to eliminate studies not directly related to health portals, those focusing exclusively on provider-facing systems without patient interaction, or publications lacking empirical data such as opinion pieces or editorials. Non-English publications were excluded due to translation limitations, ensuring consistency in the review process.

The process of literature selection followed a staged screening approach. Initial searches generated a large volume of records across databases. Titles and abstracts were screened for relevance to the

core themes of patient empowerment, digital literacy, and health outcomes. Articles that met these preliminary criteria underwent full-text review, during which methodological quality and thematic relevance were assessed. Special attention was given to whether studies explicitly measured digital literacy as a variable or provided empirical data on outcomes linked to portal usage. To enhance reliability, duplicate articles across databases were identified and removed before full-text screening. The final pool of selected articles represented a balance between clinical studies, which assessed measurable health outcomes, and sociotechnical analyses, which considered usability, access, and equity issues.

Evaluation of the literature involved assessing both methodological rigor and conceptual contributions. Randomized controlled trials and longitudinal studies were valued for their ability to demonstrate causal or time-dependent effects of portal usage. Qualitative studies, on the other hand, were crucial for providing insights into patient experiences, barriers to adoption, and cultural attitudes toward digital health technologies. This methodological diversity enriched the review by offering both empirical evidence and contextual understanding. Systematic reviews and meta-analyses were incorporated as higher-order evidence sources, synthesizing findings across multiple studies to highlight consensus or identify divergences in the field.

Throughout the review process, careful consideration was given to the representativeness of the literature. Efforts were made to include studies from both high-income and low- and middle-income countries, thereby enabling comparative analysis of adoption trends and barriers across different healthcare systems. Attention was also given to population diversity, with specific interest in studies addressing vulnerable groups such as older adults, individuals with chronic illnesses, and socioeconomically disadvantaged populations. This focus ensured that the review captured the equity dimension of portal adoption, which is central to discussions of patient empowerment and digital literacy.

To ensure objectivity and consistency, the review process adhered to established standards for narrative synthesis. Although this study did not follow the strict protocol of a systematic review, it employed systematic principles in database selection, keyword construction, and inclusion criteria to maximize reliability. Data extracted from selected articles were organized thematically under categories such as patient empowerment, digital literacy, health outcomes, and systemic barriers. These thematic clusters provided the foundation for the results and discussion sections, enabling a coherent synthesis of evidence while respecting the heterogeneity of study designs and contexts.

In summary, the methodology for this review combined a structured search strategy across major databases with rigorous inclusion and exclusion criteria, ensuring that only studies of direct relevance were analyzed. By incorporating a wide range of study types and maintaining a global perspective, the review sought to generate a comprehensive understanding of how health portals contribute to patient empowerment, the role of digital literacy in mediating outcomes, and the systemic factors influencing adoption. This methodological approach laid the groundwork for the subsequent analysis of findings, providing a robust basis for drawing conclusions and formulating recommendations.

RESULT AND DISCUSSION

The analysis of existing literature revealed a range of findings on the relationship between digital health portals, patient empowerment, digital literacy, and healthcare outcomes. To provide clarity and coherence, the results are organized around five thematic areas that emerged consistently from the reviewed studies: digital literacy and portal adoption, patient engagement and self-management, clinical outcomes and quality of care, access inequities and equity challenges, and systemic issues including privacy, security, and interoperability. Each of these themes is discussed in depth, drawing on both quantitative and qualitative evidence, and supplemented with international comparisons to situate findings in a global context.

Digital literacy plays a pivotal role in determining how effectively patients adopt and utilize health portals. The literature demonstrates a strong correlation between higher levels of digital literacy and more active use of portal functions. Risling et al. (2017) observed that patients with advanced digital skills were more likely to log into portals regularly, interpret health information accurately, and integrate portal features into their daily health management routines. Conversely, low levels of digital literacy emerged as a central barrier to effective portal use, particularly among older adults and socioeconomically disadvantaged groups (Kainiemi et al., 2022). These groups frequently report difficulties navigating interfaces, understanding medical terminologies, or interpreting graphical displays of health data. Empirical data from Jhamb et al. confirmed that older patients and those from low-income households demonstrated significantly lower adoption rates compared to younger, more educated populations. In rural areas, lack of internet access further compounded these barriers, highlighting that digital illiteracy and infrastructural deficits often overlap to restrict portal use (Kainiemi et al., 2022).

