Digital health literacy: A concept analysis

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Abstract

Objective: To elucidate the concept of digital health literacy by delineating its primary dimensions, origins and effects. Through this clarification, we seek to augment our understanding of the contemporary use of the concept of digital health literacy.

Methods: Rodgers's concept analysis was employed to investigate digital health literacy as a context-influenced concept evolving with technological progress. Six databases (PubMed, Embase, CINAHL, RISS, KISS and DBpia) and Google Scholar were searched from 2006 to 2023, focusing on the terms 'digital health literacy', 'eHealth literacy' and 'mHealth literacy'. Of 2,819 papers, 32 were included in the analysis to identify the conceptual structure of digital health literacy.

Results: The conceptual structure of digital health literacy was identified, and its evolution was traced. Currently, the four critical attributes are (a) goal-driven regulation, (b) information processing, (c) communication and (d) utilisation. Functional literacy, prior health knowledge and experience, and access to technology are antecedents, while positive health outcomes, increased perceived control and enhanced health-related quality of life emerged as consequences. Additionally, the concept was influenced by multilevel contextual factors.

Conclusions: By enhancing our understanding of digital health literacy; standardising its terminology; and exploring the interactions among its antecedents, consequences and influencing factors, this study aims to reduce health disparities and promote equitable health in the digital era. The results of this foundational work, which establishes a basis for future research and policy development, provide clear pathways for developing targeted interventions and measurement tools of digital health literacy, ultimately contributing to better health practices.

Keywords

Digital health literacy, eHealth literacy, digital health, eHealth, social determinants of health, healthcare disparities, health inequities, concept analysis

Introduction

The advancement of technology is reshaping the healthcare system. With the time- and distance-related flexibility of digital services, digital health technology is not only broadening access to medical services and fostering patient engagement but also expanding healthcare horizons, ensuring safer and more cost-effective treatments, especially for those previously underserved.[1] This transformation is also altering the dissemination of health information and the dynamics of health communication. It changes individuals from passive participants in the therapeutic relationship, which traditionally involved information imbalances between patients and healthcare providers, to active agents engaged in health self-management.[2] However, digital services and technology alone are not a panacea for everyone. As individuals who require more services are generally part of the digitally vulnerable population, the ideal vision for digital health may remain an unrealistic

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ideal if steps to equip people with digital health literacy are not implemented. Consequently, health disparities between those who can effectively access and use these services and those who cannot will increase.[3,4] This concern underscores the importance of digital health literacy, which the World Health Organization and other global organisations actively promote and emphasise as a crucial factor in achieving optimal health outcomes and promoting equitable access to health services.[3,5]

Moreover, the COVID-19 pandemic further underscored the importance of digital health literacy and expanded its use by increasing related discourse. It rapidly accelerated the integration of digital healthcare into society, with digital platforms becoming the key channels for the timely dissemination of social guidelines and information about COVID-19[6,7] and public containment measures.[7] Simultaneously, a considerable volume of misinformation and disinformation related to the pandemic, known as the 'infodemic', spread rapidly via social channels, causing social confusion and related anxiety.[7,8] At this time, the World Health Organization underpinned the integration of digital health literacy into public health strategies as both a preventive and a contagion containment measure, with the aim of enhancing the effective communication of public health messages, empowering individuals to take control over their health by accessing reliable information and bridging the digital divide by ensuring equitable access to health tools and resources.[9] During the pandemic, the burden disproportionately fell on the already vulnerable populations,[10] and scholars urged the need to integrate solidarity and social responsibility in response within the framework of digital health literacy[11,12] as well as the need to enhance critical health literacy.[8,11] In this context, metacognition (i.e., the awareness and regulation of one's own cognitive processes) was discussed as an important element of helping individuals make informed decisions amid the infodemic.[13]

Despite the current importance of the concept, digital health literacy can be a somewhat confusing construct depending on the researcher's approach and perspective. The lack of clarity surrounding its conceptualisation, standardisation, origin and perception can also make it difficult to synthesise extant related knowledge, hindering further discussion.[14] Before the concept of digital health literacy emerged, Norman and Skinner coined the term eHealth literacy, serving to describe a skill to access, understand and use health information from electronic sources.[15] In fact, these two concepts are sometimes used interchangeably by many researchers, largely regarding them as surrogate terms.[16] Under this perspective, eHEALS, a measurement tool of eHealth literacy developed by Norman and Skinner, has often been used as an operational definition in digital health literacy studies.[17] However, this tool may fail to fully explain phenomena occurring in areas beyond Web 1.0, leading to a loss of explanatory power for the concept.[17,18]

In this study, different from prior perspectives, we consider digital health literacy as an expansion of the concept of eHealth,[19] viewing eHealth literacy as a key attribute of digital health literacy rather than an interchangeable term.[20] This reflects the World Health Organization's view of digital health – encompassing technological advancements in emerging fields such as big data, genomics, the use of advanced computing science in artificial intelligence, mHealth and eHealth – as an extension of eHealth.[9,20] This perspective is nuanced and different from that which treats the terms as surrogates of one another, and we further argue that digital health literacy encompasses the capacity to timely and effectively engage with technological advancements, providing room for continual evolution. Additionally, considering digital technology heterogeneity, this 'continual evolution' would also require domain-specific skills and competence.[21] It is important to note that there is another perspective on this issue that treats digital health literacy and eHealth literacy as terms that evolved from traditional health literacy.[22] Despite the value of this perspective, we build our stance based on the conceptualisation proposed by Norman and Skinner, where eHealth literacy is a meta-literacy that combines various fundamental abilities (e.g., health literacy) – not a simple extension of health literacy.[15] Thus, we regard these two concepts as related but distinct.

In general, to enhance our knowledge and the practical application of digital health literacy, further studies that consider its key dimensions are necessary. Discussions about these dimensions and related explanations should also address expanded discourses based on digital health literacy. For the purposes of deconstructing and examining previous definitions and related factors of a concept as well as gaining a clearer understanding of it, one of the most applied scientific methodologies is concept analysis.[14] Specifically, this approach enables the elucidation of the context of a concept, what affects and does not affect it, the identification of its main characteristics and what should be integrated into its use to better capture the phenomenon. Therefore, this study aimed to identify the main dimensions of digital health literacy through a concept analysis. We hope for this study to enhance our comprehension of the concept and its impact on health as it evolves as well as identify new pathways for research and policy focused on improving health outcomes and promoting equitable health in the digital era.

