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Evaluating holistic socio-environmental impact of digital health: scoping review of decision-making frameworks

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Abstract

Purpose – The 2030 Agenda highlights the transformative role of digital technologies in advancing human progress, reducing inequalities and promoting sustainable knowledge societies. Digital Health (DH) enhances healthcare effectiveness, resilience and equity, while addressing environmental and climate challenges. To fill a literature gap, we conducted a scoping review of methodologies for DH impact assessment, focusing on social and environmental dimensions aligned with the six aims of Value-Based Health Care (VBHC).

Design/methodology/approach – The review followed JBI methodology and PRISMA-ScR guidelines. PubMed, Scopus and Cochrane searches (2014–2024, English) retrieved studies addressing at least three domains of the Sextuple Aim: Experience of Care, Population Health, Reduced Cost, Care Team Well-Being, Health Equity, and Environmental Impact.

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Findings – From 8,243 records, 53 studies met criteria. None addressed all six aims. Experience of Care (98.11%) and Population Health (94.34%) dominated assessments, whereas Environmental Impact appeared in 11.32%. Thematic analysis yielded 128 items across 10 domains, 26 topics, and 92 issues. Experience of Care, notably user engagement and process costs, was most developed. Environmental Impact remained limited to carbon footprint and transparency.
Social implications – By highlighting key gaps, the review supports balanced, evidence-based DH decision-making and helps stakeholders prioritize innovations delivering technical, social and environmental value.
Originality/value – This is the first systematic mapping of DH's social and environmental evaluation within the Sextuple Aim, resulting in a Holistic Impact Framework integrating underrepresented dimensions.

Keywords Digital health, Performance measurement, Social impact assessment, Environmental impact assessment
Paper type Literature review

1. Introduction

According to the World Health Organization, Digital Health (DH) includes the development and use of digital technologies to improve health. This field extends beyond e-health to involve digital consumers interacting with various smart devices and connected equipment. It also incorporates applications such as the Internet of Things, artificial intelligence (AI), big data, and robotics (WHO, 2021).

The 2030 Agenda for Sustainable Development highlights that information, and communications technology can significantly accelerate human progress, bridge the digital divide, and foster knowledge societies. Literature indicates that DH can disrupt healthcare systems, enhancing their capacity, effectiveness, resilience, and equity in response to environmental and climate challenges (WHO, 2022). The ongoing digital revolution presents opportunities for product dematerialization, efficient resource utilization, and improved supply chain management, with DH recognized as essential for achieving sustainable development (Manjurul *et al*., 2022). When effectively integrated into healthcare systems, DH enables remote patient monitoring, virtual consultations, and personalized care improvements (Thompson, 2021). Overall, DH can improve access to care by ensuring timely delivery of health services, facilitating access for rural and urban communities, addressing the needs of medically underserved areas, connecting patients with appropriate specialists, and increasing provider capacity (National Quality Forum, 2017).

Although global warming nears the 1.5°C limit of the Paris Agreement (2015), and WHO (2014) acknowledges climate change's indirect impacts on social equity and health, assessment of health technology's environmental and social effects remains voluntary for healthcare organizations. This evaluation is sometimes conducted through reports based on Corporate Social Responsibility models (Bowen, 1953), which define clear social goals, outline actions, and monitor results. One notable model is the Triple Bottom Line, introduced by Elkington (1999), which expands the traditional profit-loss perspective to include financial, social, and environmental dimensions.

Currently, the most comprehensive approach for evaluating digital solutions is Health Technology Assessment (HTA), a multidisciplinary process that aims to determine the value of health technology throughout its lifecycle. HTA informs decision-making to promote equitable, efficient, and high-quality health systems, and includes over twenty recognized frameworks for digital solutions (O'Rourke *et al*., 2020). However, when examining social impacts, HTA tends to focus on a narrow range of concerns. A review of the HTA Core Model® (Lampe *et al.*, 2009). shows that related questions primarily evaluate implications for patients, caregivers, and targeted social groups. The Ethics domain addresses the "Benefit-harm balance," assessing the technology's benefits and harms for various stakeholders. Evaluations are often descriptive rather than integrative, relying on literature reviews, expert opinions, and stakeholder consultations. Additionally, there is limited formal reference to the environmental impacts of technology, mostly focusing on safety and emissions of chemical substances (Vis *et al*., 2020). A report from Cambridge University confirms this, indicating that of 1,710 HTA articles, only two provided frameworks for incorporating environmental assessments, while others mainly described evidence-weighting practices (Marsh *et al*., 2016).

