

Enhancing Public Engagement with Health Information by Digital Health Literacy: A Detail Review on Role of Stakeholders, Emerging Trends, Challenges and Future Directions

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Abstract

Digital health literacy has become an essential skill in the modern health environment. It allows a person to seek, appraise, and use digital health information. The present paper is devoted to distinguishing traditional health literacy based on the ability to read and understand printed and oral health information from DHL as broader skills in information, media, and computer literacy. The role of DHL in promoting patient engagement, health equity, and improved health outcomes is emphasized while healthcare becomes increasingly reliant on digital platforms. However, digital exclusion, misinformation, and inadequate skills continue to be barriers to general adoption of DHL. DHL can be seen as a tool for reducing health disparities, particularly in disadvantaged groups. It will promote decision-making and responsible health management because people will have the skills to critically assess and use digital health information. In fact, it is a resource that cannot be ignored in public health emergencies, since it gives quick access to credible information and helps facilitate preventive care. The new emerging trends have a great deal in influencing and leveraging DHL in ways like artificial intelligence and wearing technologies.

Key Words: Digital Health Literacy, Health Equity, Digital Divide, Misinformation, Artificial Intelligence, Wearable Devices, Patient Engagement, Health Outcomes.

1. Introduction

A term that has arisen is the concept of DHL, referring to a set of skills to access, evaluate, and apply health information found in digital formats. In simpler terms, DHL means the skill of searching, understanding, evaluating, and applying health information garnered from electronic sources to health problems ("Enhancing Patient Communication Through Health Professionals' Digital Literacy", 2024). This is different from traditional health literacy, which is a set of skills that would enable one to read, understand, and use health-related information available in print and verbal forms (Patil et al., 2021). Traditional health literacy focuses on understanding health information in a static context; digital health literacy takes into consideration the dynamic nature of the digital platforms and the skills required to operate effectively in such platforms (Neter & Brainin, 2012). In this sense, the difference between digital health literacy and traditional health literacy is highly important in today's high-tech environment. Digital health literacy involves more than the basic skills required by traditional health literacy; it includes competencies such as information literacy, media literacy, and computer literacy (Hsu et al., 2014). For instance, a literate person would be able to critically evaluate the authenticity of health information online, a factor that is highly pertinent in today's scenario when there is rampant mis/disinformation on digital media (Kor et al., 2020). In addition, health management and decision-making necessitate the use of appropriate digital tools for effective communication and collaboration (Kemp et al., 2020).

Recent research indicated that the inadequacy in digital health literacy can cause negative health effects particularly in vulnerable populations (Palumbo et al., 2021). For instance, persons having low digital health literacy have

difficulty accessing trustworthy health information and therefore cannot make informed decisions regarding their health and hence hinder their ability to engage in health-promoting behaviors (Liu et al., 2022). It becomes a priority during public health emergencies like COVID-19, where the risk and hazard involved depend greatly on timely and appropriate access to health information. Improved digital health literacy enhances quality of life regarding health outcomes, especially in the prevention and promotion of healthy aging in the elderly (Liu et al., 2023). In addition, the integration of digital health technologies in healthcare environments requires strategic efforts toward meeting the digital health literacy needs of patients as well as health care professionals (Kemp et al., 2020). This involves creating educational interventions with specific competencies in digital health literacy to equip individuals in using digital health resources proficiently (Hyman et al., 2020). As digital health continues to evolve, digital health literacy will become vital in creating health equity and improving the health outcome for diverse populations (Azzopardi-Muscat & Sørensen, 2019).

In a nutshell, digital health literacy is a construct that goes beyond traditional health literacy and encompasses the skills to effectively navigate and use digital health information. As healthcare delivery becomes more digital, digital health literacy will be a vital tool for equipping people to manage their health and interact with healthcare systems effectively. Increasingly, it is seen that DHL is the most imperative competency for contemporary health care and also when the systems of the entire world shift towards a digital mode of healthcare services. Therefore, they need skills in using digital channels to acquire and critically assess health information that they are supposed to utilize. These dimensions-the role of DHL to improve patient engagement, achieve health equity, and enhance health outcomes-make its significance more vivid.