Methods

Before delving into the concept analysis, it is imperative to establish the researchers' viewpoint of the nature of the concept, which can profoundly influence the methodology employed.[14] From our perspective, providing a fixed definition of digital health literacy could be challenging owing to its dynamic nature, seeing that it evolves in response to

shifts in the digital environment where health information is created, shared and utilised. Therefore, this study embraces the evolving nature of 'digital health literacy', aligning with Norman's perspective that emphasises its dynamic evolution reflecting current usage.[23] Employing Rodgers's concept analysis method, we identified the concept of interest and related alternative terms; conducted a literature review; and collected and analysed data that included the attributes, antecedents and consequences of the concept.

Data search

The concept analysis was conducted based on a literature review. Data were collected from the following databases: PubMed, Embase, CINAHL and Google Scholar. Additionally, domestic databases (i.e., Research Information Sharing Service, Korean Studies Information Service System and DBpia) were included to identify Korean literature. We searched for data by combining a series of terms as follows: 'digital health literacy', 'eHealth literacy', 'electronic health literacy', 'mHealth literacy' and 'mobile health literacy'. We also used the main keywords such as 'concept', 'definition', 'framework', 'model', 'theory', 'instrument' and 'scale' to identify papers.

Regarding the search terms, we included 'eHealth literacy' and 'electronic health literacy' not only owing to their interchangeable use with 'digital health literacy',[16,24] but also in alignment with our evolutionary perspective. Additionally, according to the broad classification of digital healthcare into eHealth and mHealth,[25] we incorporated 'mHealth literacy' and 'mobile health literacy' as key terms to reduce the possible omission of eligible information and extract the conceptual essence under mobile environments. Additionally, we regard health literacy and digital literacy as alternative terms when they are used together with 'digital' and 'health', and consider such combinations of terms to collectively refer, in the context of their papers, to digital health literacy. Finally, as the concept of eHealth literacy was coined in 2006, we searched the literature published from 2006[15] to 2023.

Data selection

To analyse the concept of digital health literacy, both quantitative and qualitative studies were considered. The inclusion criteria were as follows: (a) studies explaining the concept of eHealth literacy or digital health literacy, including the definitions, frameworks, instruments or attributes of the concept; (b) peer-reviewed studies; (c) studies available in full text and (d) studies published in English or Korean. The exclusion criteria were as follows: (a) studies without definitions of eHealth literacy or digital health literacy, directly or indirectly and (b) studies using predefined definitions of eHealth literacy or digital health literacy. Of the initial sample of 2,819 papers, 1,850 papers remained after removing duplicates. These were then screened

based on title and abstract according to the inclusion and exclusion criteria. Subsequently, the full texts of 147 papers were reviewed. After thorough discussions among the researchers regarding the established criteria, 32 papers were ultimately selected for analysis (Figure 1).

Data analysis

Each of the 32 papers was listed with reference numbers and analysed according to the content analysis procedures. The researchers read and evaluated each paper, using single words, phrases or short sentences for coding. Codes with similar content were then grouped together. The questions 'What is digital health literacy?', 'What consists of digital health literacy?', 'What are the causes and results of digital health literacy, and what is associated with the concept?' and 'What should be emphasised to explain digital health literacy?' were repeatedly discussed to extract the antecedents, attributes and consequences of the concept as well as explore the directions for the development of the concept. Although all stages were repeated until the concept was clarified, the process was not entirely sequential. Finally, a deductive approach was adopted to construct the model and contrary cases of the concept, thereby enhancing the understanding of this work.

Ethics approval

This study is part of a multiphase research project aimed at developing tools to assess digital health literacy. The project includes several phases, beginning with defining the concept, which is a crucial initial step in the development stage to determine what will be measured, followed by developing and validating measurement tools. The overarching goal of the broader study is to enhance the understanding and measurement of digital health literacy to improve health outcomes and digital health engagement. This study was approved by Korea University's Institutional Review Board under protocol number KUIRB-2024-0021-11 on 20 May 2024, with initial approval granted on 14 September 2021. Notably, this particular phase of the study is a literature review focused on defining the concept. As such, it did not involve human subjects.