Given these limitations, applying more holistic methodologies for impact assessment in healthcare, such as Health Impact Assessment (HIA), Social Impact Assessment (SIA), and Environmental Impact Assessment (EIA), may be beneficial. These methodologies follow similar approaches: they determine the potential impacts, gather data to understand the current context, predict changes resulting from a project, and make recommendations to maximize benefits and minimize harm. Each methodology focuses on different aspects; EIA examines effects on the biophysical environment, SIA looks at social and economic impacts, and HIA considers community health impacts (Ross *et al*., 2014). These evaluation methods can enhance the recognition of the value created by DH in terms of reimbursement and accountability, as suggested by the Value-Based Health Care (VBHC) approach (Zhang *et al.*, 2025). The costs associated with implementing, adopting, and maintaining DH technologies remain significant challenges for healthcare organizations and authorities and can hinder innovation (Whitelaw *et al*., 2021). Porter's (2009) VBHC framework proposes a new competitive approach in healthcare, focusing on the value generated per money spent. According to Porter, VBHC principles have significant implications for reimbursement, suggesting that the reimbursement unit should align with the value unit. Over the past 20 years, the definition of value has increasingly included stakeholders involved in healthcare services (Berwick *et al*., 2008; Dipti, 2021). The new "Sextuple aim" framework (6AF) introduced by Alami *et al*. (2023) after the COVID-19 pandemic, recognizes the importance of valuing effective patient care, cost management, provider support, population health, equity, and environmental issues. Despite the various methodologies described, previous searches in PubMed, Scopus, Web of Science, and the Cochrane Database of Systematic Reviews (Jacob *et al*., 2023) indicate a lack of reviews assessing the literature on social and environmental impact assessments of DH. Therefore, this scoping review's main objective is to summarize the methodologies and frameworks used for impact assessment of DH, focusing on the social and environmental impacts while aligning with the six aims of VBHC. Based on this goal, we raised the following review questions (RQs).

RQ1. Contribution types: How many sources have presented new frameworks, methods/techniques, tools, metrics, or processes for the assessing of the social and environmental impact of DH?

RQ2. Holistic approach: How many sources adopt holistic approach and allow evaluation of three or more aim of the 6AF VBHC framework?

RQ3. Value domains: Mapping of domain, topic and issue that contribute to assessment of (Figure 1):

2. Methods

This scoping review was performed adhering to Joanna Briggs Institute's (Munn *et al.*, 2020) methodology for scoping reviews and complies with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis extension for scoping reviews guidelines (PRISMA-ScR) (Tricco *et al*., 2018).

Figure 1. The sextuple aim framework (Alami *et al*., 2023)

2.1 Search strategy

The Population, Concept, and Context (PCC) framework guided the formulation of the query and eligibility criteria (Munn *et al.*, 2020):

Population: This review includes studies involving users of DH solutions regardless of specific population traits to maximize inclusion and enhance result generalizability.

(1) Concept: The review will include studies that evaluate the impact of DH in alignment with three or more of the six aims of the VBHC framework. This inclusion criterion was chosen because VBHC originated with three core dimensions, which have since evolved into six, reflecting a broader and more nuanced understanding of healthcare value. Setting the threshold at three aims ensures capturing the multidimensional nature of healthcare value, allowing studies to provide a comprehensive and integrated assessment of digital health impacts across multiple relevant dimensions.

(2) Context: The review will encompass studies conducted within the last ten years in any context where DH technologies are utilized. The timeframe of the last ten years was selected to capture the most recent and relevant evidence, reflecting the rapid evolution and adoption of digital health technologies in healthcare. Limiting the review to this period ensures the inclusion of studies that are contextually and technologically current, providing an accurate understanding of contemporary digital health impacts. To determine eligible technologies, we will apply the globally recognized WHO (2021, 2016) definition of DH.

Based on the search strategy outlined below, the following search query (Figure 2) was created.

This query was utilized in December 2024 to search the title and abstract fields of all records in PubMed, Scopus and the Cochrane Database of Systematic Reviews. The search strategy, including all identified keywords and index terms, was adapted for each database and information source. Studies published in English and Italian within the last ten years (2014–2024) were included, with no exclusions based on study type. Given the exploratory focus of this review, a specific quality assessment tool was not employed, as the primary aim was to evaluate the dimensions and methodologies used across studies rather than to perform a rigorous quality appraisal. Nevertheless, the selection process was carefully conducted based on stringent criteria for peer-reviewed publications to ensure the reliability and relevance of the studies considered.

2.2 Data extraction

All records identified through database searches were retrieved and stored using the Rayyan platform, where any duplicates were removed. Two researchers independently screened the articles in a blinded manner, following pre-established inclusion and exclusion criteria to

((“digital health”) OR (“telehealth”) OR (“ehealth”) OR (“mhealth”) OR (“telemedicine”) OR (“mobile health”) OR (“big data”) OR (“blockchain”) OR (“health data”) OR (“health information systems”) OR (“infodemic”) OR (“Internet of Things”) OR (“interoperability”)) AND (((“technology assessment”) OR (“health technology assessment”) OR (HTA) OR (“social domain”)) OR ((impact assessment*) OR (impact*) OR (“health impact assessment”) OR (HIA)) OR ((“social impact assessment”) OR (“social impact*”) OR (equity) OR (“social change*”) OR (“social development”) OR (SIA)) OR ((“community impact”) OR (“patient impact”)) OR ((greenhouse) OR (“environmental sustainability”) OR (emissions) OR (“carbon footprint”) OR (“climate change”) OR (“pollution”)) OR ((“Social Return On Investment”) OR (SROI))) AND ((framework*) OR (methodology*)).