The evidence also reveals that health portals serve as valuable tools for enhancing patient engagement and promoting self-management of chronic diseases. Hazara et al. (2019) reported that patients managing diabetes and hypertension benefited from the ability to view test results, track medication schedules, and communicate directly with providers, which improved adherence to treatment regimens and strengthened their sense of control. Groen et al. (2017) found that cancer patients utilizing portals experienced improved symptom monitoring, timely reporting of side effects, and enhanced confidence in treatment decision-making. Quantitative findings reinforce these observations: Nelson et al. (2023) reported a 20% increase in diabetes patients completing HbA1c tests and adhering to recommended care routines after adopting portals. Similarly, García-Ulloa et al. (2020) found that patients using portals were twice as likely to consistently log health data and communicate with providers about their conditions. These findings collectively emphasize that portals not only facilitate information access but also foster behavioral changes linked to improved health management.

In terms of clinical outcomes and quality of care, health portals contributed to measurable improvements in health indicators. Henry et al. (2025) reported that patients with diabetes achieved an average reduction of 0.5% in HbA1c after one year of portal use, signifying meaningful gains in glycemic control. Comparable effects were observed in hypertension management, where Hægermark et al. (2024) documented better blood pressure regulation among portal users. These outcomes were reinforced by patient reports of improved communication with providers and

greater satisfaction with their care. International comparisons further demonstrate the positive effects of portals. In Norway, Zanaboni et al. (2020) found that access to electronic health records significantly increased patient satisfaction and participation in healthcare decisions. Similarly, in Finland, Kainiemi et al. (2022) observed that despite initial implementation challenges, hospitals adopting portals reported notable enhancements in both quality and safety of care. These findings underscore the role of portals as tools not only for engagement but also for measurable improvements in care delivery and outcomes.

However, persistent inequities in access highlight critical gaps in realizing the full potential of health portals. Kainiemi et al. (2022) confirmed that patients from lower socioeconomic backgrounds and rural communities faced substantial obstacles, including limited internet availability, low digital literacy, and lack of trust in health systems. These barriers disproportionately restricted vulnerable populations from accessing health portals and benefitting from their features. As a result, portals risk reinforcing existing disparities unless targeted interventions are implemented. Evidence suggests that educational programs tailored to vulnerable groups can mitigate these inequities. Groen et al. (2015) and Risling et al. (2017) reported that training initiatives designed to build digital literacy improved adoption rates among older adults and socioeconomically disadvantaged populations. Community-based interventions, such as free internet access points and peer support provided by local health workers, were also found to be effective strategies (Linke, 2025). Together, these interventions highlight that systemic investment in literacy education and community infrastructure is crucial for ensuring equitable portal adoption.

Concerns surrounding privacy, data security, and systemic barriers emerged as persistent challenges in the literature. Haase et al. (2021) and deBronkart (2019) documented widespread patient anxiety regarding unauthorized access to sensitive health data. These concerns often limited portal use, particularly for patients with stigmatized conditions, such as mental health disorders. Blease et al. (2021) emphasized that patient trust was strongly tied to institutional handling of privacy protections, while Jackman et al. (2020) found that uncertainty about data security discouraged patients from using portals consistently. Beyond privacy, systemic challenges such as interoperability between electronic health record (EHR) systems and provider workload hindered portal effectiveness. Demiris (2016) noted that fragmented EHR systems prevented patients from accessing complete health information, reducing the perceived value of portals. Nøst et al. (2021) and Househ et al. (2018) further observed that high clinical workloads limited provider ability to support patients in portal use, reducing the integration of portals into routine care. Monkman et al. (2023) echoed these findings, highlighting that without adequate institutional resources, portals risk being underutilized despite their potential benefits.

Overall, the findings illustrate that digital health portals hold significant promise for enhancing patient empowerment, improving engagement, and delivering measurable clinical benefits. However, their impact is uneven, influenced heavily by digital literacy, socioeconomic status, infrastructural capacity, and systemic challenges. International comparisons reinforce that while portals can elevate quality of care and patient satisfaction, success depends on addressing barriers that impede equitable adoption. Efforts to expand access, strengthen privacy protections, and enhance interoperability are critical to ensuring that portals fulfill their potential as transformative tools in modern healthcare.