Results

Evolution of the conceptual definition

Table 1 illustrates the previous definitions of the concept. Initially coined by Norman and Skinner in 2006, eHealth literacy was defined as an individual's ability to seek, find, understand, evaluate and utilise online health information to solve health problems.[15] This definition was expanded by Bodie and Dutta in 2008, emphasising online health information use for informed health decisions,
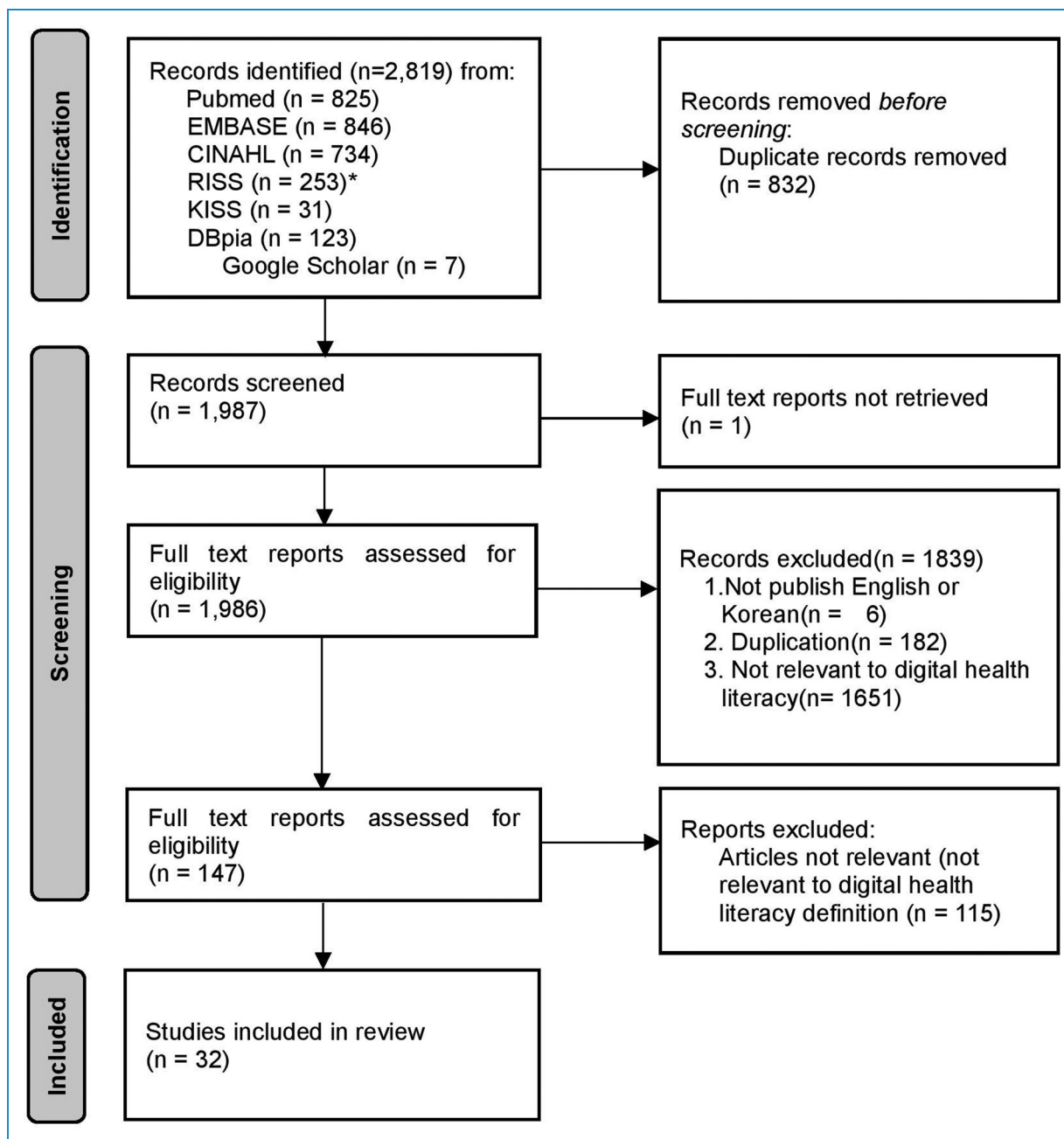
Figure 1. The flowchart of the article inclusion process (PRISMA flow diagram was derived).
Note. Asterisk '*' denotes that while we exclusively incorporated published papers, one article focused on the measurement of digital health literacy stemmed from a dissertation that conceptualized digital health literacy. Consequently, this particular paper was manually sourced through RISS, representing the only dissertation included in our study.

specifically the capability to answer health-related questions.[26] In 2011, Norman further refined the concept, positioning eHealth literacy as a foundation of skillsets that supports information and communication technology use in health and introducing a structured framework of necessary competencies.[23]

By 2014, definitions began to more prominently incorporate contextual and social factors. Gilstad enhanced the definition by including individual abilities to identify and define health issues as well as to communicate, seek, understand, appraise and apply eHealth information within various cultural, social and situational contexts, underscoring the importance of these elements in effective eHealth use.[27] Further broadening the perspective, Norgaard et al. added, in 2015, the notion of individuals' technology utilisation, which influenced the interactions with the dimensions of

Table 1. Definitions of digital health literacy based on the prior literature.

Author, year	Concept (searched)	Definition
Norman and Skinner (2006)[15]	eHealth literacy	The ability to seek, find, understand and appraise health information from electronic sources and apply the knowledge gained to addressing or solving a health problem.
Bodie and Dutta (2008)[26]	eHealth literacy	High health literacy is not just the ability to use the Internet to find answers to health-related questions. It also entails the ability to understand the information found, evaluate the veracity of this information, discern the quality of different websites and use quality information to make informed decisions about health.
Norman (2011)[23]	eHealth literacy	A foundation of skillsets that underpins the use of information and communication technology for health.
Gilstad (2014)[27]	eHealth literacy	The ability to identify and define a health problem; communicate, seek, understand, appraise and apply eHealth information and welfare technologies in the cultural, social and situational frame, and use the knowledge critically to solve health problems.
Bautista (2015)[24]	eHealth literacy	The interplay of individual and social factors in the use of digital technologies to search, acquire, comprehend, appraise, communicate and apply health information in all contexts of healthcare with the goal of maintaining or improving quality of life throughout the lifespan.
Norgaard et al. (2015)[28]	eHealth literacy	Individuals' ability to use and benefit from eHealth technologies at the micro, meso and macro levels.
Traver et al. (2016)[19]	Digital health literacy	A key element in promoting patient empowerment. It is the process of obtaining, understanding and applying health information involving the use of information and communication technologies as environments where this process develops.
Griebel et al. (2018)[29]	eHealth literacy	A dynamic and context-specific set of individual and social factors as well as the consideration of technological constraints in the use of digital technologies to search, acquire, comprehend, communicate and create health information in all healthcare contexts with the goal of maintaining or improving quality of life throughout the lifespan.
Paige et al. (2018)[30]	eHealth literacy	The ability to locate, understand, exchange and evaluate health information from online environments in the presence of dynamic contextual factors and apply the knowledge gained across ecological levels for maintaining and improving health.
Dunn and Hazzard (2019)[22]	Digital health literacy	The degree to which individuals have the capacity to obtain, process and understand basic health information and services needed to make appropriate health decisions in the context of technology, which involves the delivery (medium) of the information as well as the extent to which the information is understood.
Yoon (2020)[a,31]	Digital technology health literacy	The ability to use digital technology to find, evaluate and communicate health-related information, including personal health records, and its utility for improving relevant clinical decisions and adopting healthy behaviours.
Hwang and Park (2021)[32]	Digital health literacy	The ability to seek relevant health information utilising digital technology to solve health problems and improve quality of life. Furthermore, it refers to the translation of health-related knowledge obtained through health information processing – finding, understanding and evaluating health information and health information communication – in the context in which individual and social factors interact.

Table 1. Continued.

Author, year	Concept (searched)	Definition
Jung et al. (2022)[20]	eHealth literacy	eHealth literacy includes attributes such as active information seeking, two-way interactive communication and information utilisation and sharing. Characteristics related to personal factors, health status, attitudes towards the Internet, socioeconomic factors, and cultural factors of older adults are antecedents of eHealth literacy. eHealth literacy enhances healthcare interest, promotes health behaviour and induces active decision-making in older adults, which ultimately improves their quality of life.