Figure 2. Search strategy

ensure an unbiased selection process. Data were extracted from the articles, using a data extraction table designed to align with the review's objectives and research questions. The extracted data included the author, year, and country of the study, the technology assessed, the aims covered in the assessment, and the items used to evaluate the impact of DH. Through a thematic analysis (Clarke and Braun, 2014), the identified items were subsequently examined to eliminate duplicates and classify them based on their corresponding VBHC aim.

In the final phase, the selected items were categorized into the classes proposed by Deckers and Lago (2022).

(1) Domain: Represents the broad areas of interest affected by the health technology.

(2) Topic: Refers to specific aspects or subjects within a domain that are relevant to the evaluation.

(3) Issue: Indicates questions or concerns that arise within a topic and need to be addressed.

Any discrepancies regarding article selection, data extraction, and analysis were discussed and resolved through group consensus among an expert in HTA and AI, an expert in SIA, an expert in DH, and an expert on Big Data.

3. Results

Given the increasing attention to DH over the past decade, the initial search returned 8,243 records. After removing 3,176 duplicates, 5,067 articles were screened by title and abstract. Following this first screening, 106 full-text reports were assessed for eligibility. Of these, 53 reports were included in this scoping review, as they addressed at least three of the six aims of VBHC framework. The inclusion process is detailed in the PRISMA flowchart shown in Figure 3.

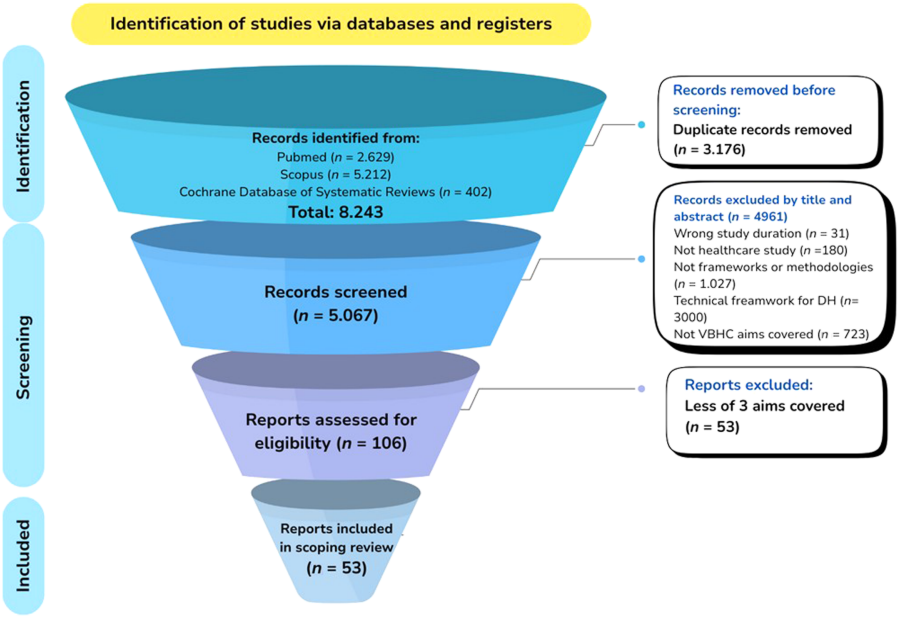

Figure 3. Prisma flowchart

3.1 Description of the included reports

As shown in the geographical distribution map (Figure 4), most studies (41.51%) originated from Europe. Within Europe, England contributed 9.43% of the studies, followed by Switzerland (9.43%) and Italy (5.66%). North America contributed 33.96% of the studies, primarily from the USA (28.30%), the first state for number of frameworks created. Oceania accounted for 13.21% of the studies, mainly from Australia, the second state with higher number of studies (11.32%).

In terms of publication trends (Figure 5), there was a notable increase in studies published during the COVID-19 pandemic, with peaks in 2019 (15.09%) and 2020 (16.98%), reflecting heightened interest during the global health crisis. Additionally, a second peak was observed in 2024 (26.42%), likely influenced by anticipated developments in AI and HTA regulations.

In terms of technological focus (Figure 6), the studies primarily addressed DH (30.19%), m-Health (28.30%), and Telemedicine (20.75%). Emerging technologies were also represented, with AI (7.55%). Other topics, each contributing 1.89%, included Big Data, Chatbots, Virtual Reality, Wearables, Connected Care, e-Health, and integrated approaches combining m-Health, AI and Robotics.

In Supplementary file I, are the frameworks, tools, and methodologies included in 53 reports, with an indication of the aims covered for DH impact assessment. As shown by Supplementary file I and Figure 7, the most frequently assessed aims were Experience of care (98.11% of studies) and Population Health (94.34%). These were followed by Equity (71.70%) and Reduced Cost (64.15%). Fewer than half of the studies (43.40%) considered the importance of care team well-being, and only six studies (11.32%) included an environmental assessment in their methodology. Only 13 studies adopted a more holistic approach to the assessment of DH; however, none addressed all six aims comprehensively.