First, DHL offers a central position to improve patients' engagement. Healthcare is likely to become digital, thereby making the patients more personally responsible for managing their health issues. The results from various investigations show that high levels of digital health literacy are often associated with effective searching and comprehension and utilization of medical information for appropriate action or decisions between a patient and their physician, thereby influencing the direction of healthcare engagement (Alhur, 2023; Yang et al., 2022). For instance, patient-specific digital interventions such as Patient Decision Aids have been proven to help empower low digital literacy patients so that they are much more active in the health decisions made for them (Melhem et al., 2023). Such participation helps one on his or her health, thereby better adhering to the set treatment plans and more healthily choosing lifestyles.

The other prominent factor in DHL is health equity. The problem of digital exclusion still lingers, with the presence of people who have inequalities as far as access and comprehension of technology; this perpetuates to make things worse for already present health inequities. There has been a considerable body of evidence that necessitates moving the level of digital literacy in populations of age and socioeconomically disadvantaged towards an equalizing digital health resource access (Campanozzi et al., 2023; Kemp et al., 2020). Upon reducing the above disparities, health systems can then strive to address an all-inclusive model by allowing all individuals of every origin to enjoy benefits out of digital health innovations. This is particularly significant in the case of telemedicine and other digital health technologies, which are now an essential part of healthcare delivery (Spaulding, 2024).

Finally, DHL is closely related to better health outcomes. Research reveals that greater digital health literacy is associated with greater engagement in health-promoting behavior and good use of health services (Yang et al., 2022; Obeid, 2023). For instance, one of the studies indicated that a chance of hospitalization was correlated with less digital health literacy. So, education would also make a good intervention towards strengthening the ability of individuals in decoding health information. Again, the assessment of digital health information and making apt judgments is likely to boost the control of chronic illness, therefore bringing about an improvement of health outcomes (Rasekaba et al., 2022; Fitzpatrick, 2023).

2. Understanding Digital Health Literacy

All health information is the key competencies required to move properly in and about the digital space. Four areas can be used to categorize DHL core competencies, which are finding, understanding, evaluating, and applying digital health information.

2.1 Finding Digital Health Information

Locating proper and relevant health information on the Internet forms a cornerstone of digital health literacy. Individuals should be able to search the internet effectively for health information on websites, apps, and social media. This is very much associated with information literacy, that is the ability to search but also the ability to distinguish sources as credible or non-credible (Ashfield & Donelle, 2020; Patil et al., 2021). People who have higher degrees of digital health literacy will better identify and utilize relevant online health information crucial in the contemporary world of information that has high risks of information exposure (Dadaczynski et al., 2021; Ashfield, 2024). Other essential skills in operations, besides that of using search engines and how to access multiple digital interfaces enhance a capacity to find information (Vaart et al., 2019; Vaart&Drossaert, 2017).

2.2. Interpretation of digital health information

After a person finds health-related information, she has to understand how to understand it. This includes the most basic form of literacy; reading and primary numeracy as well as the interpretation of complex medical terms and concepts (Ashfield & Donelle, 2020; Donelle, 2024). Knowledge also involves media literacy that enables the individual to be aware of whether the information gathered is valid and applicable (Grimm et al., 2023). The skills require synthesis, and one needs to read but also understand what the health information located entails, especially in making decisions on vaccinations or chronic disease management (Ashfield & Donelle, 2020; Kor et al., 2020).

2.3. Digital Health Information Evaluation

Most essentially, evaluating the validity of health-related information will be a requirement in the context of developing digital health literacy. Some of these skills will help patients identify bias or inaccuracy, while others will support and raise awareness concerning the context around accuracy (Ashfield & Donelle, 2020; Grimm et al., 2023; Dadaczynski et al., 2021). Scientific literacy needs to be developed among individuals to distinguish between reliable health information and false claims, which is importantly needed in public health crisis situations like the COVID-19 pandemic Kor et al. (2020). Studies have also indicated that individuals who are capable of good judgment in assessments tend to make better decisions for their health and to engage in health-promoting activities (Dadaczynski et al., 2021).