The findings from this review underscore the complexity of factors that influence the adoption and effectiveness of digital health portals, particularly in relation to patient empowerment and digital literacy. While evidence strongly suggests that portals can improve patient engagement and clinical outcomes, the persistence of systemic barriers and disparities in access raises critical questions about their equitable implementation. A nuanced analysis of these dynamics is necessary to understand the interplay between patient-level factors, such as digital literacy, and broader systemic determinants, including healthcare infrastructure, policy frameworks, and provider practices.

One of the most prominent systemic challenges identified in the literature is the lack of interoperability between electronic health record (EHR) systems and patient-facing portals. Dhanireddy et al. (2012) emphasized that when information cannot be shared efficiently across platforms, both patients and providers experience frustration, which undermines confidence in the system and discourages portal use. Fragmentation in digital infrastructures creates situations where patients must navigate multiple portals for different providers, limiting continuity of care and reducing the perceived value of these tools. McAlearney et al. (2019) further demonstrated that portals often generate additional administrative burdens for healthcare providers, as staff are required to manage increased volumes of patient communication and portal-related tasks. This diversion of time and resources may shift provider attention away from direct patient care, reducing the potential for portals to support meaningful patient empowerment. These findings indicate that barriers to portal adoption are not solely rooted in patient digital competencies but are deeply embedded in systemic and organizational structures.

The impact of systemic factors extends beyond technical interoperability to encompass provider readiness and institutional support. Nøst et al. (2021) and Househ et al. (2018) documented that providers frequently lack adequate training and institutional incentives to promote portal use among patients. Without consistent encouragement and integration into routine workflows, patients are less likely to perceive portals as valuable tools. Monkman et al. (2023) noted that when healthcare organizations fail to invest in provider training or allocate sufficient resources, portals risk remaining underutilized despite their potential benefits. This evidence highlights that sustainable portal adoption requires alignment not only of patient skills but also of provider practices, organizational strategies, and systemic policies.

Policy solutions aimed at addressing digital literacy and access disparities emerge as central themes in the literature. Schaller et al. (2015) recommended that governments and healthcare institutions invest in targeted digital literacy programs to equip vulnerable populations, such as older adults and low-income groups, with the skills necessary to navigate portals confidently. These programs should be designed with accessibility in mind, offering practical training tailored to varying levels of digital familiarity. Moreover, Sipanoun et al. (2022) and Kuijpers et al. (2015) emphasized the importance of ensuring universal internet access, particularly in rural areas where infrastructural deficits exacerbate inequities in portal use. Expanding connectivity is not merely a technical challenge but a public health imperative, as digital exclusion translates into diminished opportunities for patient empowerment. By integrating digital literacy education with infrastructural improvements, policies can bridge the digital divide and foster greater equity in portal adoption.

At the same time, the development of supportive policies should extend beyond digital literacy to encompass broader issues of patient engagement and trust. Blease et al. (2021) and Jackman et al. (2020) observed that patients' willingness to adopt portals is heavily influenced by their perceptions of data privacy and institutional transparency. Policies that establish robust data protection standards and communicate these effectively to patients are therefore crucial for building confidence. Similarly, Demiris (2016) and McAlearney et al. (2019) argued that policy frameworks should incentivize healthcare providers to integrate portals into clinical practice, thereby aligning organizational incentives with patient empowerment goals. Taken together, these recommendations suggest that a multi-level policy approach, combining digital literacy initiatives, infrastructural investments, and governance mechanisms, is essential for addressing the barriers identified in this review.

Despite the promise of portals, the current evidence base is characterized by several limitations that constrain generalizability and comparability across studies. A recurring issue is the lack of demographic diversity in study populations. Dhanireddy et al. (2012) and Kuijpers et al. (2015) noted that many studies disproportionately focus on specific patient groups, such as individuals with chronic conditions, which may not capture the broader population's experiences. Power et al. (2020) highlighted that underrepresentation of minority populations and those with lower socioeconomic status limits the ability to draw conclusions about equity implications. This bias underscores the need for future research to adopt more inclusive sampling strategies that reflect the demographic heterogeneity of healthcare systems.