3.2 Design of the Holistic Impact Framework for digital health: items identified and their categorization in domain, topic and issue

Through a thematic analysis, 163 items were initially identified as relevant to the evaluation of the six aims. After eliminating duplicates, the final list was reduced to 128 unique items. The identified items were systematically organized into three classes—Domains ($n = 10$), Topics ($n = 26$), and Issues ($n = 92$)—which together constitute the Holistic Impact Framework for DH (Figure 8).

The domains, topics, and issues concerning user satisfaction are addressed in both Aim I and IV. This approach was adopted to provide a comprehensive description of the experiences of all users, including patients, caregivers, and the care team. Following a review by an expert

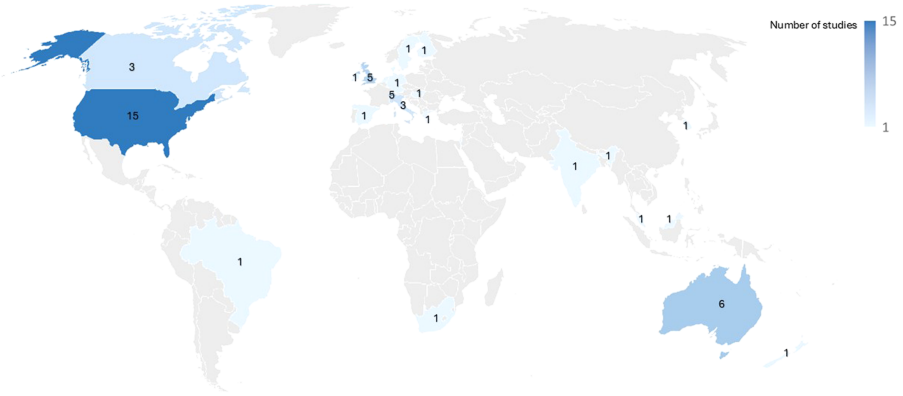

Figure 4. Geographical distribution of studies

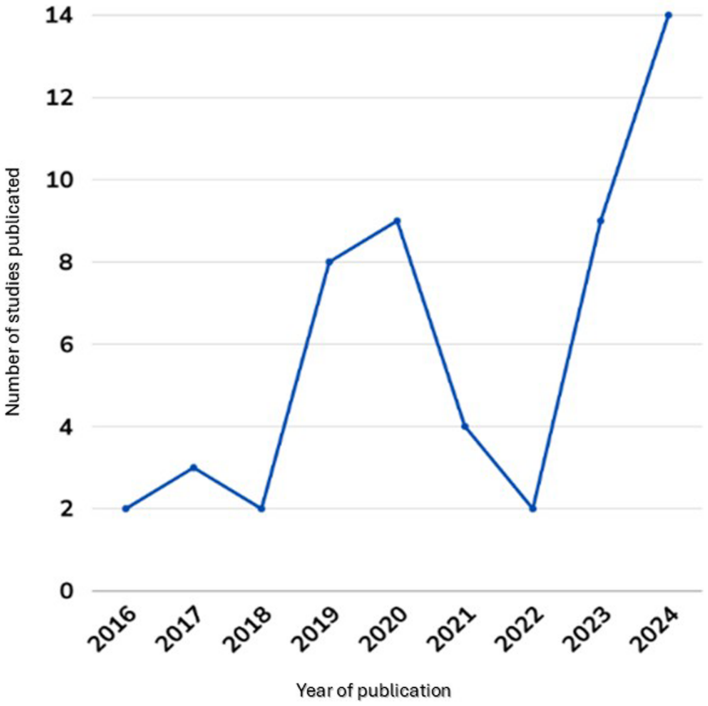

Figure 5. Publication trends

panel, the accepted items were assigned to their respective categories and aligned with the most appropriate of the six aims (Table 1–6).

3.2.1 Domain, topic and issue details for I aim – experience of care (Table 1). The I Aim result well described with 3 Domains, 10 Topics and 38 Issue. User Satisfaction (13.21%) was a prominent domain, with five topics and 24 issues identified. User Engagement was the most cited topic (22.64%), followed by Effectiveness (16.89%) and Safety (15.09%). Regarding the Issue, the three most frequently cited items were: short- and long-term Usability (18.87%), Communication and Information Sharing (13.21%), and Adherence (7.55%).