[a]Despite our inclusion criteria restricting inclusion to published papers, this particular paper warrants inclusion, as its published article references the definition of digital health technology literacy as delineated in the PhD thesis.

micro-, meso- and macro-level technology development strategies.[28] In 2018, the dialogue continued to evolve with contributions from Paige et al.[30] and Griebel et al.,[29] who considered the long-term effects of eHealth literacy over people's lifespan, with specific emphasis on interactive communication[30] and the generation of health information as integral skills.[29] In 2022, Jung et al. defined eHealth literacy with the same meanings, but in relation to the older adult population.[20]

In 2015, Bautista significantly expanded the medium of the eHealth literacy framework to digital technology, defining eHealth literacy as the interplay of individual and social factors and focusing on how digital technologies are used to search, acquire, comprehend, appraise, communicate and apply health information across all healthcare contexts.[24] This definition closely aligns with the emerging conceptualisations of digital health literacy. Introduced by Traver et al. in 2016, digital health literacy focuses on empowering patients through the process of obtaining, understanding and applying health information via digital means, which originally expanded from electronic sources.[19] Subsequent scholars such as Dunn and Hazzard in 2019, Yoon in 2020 and Hwang and Park in 2021 have each provided their definitions, focusing on the capacity to utilise digital technology for various health-related purposes, including improving clinical decisions and health behaviours and translating health-related knowledge into practical applications.[22,31,32]

Overall, the concept of eHealth literacy has evolved significantly with advancements in information and communication technology, coming to encompass various social, cultural and situational factors; interactions with technology and its potential impact on individual health throughout the lifespan. Digital health literacy was introduced as an extension of eHealth literacy, and despite terminology differences, both eHealth literacy and digital health literacy explore how individuals use health information delivered electronically and digitally. The theoretical definitions of these concepts are shaped by contextual constraints and technological advancements, which in turn determine how health information is conveyed and personal health information is managed. Hence, the scope of digital health literacy has become broader than that confined by the 'e' in 'eHealth' literacy and holds the potential for further expansion with future technological advances.

Digital health literacy attributes

Knowledge translation involves applying research findings in practical actions, with lay users taking on the role of health researchers on digitalised platforms.[30,33] Digital health literacy hence plays a fundamental role in translating health-related knowledge into actions aligned with health-related goals in the digital environment. We identified four key attributes of digital health literacy: goal-driven regulation, information processing, communication and utilisation. The conceptual structure of digital health literacy based on our findings is shown in Figure 2.

Goal-driven regulation. Goal-driven regulation is an individual's ability to monitor and regulate the knowledge translation process involving information processing, communication and utilisation to accurately meet goals. Individuals with this ability can set health-related goals based on their interests and initiatives corresponding to the health continuum and make health-related inquiries.[26–28,30,32] These goals can serve as navigational guides for goal achievement before, during and after the process of knowledge translation.[34] For example, individuals can continuously monitor their own health-related goal progression during the process of knowledge translation by remaining aware of their current situation and questioning whether their actions align with their objectives.[35] Additionally, they can coordinate the individual components involved in knowledge translation by adjusting their cognitive processes when making judgements. This is achieved through ongoing self-inquiry to assess one's own understanding, identify areas of oversight, evaluate the knowledge acquired and determine the need for further development.[35]

Information processing. Information processing is a central criterion in the original definition of digital health literacy, which encompasses the capacity to effectively structure information in a manageable manner by searching for
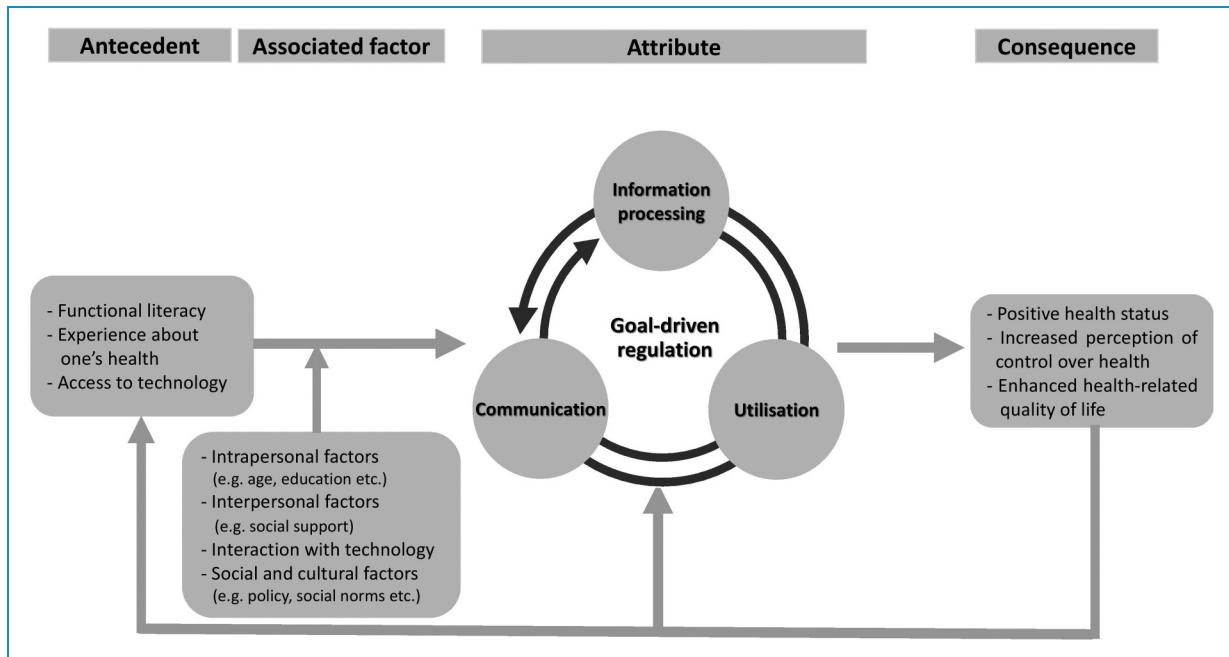
Figure 2. Conceptual structure of digital health literacy.

and navigating information,[15,20,23,24,26,27,29–32] followed by the evaluation of information quality in terms of its veracity and relevance.[15,24,26,27,30–32] Additionally, owing to the recent expansion of media that delivers information from the Internet to diverse technologies, the ability to select a target technology according to one's own needs has been incorporated into the initial step of information search.[32] Information processing also includes comprehension.[15,19,22,24,26,27,29,30,32] This comprehension is dependent on meaning-making (i.e., involving the interpretation of information contributing to the generation of subjective health knowledge related to oneself), which gives individuals a sense and awareness of their own health.[19,27] For example, through information processing, individuals can reflect on the acquired information by comparing, contrasting and integrating it with similar experiences,[24] professional advice[23] and personal health data derived from technology,[27] leading to the generation of health information suitable for their own conceptual and experiential frames.