2.4. Using Digital Health Information

The last is health information usage in making decisions about self-health or even effective communication with providers of health services. Beyond merely including information in individual contexts, this would be making decisions informed about healthy behaviors (Grimm et al., 2023; "Enhancing Patient Communication Through Health Professionals' Digital Literacy", 2024). For example, one may use digital technologies in chronic disease care or even the decision to take preventive treatment (Haikal et al., 2023). Adoption of digital health information also falls under the perception of the patient in regard to their ability to involve themselves with their digital health literacy, which subsequently determines the outcome of the health status of the patient (Kor et al., 2020). Thus, it describes the complex construct of competencies in seeking, understanding, judging, and applying relevant health information in digital contexts. Which means, it describes some aspects that would facilitate effective navigation of a new dimension of healthcare through technology.

Digital health literacy is increasingly recognized as an important ability in the current era of the digital age regarding health information. It includes cognitive, technical, and social skills, as well as their combined contributions to a person's ability to navigate health-related digital resources effectively. Further research on how these interactions occur could prove useful for optimizing health outcomes as well as the overall effectiveness of digital health interventions. Cognitive skills are underlying competency elements of digital health literacy as they empower any individual to process and understand health information. According to research findings, cognitive abilities have been shown to be associated with better outcomes in health literacy amongst older adults (Federman et al., 2009).

Cognitive reserve, which refers to the brain's resilience to damage, has been shown to impact health literacy skills, suggesting that maintaining cognitive engagement through social and physical activities can bolster health literacy (Kobayashi et al., 2014). Furthermore, studies have demonstrated that individuals with better cognitive performance are more adept at utilizing health information from electronic sources, thereby enhancing their eHealth literacy (Li et al., 2020). Technical skills are also just as important, as they refer to the use of digital devices, including online platforms. Digital literacy which includes technical skills is important for accessing and evaluating health information (Kaeophanuek et al., 2019). For example, older adults who develop technical skills via interaction with Web 2.0 technologies can enhance eHealth literacy, which in turn enhances their eHealth information-seeking behaviors (Tennant et al., 2015). Furthermore, the use of digital tools is related to better health outcomes because

people who are good at using digital tools can quickly find and apply health information for their personal health management (Wray et al., 2021).

Social skills also contribute to digital health literacy. Digital communication and collaboration can be a great enhancer of the ability to search and use health information. EHealth literacy has been determined by social engagement, especially in older adults, as it promotes a support network for sharing health-related knowledge (Kyaw, 2024). Socialization skills also make a person more motivated to use digital health literacy resources appropriately for sustained health management. "The intersection of social and digital literacies therefore is particularly relevant in addressing health-literacy disparities because persons with strong social networks are better positioned to understand health information in digital contexts" (Cheng et al., 2023).

3. Benefits of Digital Health Literacy

In essence, digital health literacy enhances people's access to timely and reliable health information in an ever-evolving digital world. DHL refers to the abilities and competencies that are necessary in identifying, locating, interpreting, evaluating, and utilizing health information from electronic sources (Donelle, 2024; "Improving Patient Communication Through Health Providers' Digital Literacy", 2024). This diversity in DHL is critical in enabling a person to wade through the ocean of health information available on the internet, especially in a time of crisis like the COVID-19 pandemic, when information was mostly fake (Assaye, 2023; Choukou et al., 2022). Enhanced digital health literacy will benefit the people by availing reliable health information to them. It thus means that those with good levels of DHL are more capable of recognizing between good and bad information sources, a factor, whereby misinformation is predominant in today's world (Palumbo et al., 2021). For instance, studies establish that people who have favorable DHL levels are those who are more satisfied in the online health information services offered because they can evaluate the quality and acceptability of information received, from the sources involved (Kor et al., 2020). This is what allows an individual to evaluate information; it not only allows an individual to manage their health but also allows the individual to make decisions about their health care, as informed (Koh et al., 2013; Taylor et al., 2021).