3.2.2 Domain, topic and issue details for II aim – population health (Table 2). The II Aim centers on Disease Burden, reflecting population health impact. It is assessed via systematic health data collection and analysis, guiding public health and patient management. Accurate information on disease burden is essential for policymaking, particularly in guiding the prioritization of health interventions and the allocation of resources; an aspect of growing importance in light of the increasing prevalence of chronic illnesses. Instead, the literature highlights several key Topics within this aim. The most frequently cited is Behavioural Change (9.43%), which reflects the potential of DH solutions to empower Lifestyle modifications and support patients' Intentions towards healthier behaviours. Closely related is the recognition of the importance of framing the health problem itself and demonstrating how DH can act as an effective solution. Among the specific issues, the most cited is Trustworthiness (9.43%), underscoring the crucial role of patient and stakeholder trust in ensuring the successful implementation of new technologies. This is followed by two issues equally represented (5.66% each): the Utility of the digital solution, and its Congruence with the identified problem. These highlight the necessity of carefully analysing the healthcare context before

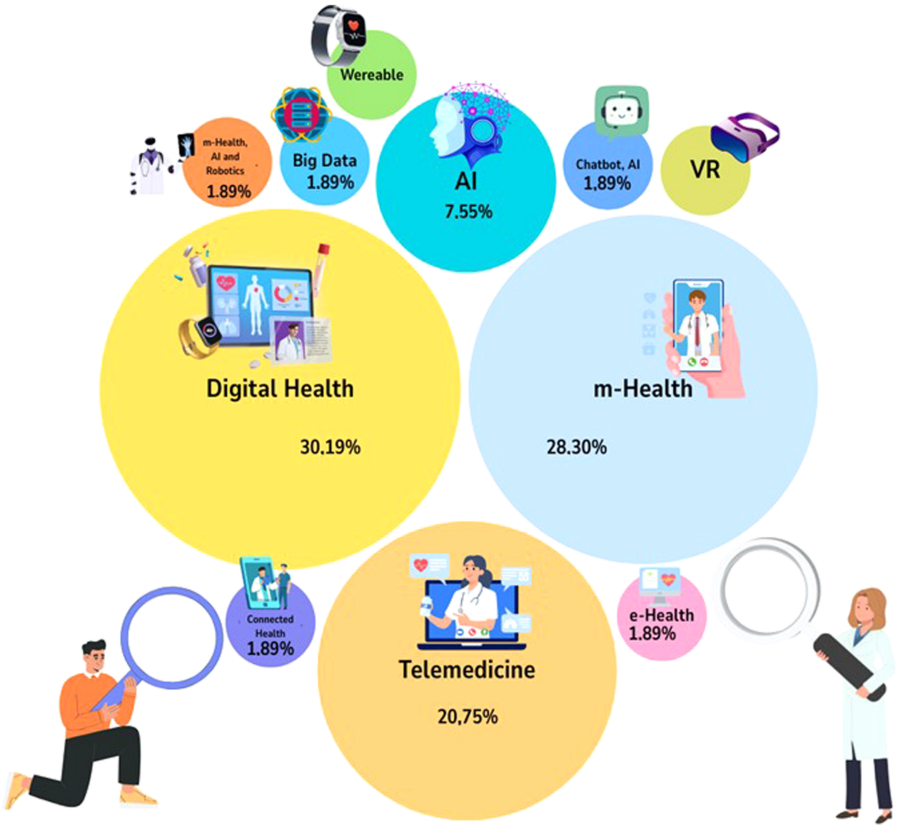

Figure 6. Technology assessed by the studies

implementing digital innovations. In summary, the II Aim encompasses 1 Domain, 5 Topics, and 9 issues.

3.2.3 Domain, topic and issue details for III aim – Reduced Cost (Table 3). The focus of the Economic Aim in healthcare is to enhance transparency in investments, with particular attention to the topic of Cost Assessment (16.98%). A related priority is the reduction of the Financial Burden (5.66%) for healthcare authorities and the avoidance of additional costs for final users, namely patients and their families. This emphasis is further reflected in the literature through the issues of Cost–Benefit Analysis (7.55%) and Cost-effectiveness analysis (5.66%). Equal attention is devoted to the topic of the Economic and Financial Sustainability of Technology, which underlines the importance of developing solutions with a solid financial basis. Such solutions must be capable of supporting patients over time within a structured budget that accounts for all detailed costs. The costs are well described in more of 15 issues. Overall, this aim is structured into 3 domains, 5 topics, and 24 issues.

3.2.4 Domain, topic and issue details for IVaim – care team well-being (Table 4). With its 2 domains, 7 topics, and 25 issues, the IV Aim emphasizes the centrality of the Care Team's Experience, including the impact on Teamwork dynamics. Within this aim, particular attention is given to the Domain of Well-Being (1.89%), where the primary topic is represented by the Impact of DH on the Social Life of healthcare professionals.

3.2.5 Domain, topic and issue details for Vaim – Health Equity (Table 5). DH represents an important opportunity for strengthening Healthcare Equity, as demonstrated by the fact that the

Figure 7. Ranking of aim

V Aim contains the most frequently cited domain: Equity (32.08%). Within this domain, the most frequently cited topic is Accessibility (37.74%), followed by Skill Equity (11.32%) and Access to Care (7.55%). These findings are further corroborated by the centrality of issues such as Customizability (11.32%), along with Digital Health Literacy (7.55%) and Inclusivity (7.55%). Together, these highlight that achieving "Health for All" (WHO, 2023) requires digital health solutions to be both personalized and attentive to different social classes and minorities, while simultaneously ensuring that patients, care teams, and society at large are informed and aware of the importance and opportunities offered by digital solutions. In total, this aim includes 1 Domain, 4 Topics, and 17 Issues.