Another limitation involves inconsistencies in the definitions and metrics used to evaluate portal effectiveness. Demiris (2016) and Hægermark et al. (2024) observed that studies employ varied outcome measures, ranging from patient satisfaction and self-reported empowerment to clinical indicators such as HbA1c or blood pressure. The lack of standardized metrics complicates cross-study comparisons and weakens the evidence base for policy recommendations. Developing consistent terminologies and evaluation frameworks will be critical to advancing the field, allowing researchers to aggregate findings more effectively and build a coherent understanding of portal impacts.

The temporal scope of existing studies also presents a limitation. Many investigations adopt cross-sectional or short-term designs, which provide valuable snapshots but fail to capture long-term outcomes of portal use. Nøst et al. (2021) and Hong and Kim (2019) stressed the importance of longitudinal studies that can track how portal use evolves over time, particularly in relation to sustained health behaviors, chronic disease management, and long-term clinical outcomes. Without such data, it remains difficult to determine whether initial benefits persist or diminish with continued use. This gap highlights the need for more rigorous longitudinal research to inform the design of interventions and the development of sustainable policies.

Furthermore, the literature points to gaps in understanding the interplay between digital literacy and specific health outcomes. While existing evidence suggests that higher literacy correlates with improved portal adoption and engagement (Risling et al., 2017; Kainiemi et al., 2022), relatively few studies have examined how literacy levels influence outcomes such as treatment adherence, disease progression, or mental health management. Future research should therefore explore these causal pathways in greater depth, potentially through mixed-methods approaches that combine

quantitative outcome measures with qualitative insights into patient experiences. Such approaches would enrich understanding of the mechanisms by which portals contribute to empowerment and health improvements.

In addition, the global context of portal adoption requires further exploration. Comparative studies, such as those by Zanaboni et al. (2020) in Norway and Kainiemi et al. (2022) in Finland, demonstrate that portals can enhance satisfaction and quality of care, yet outcomes vary significantly across healthcare systems. Factors such as infrastructural capacity, cultural attitudes toward technology, and national policy frameworks play critical roles in shaping adoption and effectiveness. Expanding cross-national research can illuminate best practices and provide lessons for countries at different stages of digital health implementation. Such insights are particularly relevant for low- and middle-income countries, where infrastructural and literacy challenges are more pronounced.

Finally, the integration of emerging technologies into health portals presents both opportunities and challenges that warrant further investigation. Advances in artificial intelligence, personalization algorithms, and mobile health applications offer potential for portals to deliver more tailored and effective interventions. However, as Monkman et al. (2023) caution, these innovations may also exacerbate inequalities if access remains uneven. Future studies should therefore evaluate not only the efficacy of technological enhancements but also their implications for equity and inclusivity. Ensuring that portals evolve as inclusive tools will require ongoing attention to how innovations intersect with systemic barriers and patient diversity.

CONCLUSION

This review highlights the growing significance of digital health portals as tools for patient empowerment, with digital literacy emerging as a decisive factor influencing their adoption and effectiveness. Evidence from diverse studies demonstrates that portals enhance patient engagement, support chronic disease self-management, and contribute to measurable improvements in clinical outcomes such as glycemic control and blood pressure regulation. However, systemic challenges, including limited interoperability of electronic health records, provider workload, and persistent inequities in digital access, continue to undermine their full potential. Vulnerable populations—particularly older adults, low-income groups, and rural residents—remain disproportionately excluded from portal benefits due to limited digital skills and infrastructural barriers. Addressing these gaps requires integrated strategies that combine digital literacy education, equitable internet access, and robust privacy protections to foster patient trust and ensure inclusivity.

Policy interventions should prioritize investments in digital literacy programs tailored to vulnerable groups, infrastructural expansion to underserved regions, and systemic reforms that align provider incentives with patient empowerment goals. Future research must adopt inclusive and longitudinal designs to capture the long-term impacts of portal use across diverse demographics and conditions, while also standardizing evaluation metrics to strengthen comparability across studies. Additionally, exploring the integration of emerging technologies, such as artificial intelligence and

personalized health applications, may further enhance portal effectiveness but requires careful consideration of equity implications. Ultimately, the advancement of digital health portals hinges on addressing systemic barriers and ensuring equitable access, thereby transforming them into sustainable and inclusive tools for modern healthcare.

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