DHL also allows the understanding of complex health information, which is fundamental for proper health communication. Sørensen et al. define that health literacy is the ability to not only understand information in obtaining but also in interpreting, processing, and using this information in making decisions or proper actions (Sørensen et al., 2012). This could be necessary when people require technical jargon in communicating health information. High DHL enables a person to commit fewer mistakes owing to interpretation errors as it arms the individual with the correct skill in interpreting health information (Haikal et al., 2023). Additionally, given the reliance of digital channels for all health information, appropriate ability to interact with those channels is essential for the various populations, such as the vulnerable populations (Choukou et al., 2022; Hider et al., 2022).

Apart from offering access to health information for individuals, DHL also contributes to greater public health outcomes. Some interventions for developing digital health literacy include improving the quality and outcome of health care, such as better patient engagement and self-management of their condition (Koh et al., 2013; Liu et al., 2015). This is highly relevant in the management of chronic diseases, where a higher DHL patient is likely to be more active in his care and adherent to the treatment protocol (Taylor et al., 2021; Lee et al., 2021). Thus, DHL promotion would result in an enlightened and responsive population of patients who would end up reducing health disparities and improving the overall public health. DHL, or digital health literacy, empowers the individual to effectively access, understand, and use information from digital platforms in a manner that promotes preventive healthcare behaviors. Since most health information is now accessed online, the better one's DHL, the better one will be at negotiating the complexities of health information and engaging in preventive health behaviors.

For instance, low digital health literacy limits one's ability to judge the credibility of information online about health issues, which consequently leads to the inability to make rational health decisions. Palumbo et al. highlighted that people with poor digital health literacy will have great difficulties using information and communication technologies in relation to health promotion and risk prevention and therefore their health outcome will be affected (Palumbo et al., 2021). This assertion is supported by the findings of Vaart and Drossaert who state that digital health literacy mediates health behaviors to the extent that individuals having a high DHL score are likely to be more proactive in terms of health management and also in adopting preventive measures (Vaart&Drossaert,

2017).Moreover, Melhem et al. Point out that tailored digital interventions can enable low-literate patients to gain control over their decisions on health, thus preventive behaviors (Melhem et al., 2023).

Finally, health literacy also bears a relationship to digital health literacy. According to López, conceptualizing health and digital literacy are competency-based frameworks that draw across dimensions such as access, understanding, and the application of health information towards the individual (López, 2023). This dimensional concept puts light on the role that digital health literacy plays in this factor of health-related behaviors, particularly preventive ones. Yang et al., further buttress this by stating that the associated factor with better health status and behavior is the ability of digital health literacy which then implies that DHL may be enhanced to better serve improved health outcomes (Yang et al., 2022).

In addition, the COVID-19 pandemic has highlighted the need for digital health literacy in the timely access of health information. Older adults with low digital health literacy were found to be confronted with difficulties in the access of online health resources, and this limited their engagement in preventive health practices during the pandemic (Liu et al., 2022). In such a situation, there is a need for strategic planning of interventions that will address the gaps of literacy that can hinder health management (Kemp et al., 2020). It thus means that digital health literacy is a key factor to achieve preventive healthcare behaviors. Improvement of the ability of an individual to access, interpret, and apply health information from any digital source empowers one with DHL, enabling him or her to make informed health choices and to be more interactive in health management. There would be a need to boost health equity and effective preventive care in the health care systems amid the changing landscape of care under technological advancement.

4. Challenges and Barriers

Increasing high levels of digital health literacy is increasingly recognized as a condition required to effectively manage health in this modern day and age. However, this has come with several barriers, namely digital exclusion, misinformation, and lack of enough skills of literacy. The digital divide is one of the most significant barriers to achieving high levels of DHL, especially among vulnerable populations. This split relates to the fact of socio-demographic divisions which often separate people with digital access from those without digital access, such as, but not limited to, age, educational status, income level (Alkureishi et al., 2021). For instance, the elderly people usually face a major challenge in utilizing or accessing digital health sources mainly because of a lack of skill and low internet penetration among this age group (Levy et al., 2014). Studies have demonstrated that individuals with low health literacy are less likely to use digital health tools, thereby fostering health disparities and depriving them of access to the health information they require through the internet (Chou et al., 2011). Finally, as technology delivery has been used as a means of providing health services in most places, especially after the COVID-19 virus broke out, this has resulted in the fact that people without means and competency are, thus disenfranchised (Melhem et al., 2023).