3.2.6 Domain, topic and issue details for VI aim – environmental impact (Table 6). Despite the importance highlighted in the literature regarding the need for a Clearer understanding of the environmental impact of technology, and despite evidence of the multiple influences of DH with respect to planetary boundaries, the evaluations remain limited. The most frequently assessed Issue is the Carbon Footprint (7.55%), followed by only modest attention to Resource Depletion (1.89%).

3.3 Rankings of domains, topics, and issues

A comparison of the rankings based on citation data for domains, topics, and issues, as shown in Figure 9, demonstrates that the literature gives central importance to investigating whether DH can truly foster Equitable healthcare. This emphasis is primarily on the Accessibility topic

Figure 8. Holistic impact framework for DH

and ensuring access for all minority groups. This finding is further corroborated by the third most cited issue, Customizability, which demonstrates the importance of considering cultural and social contexts when designing digital solutions.

Table 1. Domain, topic and issue details for I aim – experience of care

I aim – experience of care (98.11% of studies)		
Domain (% occurrence)	Topic (% occurrence)	Issue (% occurrence)
User experience/Satisfaction for patient and family/caregiver (13.21%)	Acceptability (9.43%)	Capacity to use (1.89%)
		Future use (1.89%)
		Usability in short and long time (18.87%)
		Impression first and after using (3.77%)
	Aesthetics (5.66%)	Background colour and content, button colour, shape, icon (1.89%)
		Flexibility (3.77%)
		Tailoring (1.89%)
	Ease of use (13.21%)	Interaction quality (1.89%)
		Intuitive (1.89%)
		Integration (1.89%)
		Functionality (5.66%)
	Relationship aspect (3.77%)	Empathy (1.89%)
		Humanistic care (1.89%)
		Patient/caregiver – clinician encounter (1.89%)
		Patient – carer dependency (1.89%)
	User engagement (22.64%)	Co-design (1.89%)
		Collaboration and end-user participation (1.89%)
		Adoption input (1.89%)
		Communication and information sharing (13.21%)
		Gamification or entertainment (1.89%)
		Persuasiveness (3.77%)
		Self-management (3.77%)
		Autonomy in health-related decision (1.89%)
		User control (3.77%)
Quality (9.43%)	Effectiveness (16.89%)	Adherence (7.55%)
		Appropriateness of service (1.89%)
		Appropriateness of response (1.89%)
		Context awareness (3.77%)
		Continuity of care (3.77%)
		Feasibility (1.89%)
	Safety (15.09%)	Tech reliability (1.89%)
		Accuracy (5.66%)
		Precision (1.89%)
	Timely (3.77%)	Time to event (to treat or decision) (1.89%)
		Timely access to care (1.89%)
Quality of life (7.55%)	Impact on morbidity (3.77%)	Life year saved (5.66%)
	Impact on social life (7.55%)	Relationship (i.e. family dynamics, friends, and other relevant social relations) (3.77%)
		Patient dignity (1.89%)

Following this, the second most important domain for evaluating the impact and successful implementation of DH is User Experience, with particular attention to User Engagement. The centrality of the end-user's experience is also corroborated by the most frequently cited issue, short- and long-term Usability (an issue within the Acceptability domain). This testifies to the need for solutions that are not merely marketing actions but provide genuine, long-term effectiveness. This is followed by Communication and Information Sharing issue, which highlights the importance of DH as an add-on channel between patient and Care Team. Finally,

Table 2. Domain, topic and issue details for II aim – population health

II aim – population health (94.34% of studies)		
Domain (% occurrence)	Topic (% occurrence)	Issue (% occurrence)
Disease burden (1.89%)	Effect on mortality (1.89%)	Life expectacy (1.89%)
	Effect on disability (1.89%)	Number of years lost due to disability (1.89%)
	Effect on quality of life (1.89%)	Quality-adjusted life years saved (1.89%)
	Behavioural change (9.43%)	Intention (1.89%)
		Life style changes (1.89%)
		Disease onseat and severity (1.89%)
	Relevance (5.66%)	Congruence (5.66%)
		Utility (5.66%)
		Trastwortiness (9.43%)

Table 3. Domain, topic and issue details for III aim – reduced cost

III aim – Reduced cost (64.15% of studies)		
Domain (% occurrence)	Topic (% occurrence)	Issue (% occurrence)
Economic impact on patient/ family/caregiver (5.66%)	Financial burden (5.66%)	Cost of device/service (1.89%)
		Cost of internet (1.89%)
		Cost of maintenance (1.89%)
Economic impact on healthcare provider (1.89%)	Process related cost burden (1.89%)	Purchase Price (1.89%)
		Labour cost (h-team, engeeneers, technical, admistration and support staff) (1.89%)
		Cost of device and delivery (1.89%)
		Development and Implementation cost (1.89%)
		Mantainance and support cost (1.89%)
		Training cost (1.89%)
		Operational cost (1.89%)
		Uptake cost (1.89%)
		Economic/financial sustenability of technology (5.66%)
	Cost-opportunity (1.89%)	Trasport reduction of care team (1.89%)
		Cost savigs for staff turn-over (1.89%)
		Time savigs of staff in daily work (1.89%)
		Reduction of hospital and emergency department (ED) utilization rate (1.89%)
		Improve the number of custmers/patient (1.89%)
Economic impact on healthcare authorities (5.66%)	Cost assessment (16.98%)	Frugality (1.89%)
		Cost – effectiveness (5.66%)
		Cost- utility (1.89%)
		Cost – Benefit (7.55%)
	Financial burden (5.66%)	R&D (1.89%)
		Investment (1.89%)
		Regulatory cost (1.89%)