Communication. Digital health literacy includes the capacity of the sender and receiver – including lay users, health professionals and digitalised health systems – to engage in reciprocal information exchanges and expressions.[20,23,24,29–32] By effectively establishing communication[20,30] and accurately conveying their needs to their counterparts, people can achieve their health goals.[28] In this way, people can also decide which information can be shared safely, given the context, and clearly convey health issues (e.g., medical conditions, personal health data and treatment regimens) with a

sense of responsibility.[20,23,27,30,31] Additionally, when necessary, individuals can ask targeted questions to enhance their understanding.[20]

Furthermore, some recent studies have focused on the capability to respond to others' information-seeking needs, acknowledging their potential influence on value judgements regarding health.[30] For example, Paige et al. incorporated the act of assisting others in searching for online health information to achieve their health goals into their measurement of eHealth literacy,[36] while Liu et al. highlighted responding responsibly to the information-seeking needs of others searching for health information online as a crucial communication aspect.[37] Paige et al. also suggested, despite the limitations inherent in digitalised communication, that capturing the emotional tone is an important indicator of digital health literacy,[36] and mentioned, in another study,[30] the salience of social and non-verbal cues and how they aid in building relationships and facilitating a better understanding of conversations.

Utilisation. Utilisation refers to the ability to actualise knowledge acquired from information processing and communication to actively solve health problems through disease management, prevention and rehabilitation.[15,19,20,22,24,26–32] For example, with this ability, individuals can gain a deeper understanding of their health and then make more informed decisions on medical issues and treatment procedures in collaboration with healthcare providers, acting as experts on their own health and effectively navigating the healthcare system.[38] Additionally, they can make decisions about health risk factors, adopt preventive measures and engage in healthy behaviours.[39] Moreover, people with this ability can

further engage in improving the public's understanding and utilisation of digital health resources, thereby fostering a more informed and health-literate community. This means that these individuals can act upon their digital health citizenship to potentially apply their own digital experiences and knowledge to real-world health management, ultimately enhancing health in their communities through social responsibility.[19,40,41]

Derived definition of digital health literacy

Based on the aforementioned key attributes identified in this study, digital health literacy can be defined as the ability to convert knowledge into practical actions by processing, communicating and utilising health information from digital platforms, while continually regulating the knowledge translation process aligned with one's health goals. This empowers individuals to make informed judgements related to the health continuum, ultimately enhancing their overall quality of life throughout the lifespan.

Antecedents of digital health literacy

We identified three antecedents of digital health literacy: functional literacy, prior health knowledge and experience and access to technology. Consistent with the concept of health literacy, functional literacy and prior health knowledge and experience precede the development of digital health literacy. First, digital health literacy represents an advanced level of literacy, requiring basic literacy proficiency as its foundation.[30] Therefore, to develop knowledge, individuals must possess functional literacy to read written health information and write about their health.[15]

Second, as the logical context of health information within an individual's cognitive framework, digital health literacy, which involves seeking information and being motivated to address current and potential health issues, may be influenced by prior (i.e., before the occurrence of the concept) experience and knowledge regarding the health continuum.[34] Prior experience and knowledge indeed act as fundamental references for goal setting within an individual's cognitive framework.[42] Hence, individuals can extract subjective meaning from general information guided by a goal that reflects high-priority health concerns and issues.

Finally, the concept of digital health literacy emerged with recent technological advances. As Norman mentioned, computer literacy should precede the concept of eHealth literacy,[15] as a certain level of experience related to access to technology and digital skills must exist before the development of the concept.

Consequences of digital health literacy

We identified three consequences of digital health literacy: positive health outcomes, increased perception of control over health and enhanced health-related quality of life (HRQoL). With the increased knowledge, skills and positive attitudes driven by digital health literacy, individuals can more actively engage in activities related to their health and experience positive health outcomes.[43] They can also develop increased perceived control and autonomy over health through greater engagement and empowerment,[1,43,44] which then leads to positive health outcomes owing to the effective resolution of health issues.[43,44] This, in turn, enhances HRQoL.[20,24,29,32] These consequences are viewed as integral to the constantly evolving concept of digital health literacy and may influence its evolution by impacting antecedents through the positive health outcomes driven by the concept.[45] This process fosters the development of the concept through continuous learning and improvement.[20]

Influencing factors

According to Rodgers,[14] extraneous information can sometimes provide contextual insights into the current use of a concept and its future development directions. Therefore, it is valuable to consider such information along with the main themes of a concept. We thus identified several influencing factors, unessential for concept development, of digital health literacy.

First, intrapersonal factors, including demographic and socioeconomic status, along with language[46] and location (living in rural vs. urban areas), affect the concept.[47] Moreover, a higher level of income and education has a positive effect on digital health literacy.[48,49] Regarding age, prior research finds a positive relationship with the concept in adult groups; however, a negative relationship exists among older adults.[49] Recently, Estrela et al. reported that the older population is significantly heterogeneous,[50] owing to the generation gaps in this age group, which may influence their digital health literacy through the different experiences related to the generation to which older adults belong (e.g., baby boomers) and variations in economic development and cultural issues, which afforded older adults varying opportunities to engage with technology during their era.[51] There are also issues related to the ageing process, including cognitive decline and sensory deficits (e.g., visual and auditory impairments).