Table 1: Core Competencies of Digital Health Literacy.

Competency	Description	Source
Finding	Locating relevant, credible health information online.	(Ashfield & Donelle, 2020)
Understanding	Interpreting medical terms and synthesizing complex information.	(Grimm et al., 2023)
Evaluating	Assessing the validity and reliability of health information.	(Dadaczynski et al., 2021)
Applying	Using information effectively in health-related decisions and behaviors.	("Enhancing Patient Communication", 2024)

Poor information is another critical problem impeding effective DHL. Inaccuracy of information propagated online can create confusion and misinterpretation among the users, mainly those who have lower digital literacy (Alhur, 2023). A study shows that people find it hard to evaluate the credibility of online health information, and such evaluation leads to a poor health outcome (Patil et al., 2021). Misinformation has also led to public health crises, such as that seen during the COVID-19 pandemic, where there were many false narratives surrounding the virus and vaccines that resulted in widespread confusion and hesitation (Vaart&Drossaert, 2017). The ability to critically evaluate online information is an essential component of DHL; however, most people do not possess the skills to successfully negotiate this challenging landscape (Diviani et al., 2015).

Low literacy skills both in general and health specific compound problems associated with DHL achievement. Low-literate patients may not understand health-related information, which is often presented in such complex formats

that require much more expertise in reading and comprehension (Wolf et al., 2012). This lack of understanding results in an inability to genuinely engage with digital health sources in a way that will help them in better management and the desired outcome in healthcare (Li et al., 2023). Moreover, at the intersection of digital and health literacy is a critical understanding: that a person will require both kinds of skills to better avail themselves of digital health tools (Zakar et al., 2021). Thus, any intervention aimed at improving DHL has to address these fundamental literacy skills to be effective. Social media proliferations, mainly by disseminating wrong and disinformation, have serious impacts on public trust in health information in the digital media. While social media enables a very fast spread of information in the health sector, they are also breeding grounds for false narratives and misleading claims. This duality therefore makes the environment complex enough where users have to live amidst credible and non-credible sources, which can ultimately affect their trust in health information.

Misinformation leads to the downfall of public trust in healthcare systems and professionals. In essence, misinformation grows in that the absence of efficient filtering and fact-checking provides leeway to unfounded beliefs and conspiracy theories to develop within a network of users (Wang et al., 2019). This phenomenon especially occurs in movements such as anti-vaccination campaigns that spread with social media, even challenging the efforts of public health and weakening public confidence in scientific expertise (Wang et al., 2019; Pickles et al., 2021). It was termed an "infodemic" in which the sheer amount of information-most untrue-causes confusion and skepticism over the credibility of health communications in a health crisis, such as the COVID-19 pandemic (Fahim et al., 2023).

Digital health literacy is a critical factor in how one engages with health information online. Warner et al. state that a person's critical thinking capacity about the credibility of health information greatly impacts his or her susceptibility to misinformation (Warner et al., 2020). Advanced levels of digital health literacy help to counteract the impacts of misinformation, leading to a more astute audience less vulnerable to false assertions (Warner et al., 2020). Conversely, low digital health literacy can fuel the spread of misinformation because people lack skills to distinguish between credible and non-credible sources (Warner et al., 2020).

Misinformation has consequences that go beyond influencing individual beliefs; they impact public health behaviors and outcomes. For example, it has been demonstrated that misinformation contributes to vaccine hesitancy, especially among populations relying on social media for health information (Jennings et al., 2021; Naqvi et al., 2022). The association between trust in health institutions and the acceptance of misinformation is crucial: those who have lower levels of trust in healthcare entities are more likely to interact with and believe in misinformation (Arambul, 2023). This leads to a vicious cycle in which misinformation devours trust and then continues to depend more on unverified sources.