the third most important domain is the Quality of the solution, expressed in terms of Effectiveness, Safety, and Timeliness. Additionally, a third significant topic is Cost Assessment. This underscores that while the user's experience and adherence to objectives are central, it is also crucial to contain costs and ensure that the investment is justified for the solution to be viable.

Table 4. Domain, topic and issue details for IV aim – care team well-being

IV aim care team well-being (43.40% of studies)		
Domain (% occurrence)	Topic (% occurrence)	Issue (% occurrence)
Care team experience/ Satisfaction (5.66%)	Acceptability (9.43%)	Capacity to use (1.89%)
		Future use (1.89%)
		Usability in short and long time (18.87%)
		Impression first and after using (3.77%)
	Aesthetics (5.66%)	Background colour and content, button colour, shape, icon (1.89%)
		Flexibility (3.77%)
		Tailoring (1.89%)
	Ease of use (13.21%)	Interaction quality (1.89%)
		Intuitive (1.89%)
		Integration (1.89%)
		Functionality (5.66%)
	Relationship aspect (3.77%)	Empathy (1.89%)
		Humanistic care (1.89%)
		Patient/caregiver – clinician encounter (1.89%)
	User engagement (22.64%)	Co-design (1.89%)
		Collaboration and end-user participation (1.89%)
		Adoption input (1.89%)
		Communication and information sharing (13.21%)
		Gamification or entertainment (1.89%)
		Persuasiveness (3.77%)
		Self-management (3.77%)
		User control (3.77%)
	Impact on care teamwork (3.77%)	Smart working (1.89%)
		Teamwork (3.77%)
Well-being care team (1.89%)	Impact on social life (1.89%)	Relationship (i.e. family dynamics, friends, and other relevant social relations) (1.89%)

Table 5. Domain, topic and issue details for V aim – health equity

V aim – Health equity (71.70% of studies)		
Domain (% occurrence)	Topic (% occurrence)	Issue (% occurrence)
Equity (32.08%)	Access to care (7.55%)	Availability across platform (3.77%)
		Financial burden for user (1.89%)
		Coverage (improve access in rural settings) (1.89%)
		Offline functionality (1.89%)
		Waiting time (1.89%)
		Fairness (1.89%)
		Corruption (1.89%)
	Accessibility (37.74%)	Comprehensibility (Language availability, Linguistic accuracy, Numeracy, Visual Interpretation, Font type and size) (5.66%)
		Customizability (11.32%)
		Inclusivity (7.55%)
		Cultural appropriateness and political will (3.77%)
	Advocacy (1.89%)	Stakeholder involvement (5.66%)
		Influence and endorsement between peers (1.89%)
		Empowerment (5.66%)
		Social support (1.89%)
	Skill equity (11.32%)	Health Literacy (3.77%)
		Digital Health Literacy (7.55%)

Table 6. Domain, topic and issue details for VI aim – environmental impact

VI aim – environmental impact (11.32% of studies) Domain (% occurrence)	Topic (% occurrence)	Issue (% occurrence)
Clearness of technology environmental impact (1.89%)	Climate change (1.89%)	Carbon footprint (7.55%) Resource depletion (1.89%)

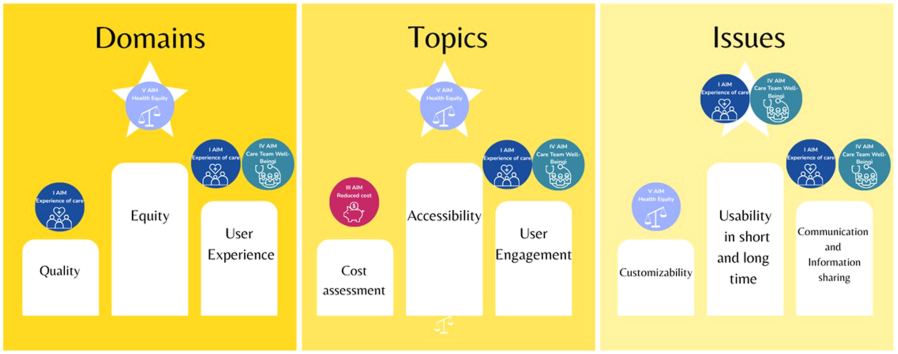

Figure 9. Ranking of domains, topics and issues

4. Discussion

Our research underscores the increasing importance of evaluating the impact of DH within the healthcare sector. This scoping review makes a substantial contribution to the scientific debate by providing a critical and comprehensive mapping of existing evaluation approaches, with a particular focus on uncovering significant gaps in the social and environmental dimensions.