Second, interpersonal factors and technological assets also influence digital health literacy. Social support from families, social networks and health professionals positively affects digital health literacy.[52] Nevertheless, an overabundance of support and assistance, particularly for older adults, may impede their digital health literacy development by usurping their opportunities to voluntarily engage with technology and digital health information, consequently rendering them passive.[53] Moreover, the attributes of digital services (e.g., user-friendliness and customisation as well as the channels, sources and modalities used for information delivery) and their shaping of

the manners by which users can interact with said services play a pivotal role in either facilitating or hindering digital health literacy.[28,30] For instance, customisation significantly tailors digital tools to user needs, enhancing the clarity, intention and practical use of information,[54–58] while the reliability and accuracy of the source of information help users judge information quality, supporting their decision-making.[59] User-friendly design such as through the adherence to Web Accessibility Initiative standards or universal design for user interfaces can also facilitate easy access to technology. Meanwhile, user information access can be supported by providing different types of channels and modalities and improving interoperability between channels.[54,57] In general, these various features hold potential in helping lower barriers and increase people's competence, confidence and effectiveness in digital tool use and information management.[28,30]

Finally, from a broader perspective, social and cultural factors, including resources, policies, social norms and healthcare accessibility, can significantly influence the development of digital health literacy in individuals.[41,46] Specifically, social changes such as shifts in disease paradigms, digitalisation and the impacts of a public health crisis (e.g., the COVID-19 pandemic) fundamentally affect societal norms and policies. These macro-level factors can significantly impact the experience of digital health literacy, especially among populations facing inequities. Specifically, they can act as barriers or facilitators that influence the presence of limited resources and competing priorities, which are more prominent in these populations.[46]

Exemplar

Model case. This subsection presents a model case of digital health literacy, namely an example that demonstrates all attributes of the concept. Mr A, a 35-year-old male, was recently diagnosed with inflammatory bowel disease, a condition his doctor described as challenging to cure and crucial to manage symptomatically in daily life. Setting a personal goal to mitigate inflammation-induced diarrhoea and pain, Mr A found it difficult to develop a practical management plan because of his lack of knowledge and experience of the disease.

To enhance his understanding and discover effective symptom management strategies, Mr A turned to online resources using a mobile phone and/or laptop. Throughout his search, he focused on ensuring the information he gathered was directly relevant to his questions about the disease and the dietary habits for disease management. He diligently sought reliable sources, constantly reminding himself to verify if the information was relevant to his specific disease management-related queries. He even ensured, when searching about this inquiry using ChatGPT, that the references of the information acquired were reliable. By comparing the information from various verified sources, he gained an understanding of the topic.

Mr A learned that the dietary response to inflammatory bowel disease could vary significantly with different types of foods, underscoring the importance of maintaining a food and symptom diary to monitor these responses. However, Mr A felt that professional advice alone was insufficient for his lifestyle, which often involved dining with others owing to his job's social nature. He began participating in online communities to share experiences and strategies related to meal choices with other patients and seek detailed advice on strategies that could be specifically tailored to his situation, aiming for clear answers that would help others understand the situation as well. Based on this shared knowledge, Mr A developed strategies for managing dining situations, such as opting for customisable meals like shabu-shabu (Japanese hotpot dish) and bibimbap (traditional Korean dish), allowing him to control the meal content more effectively.

Subsequently, he planned his diet around recommended foods and began recording his meals and symptoms using an app. Through this process, Mr A observed that his symptoms intensified after consuming meals rich in flour. Further online research revealed that while flour is not universally restricted for inflammatory bowel disease patients, individuals' tolerance to flour varies. Consequently, he decided to adjust his diet by replacing flour with white rice. Believing that his experiences could benefit others, Mr A began sharing them in one of the online communities in which he was participating. He was mindful about sharing his experiences and how they could influence others' decision-making, so he ensured that his contributions were evidence-based and clearly distinguished between his personal opinions and general advice.

Contrary case. This subsection presents a contrary case, which is an example that lacks all attributes of digital health literacy. A 30-year-old office worker, Mr B, was recently classified as being at a high risk for depression during a routine health screening and was advised that further diagnosis and medication may be necessary. Despite leading a stressful daily life, Mr B had never anticipated facing serious mental health issues and was taken aback by the screening results. However, he dismissed it as just temporary stress, reassuring himself that he would be fine. As a result, he chose to continue his usual daily life instead of seeking further hospital visits or medication.

A friend, who accidentally learned about Mr B's health condition, was concerned and shared links to YouTube videos from experts on depression prevention and management as well as links to mental health counselling on social media. Citing work-related reasons, Mr B did not take the time to look at these resources. He trivialised his symptoms as a result of mere stress and although Mr B experienced a sudden lethargy and a decrease in concentration one day, he

attributed this to a lack of sleep. Despite the recommendation for professional consult, he was reluctant to do so, fearing the social stigma and negative perceptions associated with a depression diagnosis. He hesitated to seek help from those around him and did not pursue the additional hospital treatment recommended after his high-risk diagnosis.

Related concepts of digital health literacy

According to Rodgers, related concepts are those that are somehow associated or connected with but not the same as the concept of interest.[14] Health information orientation refers to an individual's willingness to seek health-related information and find a way to self-educate about associated issues.[26] The Health Information Orientation Scale of DuBenske et al. comprises two dimensions – information engagement and apprehension – measuring health-related beliefs and healthy behaviours.[60] Dutta-Bergman identified health information orientation as the principal indicator of an individual's health orientation,[61] while DuBenske et al. considered it the underlying reason for information seeking and avoidance.[60] Hence, health information orientation is related to enhanced motivation for health-related information seeking, acting as an antecedent, associated with one's knowledge and experience with health, of digital health literacy.

Other concepts related to digital health literacy include perceived easiness (i.e., the belief that using a system will be effortless) and perceived usefulness (i.e., the belief that using a system will be beneficial). These two are integral components of the technology acceptance model,[62] and its extensions[45] are shaped by the features of the technology and significantly influence individuals' intention and engagement with digital health tools and information.[62] Recent evidence also shows that an enhanced level of digital health literacy affects perceived easiness and perceived usefulness, with the direction of their relationship being reversed.[63] Prior user experiences also impact both concepts in return.[45,64] This highlights the dynamic interplay between digital health literacy and these two key factors, which can facilitate/hinder the development of digital health literacy by increasing the likelihood of engaging with technology and digital health information, and vice versa.

Discussion

This study involved a systematic review of the literature to clarify and redefine the concept of digital health literacy. The concept analysis enabled the documentation of the evolution of the definition of digital health literacy over time as well as the identification and refinement of its current definition, essential attributes, antecedents, outcomes and influencing factors.