Table 2: Barriers to Digital Health Literacy.

Barrier	Description	Source
Digital Divide	Limited access to technology among socio-economically disadvantaged populations.	(Alkureishi et al., 2021)
Misinformation	Proliferation of false health information, particularly during crises like COVID-19.	(Vaart&Drossaert, 2017)
Literacy Gaps	Low general and health-specific literacy limiting the ability to interpret digital information.	(Wolf et al., 2012)

In addition, the pace at which misinformation spreads through social media is appalling. Recent studies have shown that false information tends to spread much faster than if true, which puts public health messaging into a highly challenging environment (Zhou et al., 2022; Scherer et al., 2021). This overwhelming speed of false information may overwhelm the proper messages from health authorities, making it difficult for them to maintain people's trust and communicate true information (Pickles et al., 2021; Joseph et al., 2022). Thus, it can be concluded that the penetration of misinformation and disinformation has a deep and wide impact on the public trust in digital health on social media sites. This erosion of trust has become fueled by low digital health literacy, rapidity in information spread, and complexity found between individual beliefs and the credibility of institutions. For any kind of victory against challenges associated with poor digital health literacy, higher quality information on social networks, and partnerships between credible agencies and public health authorities with trusted organizations to counter myths can

be achieved. It is challenging to develop digital health literacy among marginalized populations due to a myriad of challenges in the highly technology-driven healthcare environment. Some of the challenges have included limited access to technology, inadequate digital literacy skills, and barriers to the sociocultural promotion of losing direct access to valuable digital health resources.

Some of the prominent barriers are bias against digital accessibility and internet, limiting their usability for marginalized groups. For example, people living in poverty, people from rural areas, and racial and ethnic minorities may not have an internet connection or other tools that are needed to interact appropriately with digital health (Adeleye, 2024). Digital divide makes the pre-existing health inequities even worse since those without it cannot access digital health solutions that may help them attain better health outcomes (Lyles et al., 2021). Additionally, though technology exists, people feel awkward or unsafe in availing themselves of health information in public, hence discouraging them from seeking necessary health information (Sturman, 2024). There is an urgent need for a basic form of digital literacy among marginalized peoples. Digital literacy is the capacity to interpret and apply information from a variety of digital formats. It has been advocated to be fundamental in surfing health-related information online (Spaulding, 2024). Without such skills, evaluation of the reliability of information relating to health is challenging, resulting in misinformation and poor health outcomes (Alhur, 2023). Low health literacy has been reported to have a negative relation with practicing health-promoting behaviors, which underscores the significance of arming the marginalized populations with necessary skills to skillfully employ digital health tools (Mackert et al., 2016).

Sociocultural factors significantly influence digital health literacy as well. Many of the marginalized populations may have varying levels of perceptions and understanding based on their cultural backgrounds and previous exposure to health care systems (Tappen et al., 2021). Moreover, there exists a generational gap in which older adults, especially the minority elderly, may have less confidence in utilizing digital health resources in comparison with their younger counterparts (Gordon & Hornbrook, 2018). This generational gap can further complicate the transfer of digital health literacy within families, as younger members may not effectively communicate the necessary skills to older relatives (González et al., 2020).

The challenges have been compounded and even highlighted by the COVID-19 pandemic; most of the community-based digital literacy training programs were disrupted, and this, according to Detlor et al. (2022), left the low-income populations without this basic support. According to Yameogo, 2023, therefore, there will be a need for targeted interventions in digital health that cognize the unique needs and conditions of the vulnerable populations facing higher risks for adverse health outcomes given their limited digital health literacy. This then leaves for marginalized populations the challenges of digital health literacy as issues of access, skills, and sociocultural perceptions. These would thus be comprehensively dealt with by ways of improving access to technology, enhancing education in digital literacy, and fostering an all-inclusive environment that can recognize and respect the diversified backgrounds of these populations.