The originality of this work lies in the design of a holistic framework that encompasses all six aims of health value as defined by the VBHC model. This framework serves as a practical checklist to assess potential implications and impacts related to the implementation of DH in real-world healthcare contexts.

Importantly, this framework can function as a pre-implementation screening tool to highlight potential barriers, risks, and unintended consequences related to social and environmental issues. Concurrently, it provides a systematic basis for post-implementation monitoring to verify whether expected outcomes and mitigation strategies are effectively realized in practice.

Beyond its methodological contribution, the framework could be operationalized within institutional decision-making processes by being adopted as a supportive tool for HTA committees, innovation boards, and policy advisory groups. In such settings, it could complement existing evaluation protocols and facilitate multi-stakeholder dialogues during the early stages of digital health adoption, ensuring that investment, design, and governance choices are systematically informed by broader societal and environmental considerations.

The study provides a clear and detailed picture of current research trends and identifies persistent gaps. While our findings reveal a broad spectrum of methodological tools employed across studies, none fully address all six value dimensions. This disparity highlights the prevailing dominance of evaluation models cantered on clinical outcomes and economic considerations, often neglecting the broader, more holistic value that DH could generate across social and environmental spheres.

Even within the well-studied domains, key gaps persist. For example, the impact of DH on Care Team members is often narrowly focused on their experience and engagement, while the broader concept of health professional well-being, encompassing physical, psychological, and emotional health, is frequently overlooked. This omission is concerning in light of the fourth aim of VBHC, which highlights the critical importance of supporting healthcare providers' well-being. Recent literature, especially emerging from the COVID-19 pandemic experience, emphasizes the rise of technostress, burnout, and other digital-related occupational hazards affecting healthcare professionals (Golz *et al*., 2021), yet these remain insufficiently explored in DH impact evaluations.

Another notable insight from our review is the still limited adoption of integrated and multidisciplinary assessment methodologies. Their limited use highlights the need for cultural and methodological change to overcome disciplinary silos. Promoting cross-sector collaboration, where frameworks like corporate social responsibility support the demonstration of social value through credible, measurable, and transparent methods, is essential. Specifically, to close the environmental evaluation gap, embedding standardized environmental metrics into HTA processes is imperative. This includes fostering strong partnerships between HTA professionals and sustainability experts and encouraging an evaluative culture aligned with the principles of the 2030 Sustainable Development Agenda. Although environmental issues like carbon footprint and transparency receive some focus, evaluations remain shallow. Current models lack clear, objective lifecycle indicators capturing DH's environmental impacts from production to disposal (Liu *et al*., 2024). Integrating these indicators into future frameworks is necessary to provide more actionable insights for policymakers and healthcare providers focused on environmental stewardship. Overall, the findings of this review emphasize the importance of expanding the evaluation scope of DH technologies beyond traditional clinical and economic outcomes. By incorporating social and environmental dimensions, this broader evaluative lens can better capture the multi-faceted value that DH brings to healthcare systems, patients, providers, and society at large. This approach aligns with the emerging triple-bottom-line perspective, which recognizes that sustainable healthcare innovation must generate positive impacts economically, socially, and environmentally.

Future research should focus on refining and expanding this framework, particularly by addressing critical but underexplored dimensions rooted in the triple-bottom-line approach. Emphasis should be placed on developing and validating clear, actionable indicators that capture environmental impacts throughout the DH technology lifecycle. Similarly, the distinct but interrelated domain of care team well-being warrants much deeper investigation, encompassing physical, emotional, and psychological facets influenced by digital solutions.

5. Conclusion

This study advances the discourse by broadening the evaluative lens on digital health impact assessment beyond conventional focus areas such as cost-effectiveness and clinical outcomes. By introducing a holistic framework grounded in the VBHC sextuple aim, it empowers decision-makers to integrate sustainability and equity criteria systematically into health policy formulation, regulatory decisions, and investment prioritization processes.

The proposed framework provides stakeholders with a structured and evidence-based approach to discern which digital health technologies deliver tangible technical, clinical, societal, and environmental value—thus promoting a culture of responsible and sustainable innovation within healthcare systems.

To operationalize this vision, the active engagement of a broad range of stakeholders across all phases of digital health design, development, deployment, and evaluation is essential. Ensuring the participation of healthcare professionals, patients, policymakers, technology developers, and environmental specialists will foster comprehensive assessments that reflect the complex interplay of benefits and trade-offs in real-world contexts.

Ultimately, facilitating meaningful stakeholder engagement transforms the evaluation process into a democratic and shared responsibility, rather than a unidirectional exercise controlled solely by top-level authorities. Empowering those most affected by digital transformation enhances the legitimacy, accountability, and overall societal impact of DH decision-making. This participatory approach is essential to realize the full potential of digital health innovation as a driver of equitable, sustainable, and value-based healthcare systems.

Supplementary material

The supplementary material for this article can be found online.

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