Regarding the evolution of the concept, advancements in information and communication technology have driven the evolution of eHealth literacy, expanding its characteristics to encompass various social, cultural and situational contexts. The theoretical definitions of eHealth literacy and digital health literacy are contextually constrained in that both have technology as a contextual driving force; specifically, it is technology that affords us the media through which health information is conveyed and personal health information is generated and distributed. According to the evolutionary approach to concept analysis proposed by Rodgers, these two concepts are not merely words but ways of use, and reflect how individuals engage with electronically or digitally delivered health information.[14] Despite the two concepts using different terminologies (e.g., one uses the term 'e' and the other the term 'digital'), their applications explore how individuals utilise electronically or digitally delivered health information for their own health. That is, while the characteristics of digital health literacy and eHealth literacy and their empirical measurement indicators may change to accommodate expansions and accompany emerging technologies, the first does not exist independently of the latter. As outlined by the authors who defined the digital health approach,[19,22] digital health literacy is an evolving term designed to broaden the scope of eHealth literacy by integrating technological advancements to improve health outcomes and allowing for the concept's continual evolution in response to technological progress.

This study's evidence underpins that digital health literacy has four critical attributes, namely goal-driven regulation, information processing, communication and utilisation. First, goal-driven regulation refers to the ability to continuously monitor the progress of knowledge translation towards a defined goal and adjust strategies as needed. Previous studies have emphasised the importance of setting goals and making inquiries when defining digital health literacy.[15,24,26,27,29,30,32] However, these prior definitions do not highlight the role of goal-driven regulation in ensuring that information acquired from the digital environment aligns with one's intended objectives. This self-regulation process corresponds to thinking about thinking, as emphasised by Norman, who highlighted the importance of metacognitive reflective strategies by means of study.[15] As mentioned, the issue with most previous studies on digital health literacy is that they did not incorporate the awareness of individuals' own information processing into the concept's definition and measurement.[65] The incorporation of this notion into the concept also showcases how our perspective aligns with Norman's view, which emphasises the importance of recognising the limitations of science as a significant pillar of the concept.[15] Hence, laypeople who assume the role of health researchers on digitalised platforms should be aware of their cognitive limitations, beliefs and thinking processes to reduce bias when engaging in knowledge generation and

application.[66] These discussions imply that the goal-driven regulation attribute of digital health literacy involves introspective contemplation in the process of exploring and selecting information. By recognising cognitive limitations, individuals can deepen their understanding of the information they seek and paradoxically establish clear boundaries. Here, the ability to regulate the entire process of knowledge translation becomes essential for maximising the long-term interests of individuals and reducing uncertainty in achieving their own health goals in a digital environment.[66,67] The goals established based on the needs and inquiries related to one's health serve, in this context, as the foundation for harmonising the functions of all components engaging in knowledge translation, providing a roadmap and maintaining cohesion among the individual attributes of digital health literacy.[34] Hence, we propose including the ability to assess whether one is addressing relevant questions and transforming knowledge into actions aligned with one's own goals. This addition to the concept of digital health literacy can help prevent errors in knowledge application owing to an enhanced awareness of the thought process.[67]

Second, information processing can reconstruct health information from digital environments by reducing its volume to an extent that is manageable and interpreting it. Previous definitions and measurements of the concept have predominantly centred on the former aspect, driven by concerns about the uncertainty related to information reliability. However, notably, even if the information acquired through digital technologies is accurate in a general sense, there is no guarantee that it will be applied accurately by individuals, as they have unique health conditions and personal characteristics that interact with their environment.[27,68] That is to say, rendering health information from digital environments manageable and meaningful, along with transforming it into personalised knowledge based on individual knowledge and experiences, serves as a bridge between written words and an individual's real-world experiences.[68] Consequently, information processing empowers people to appropriately determine the applicability of information and respond to specific requirements.[28]

Third, communication is a key aspect of the social dimension of digital health literacy.[24,29,30] It refers to the ability to effectively manage health-related communication to achieve personal health goals and collaborate with others to help them reach their objectives through active sharing and co-creation of knowledge.[20,29–32] Given that communication is a two-way process, the responsibility of determining the credibility and authority of one's own information sources should be regarded as an aspect of digital health literacy.[20,37] Communication in this context implies active participation in information production and dissemination processes within digitally networked environments.[69] This is crucial because laypeople, often seen as vulnerable to unreliable online information, may unknowingly engage with such information on a large scale. Therefore, ethics

and individual responsibility in communication should be considered within this concept.[70]

Finally, utilisation in relation to the digital health literacy concept refers to the ability to use the health knowledge gained from digital environments. Previous studies have defined knowledge translation as an attribute of digital health literacy,[30,32] whereas we consider utilisation as the final step of the knowledge translation chain that directly converts information into real-world actions. It is necessary to focus on utilisation capacity in the context of digital health literacy because not all information is translated into action. Consequently, without utilisation, there would be a gap between what people know and what they do in general,[30,71] and maximising the health benefits requires effort and encouragement to close this gap. This renders essential the development of skills and strategies to raise the awareness of the consequences of information usage, evaluation outcomes and sustainable knowledge use, all while considering personal and situational contextual factors.[30]

Additionally, we identified the antecedents, consequences and influencing factors associated with digital health literacy. Regarding antecedents, they were functional literacy, prior health knowledge and experience and access to technology. Digital health literacy enhances control over one's health, encompassing aspects such as disease management and prevention, health promotion and rehabilitation, ultimately leading to enhanced HRQoL. We also found that individuals with a relatively great need for health information owing to higher and unmet healthcare needs are often older, have lower levels of income and education, and reside in rural areas; these are all characteristics that negatively impact their level of digital health literacy.[72] While social support typically correlates positively with digital health literacy, excessive support influenced by ageism may deter older adults from engaging with digital health information. Additionally, technological interactions within specific user contexts can either promote or hinder the development of digital health literacy by affecting user perceived easiness and usefulness regarding health information resources.[63]

The consequences of the concept of digital health literacy affect its reoccurrence by continuously impacting its antecedents. Digital health literacy is considered to be a social determinant of health and is pivotal because of its dual nature: either holding great potential or exacerbating health risks.[4,41] For example, positive health outcomes facilitated by digital health literacy can serve as a motivating factor that fosters positive attitudes towards using digital health information.[45] Conversely, the underdevelopment of this concept may result in reduced digital health information use or adverse experiences stemming from safety risks or errors. This deficiency could put individuals at a disadvantage by impeding the development of their digital health literacy. This disparity indicates that

individuals with more digital health literacy may experience better health outcomes owing to their enhanced capability to navigate and make informed decisions in the digital landscape. Conversely, individuals lacking digital health literacy miss opportunities for engagement with health-related resources in digital environments, creating barriers to accessing and effectively utilising the said resources. The gap between these two groups is also generally more likely to widen, exacerbating the existing health inequity on a large scale, as this concept acts as a pivotal determinant of health.[41] Additionally, considering its associated factors, the inverse care law suggests that people with the greatest healthcare needs are the least likely to receive such care; however, this thesis does not limit the concept to the context of care.[73]