5. Strategies to Enhance Digital Health Literacy

Improving DHL is a way to promote digital health literacy among diverse populations toward ensuring that equitable access to health information and services is ensured within an increasingly digital world. There are three ways to improve the methods for enhancing DHL: education initiatives, technology design considerations, and community engagement strategies. Educational initiatives play an important role in improving DHL. Research has indicated that specifically designed educational courses can effectively enhance the levels of digital health literacy in various populations, depending on initial knowledge and skill. Liu et al., for example, found that seniors in Southwest China who used professional health websites more frequently were significantly more likely to have higher levels of digital health literacy (Liu et al., 2022). For example, Alhur announced the demand for programs that focus on the population of Saudi Arabia and a specific appeal to skill upgradation in digital health technology, by Alhur, 2023. In addition, Hyman et al. showed school-based programs that could positively reach elementary students and could be relevant as content and messaging for a specified age group (Hyman et al., 2020). Such findings indicate a call for focused education intervention to reach out to various sub-groups of demographics and their distinctive features and requirements.

Not only the education, but also the design of digital health platforms has to be accessible to persons of different literacy levels. Kemp et al. argued that some of the significant causes of barriers in digital health literacy are related to social determinants of health, such as income and education level, as these limit access to digital health

technologies (Kemp et al., 2020). The health sector, therefore, needs to develop electronic innovation that would fill the gaps created as a result of the disparities. It includes the development of appropriately culturally receptive and linguistically accessible content for which Roberts et al. pointed out that the approaches of health communication need to be adjusted for reaching the diversifying population group (Roberts et al., 2017). Finally, features such as user-friendly navigation and visual aids will enhance accessibility (Hyman et al., 2020; Roberts et al., 2017).

Improving strategies for community engagement are just as relevant to improving DHL. Engagements with community leaders and organizations can facilitate outreach and education efforts with target populations. For example, the scoping review by Choukou documented the importance of awareness related to digital health services among vulnerable populations during the COVID-19 pandemic (Choukou et al., 2022). This means that community-based interventions can help fill the gap in digital health literacy through promoting trust and involvement in health activities. The Jones et al. paper provides support for an integrated approach to health and community literacy in addressing health inequities in rural and remote settings, with a strong emphasis on community engagement in health literacy activities (Jones et al., 2020).

Table 3: Strategies to Enhance DHL.

Strategy	Approach	Source
Educational Initiatives	Tailored interventions for improving digital skills in vulnerable populations.	(Hyman et al., 2020)
Tech Design	User-friendly, culturally and linguistically accessible digital tools.	(Roberts et al., 2017)
Community Engagement	Leveraging local leaders and organizations to promote health literacy education.	(Choukou et al., 2022)

Effective strategies for improving the different population groups' digital health literacy include educational interventions, human-centered designs of technology, and participation in the community through engagement approaches. Special needs in a group can be considered to contribute to an inclusive approach toward improving this kind of literacy, which benefits in the end with much better health outcomes among different populations. Health organizations and governments can collaborate to promote digital health education through intersectoral partnerships, developing the workforce's digital competencies, and supportive policies that facilitate the integration of digital health into healthcare systems. Intersectoral and transdisciplinary partnerships are important for the full exploitation of resources and expertise in digital health education. According to Iyamu et al., such partnerships have the potential to create coherent and integrated frameworks that enhance interoperability and governance in digital health initiatives. Such partnerships may involve governments, academic institutions, or private players, and such multi-dimensional collaboration may help mitigate most of the challenges to implementing effective digital health interventions (Iyamu et al., 2022). Uganda offers an example of how harmonization of digital health targets with the broader national strategic goals may represent potential areas for effective collaboration toward national public health needs (Labrique et al., 2018).