Therefore, instead of merely acknowledging the significance of digital health literacy as a pivotal determinant of health, we must also address how to manage its dual aspects. To effectively tackle this challenge, there is a need to comprehensively encourage and promote individual responsibility along with health-related community and society-level efforts – especially as the latter two can influence the impact of micro-level factors. This impact stems not only from the association of the general population's perception of digital health literacy with community and societal beliefs and attitudes towards technology and health, but also from the geographical location where individuals reside, which can impact digital access. Hence, an upstream approach to healthcare involving third-party decision-making should be adopted for the development of digital health literacy. In this context, initiatives involving the promotion of digital health education, establishment of design standards considering user diversity and formulation of policy interventions addressing age-related discrimination and digital deserts can improve digital health literacy.[46]

Implications for research and policy

Building on the established findings and focusing on healthcare provision, first, professionals should prioritise maintaining and enhancing the digital health literacy of their clients and potential clients. Healthcare providers, adept at teaching new health-related skills, should assume a pivotal role in the planning, development and dissemination of digital health literacy education programmes. To enhance practical implementation, clear protocols and guidelines for healthcare providers should also be developed, as these may facilitate the seamless integration of digital health literacy efforts into providers' regular interactions with clients.

It is also essential to identify key areas where digital health literacy interventions can be applied and promote the significance of such literacy among the general public, especially among vulnerable populations. Identifying cases in need of inclusion and advocating for the importance of their inclusion are additional critical steps to help secure a future where people have equitable access to digital health resources. This is because the provision of a much-needed intervention does not equate to intervention accessibility for individuals, underpinning the need for special focus on addressing the needs of those who are concomitantly most in need of health information and least likely to access educational programmes (e.g., those with a lack of awareness or diminished interest caused by negative past experiences with digital health tools). If individuals are unaware of the significance of digital health literacy, demand for related educational services may become minimal, potentially exacerbating health disparities.

Second, there is a need to promote the systematic development of practical educational interventions on digital health literacy that consider the attributes of the concept and tools to assess the impact of the said interventions. These tools could then also become useful for screening populations vulnerable to a lack of such literacy, facilitating targeted support. The findings of this study afford stakeholders a deeper understanding of the attributes of digital health literacy, which may then serve as a robust theoretical foundation for conceptual measurement and intervention. These implications help address historical limitations in the related literature and may help enhance the robustness of the results of future studies.

However, simply accounting for the attributes of digital health literacy does not secure intervention success or adoption. Instead of designing and developing digital services solely from the provider's perspective or based on assumptions about users' digital literacy, it may be wiser to adopt participatory approaches that incorporate end-users' experiences, opinions and needs, as these can significantly enhance the success and user satisfaction of these programmes.[21] To make participatory approaches feasible, the system design process should secure the involvement of all stakeholders (e.g., providers, developers, clients and their caregivers) in value co-creation whenever necessary.[21,74] This involvement becomes particularly crucial when services target vulnerable populations such as older adults, people with disabilities and non-native speakers, as these groups are more likely to be left out of digital services.[75] Such a tailored approach can help bridge the gap between programme development efforts and usage as well as increase sensitivity to user requirements and preferences.[74] Of importance, traditional methods of service delivery remain meaningful, especially in cases where vulnerable individuals may be excluded from digital systems due to their specific vulnerabilities. This dual approach can help mitigate the unintentional exclusion of individuals from available services, ensuring that everyone has access to the support they need.[75]

Finally, this study has political implications that support advocating digital health literacy promotion policies. The strategies mentioned in this subsection cannot and should not operate independently of policy; they rather necessitate

government action, which should create and enforce policies that promote digital health literacy. Without political advocacy, these strategies would lack the capacity to sustain their impact over the long term. Political advocacy efforts could include establishing regulations that mandate the integration of digital health literacy into healthcare education and practice, developing a framework supporting the dissemination of digital health resources, and promoting public awareness of such literacy, especially for vulnerable populations most at risk of exclusion from digitally delivered health services and care systems. Thus, a balanced and combinatory focus on the operational, educational and political dimensions should be considered to achieve equitable health – as one of the goals of digital services.

Limitations

While we conducted a systematic literature review using Rodgers's concept analysis method, we cannot rule out the possibility of the non-inclusion of some studies on digital health literacy. Additionally, although this study discussed digital health literacy in the context of solidarity with others and its overall impact on society, the discussions largely focused on the individual level. Given that individuals are not isolated from their communities, future studies could adopt a collective approach to digital health literacy and examine its impact on the general population.

Finally, although we employed Rodgers's rigorous theoretical method, it is important to acknowledge the possibility that the researchers' subjective interpretation and bias may have influenced the derivation of the conceptual attributes and definitions. For instance, we included two examples in the study to improve the understanding of the concept of digital health literacy and recognise that the authors' personal viewpoints may have influenced how these examples were constructed. In alignment with this perspective, Rodgers advocated for identifying examples from the existing literature rather than creating them; although we tried, we could not find examples from the literature that reflected all the identified attributes of digital health literacy. This can be considered to be a sign of the ongoing evolution of the concept,[14] rather than a limitation of the current research. Nonetheless, this situation calls for the further consolidation of the attributes through sustained research and additional investigation as well as discussion about these attributes as areas of interest within the field.

Conclusion

Using an evolutionary perspective, we identified the attributes of digital health literacy and derived its conceptual definition. Digital health literacy is here defined as the capacity to translate health knowledge acquired from digital environments into actions, and its conceptual attributes are four, namely goal-driven regulation, information processing, communication and utilisation. The evidence in this research represents an expansion of the concept of digital health literacy – a shift from its primary operational associations with its recognition playing a pivotal driving role in goal achievement based on user control.

Digital health literacy must be fostered to optimise the health of individuals and enhance their quality of life. Although our findings provide a current and relevant snapshot of the concept, the evolving nature of digital health literacy necessitates ongoing research to continue to uncover its dynamic aspects. Developing interventions that integrate these expanded attributes can improve public understanding of digital health literacy. Moreover, creating standardised tools to measure these attributes would support researchers in their efforts to study and advance this field.

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