Moreover, enhancing the digital competencies of the healthcare workforce is crucial. The COVID-19 pandemic has underscored the importance for healthcare professionals to become skillful in digital health technologies toward better patient outcomes and optimized care coordination (Machleid et al., 2020). According to Edirippulige et al., digital health may empower consumers and allow better health management, thus requiring a workforce that is aware of these technologies (Edirippulige et al., 2020). Training programs on digital competencies, as suggested by Woods, are important for building healthcare professionals' ability to work with digital tools (Woods, 2023). Chen and Banerjee also point out the need for health informatics and data science in medical training, to prepare the healthcare workforce for the long term (Chen & Banerjee, 2020).

Lastly, policies and frameworks are required to promote the development of an enabling environment for digital health education. The Indian National Education Policy is in focus to train health professionals on the way to inclusive, technology-based educational policies in practice (Karan et al., 2023). Experiences through public health students by providing advocacy for policy change underscored the significance of involving emerging professionals into health education advocacy (Marquez et al., 2017). Involving students and professionals in the policy discussion

gives governments an assurance of the fact that digital health education aligns with their current and future healthcare requirements.

6. Role of Stakeholders

6.1. Healthcare Providers

Healthcare professionals are central to support for patients in this complex landscape of digital health information. This support especially improves health literacy and equitably distributes digital resources while enhancing the communication channels of the patient-provider network. Support can be delivered through a variety of avenues; however, one extremely important area pertains to the issue of health literacy within the digital space. According to Palumbo et al., new technologies, for example, artificial intelligence, will be utilized in supporting patients and caregivers to better navigate through the digital health environment and ultimately maximize their ability to find credible information online (Palumbo et al., 2021). This is very important since there is large unregulated health information on the internet, which confuses and sometimes misleads (Shen et al., 2022). Healthcare providers can educate patients about how to critically assess online health information and explain the importance of finding evidence-based resources and recommendations from reliable healthcare providers (Shen et al., 2022).

Digital equity programs should also be implemented. The Digital Access Coordinator program Rodriguez discussed is based on significant areas in the context of digital health equity, for example, digital literacy and broadband access (Rodriguez, 2024). Healthcare organizations can improve the quality of care and clinical outcomes by facilitating patient portal registration and encouraging the use of digital technologies such as continuous glucose monitoring (Rodriguez, 2024). This is a systemic approach that empowers patients but also helps bridge the digital divide, so that all patients, regardless of their background, can benefit from digital health technologies.

Training healthcare professionals in digital health literacy is another critical aspect of supporting patients. Continuous education and training in digital health literacy will provide a solid ground for healthcare professionals so that the future of their work can be integrated through effective application of the digital tools used in health care, which is proposed by Machleid et al. That is to say, "Advancements in patient-centered care entail neither reevaluating traditional relationships by itself nor a reconsideration of communication skills alone: an imperative to update education as a means for training providers in the modern, accelerating context of technological evolution" (Machleid et al., 2020). Prepared health professionals will equip other caregivers with the competencies that will help steer their patients in using better and digital resources.

Furthermore, there is an emerging role of the digital navigator in healthcare as a precious asset. Digital navigators, as stated by Wisniewski et al., can assist the patient in customizing and troubleshooting the digital health tool, which in turn ensures data quality and enhances the therapeutic alliance (Wisniewski et al., 2020). It is particularly helpful for chronic patients as treatment could be more individualized when the patient needs special handling in managing his health digitally (Schooley et al., 2020). The presence of a digital navigator in the team allows providers to administer services that are specific and tailored to the needs of an individual patient.

6.2. Tech Developers

Health care professionals are at the heart of the support for patients in this digital information health complex landscape. Support specifically strengthens health literacy and distributes the resources fairly as it enhances the communication channels of the patient-provider network. There are many ways to provide support, but one highly crucial area is the issue of health literacy in the digital world. According to Palumbo et al., new technologies, for instance, artificial intelligence, will be applied in assisting patients and caregivers to navigate the digital health environment more effectively and hence achieve their potential to seek valid information online (Palumbo et al., 2021). This is very essential since there is huge uncontrolled health information on the internet that misleads and confuses at times (Shen et al., 2022). Healthcare providers should further educate the patients on the critical thinking skills needed in critiquing online health information and educating them about evidence-based recommendations and resources provided by reliable health care professionals, according to Shen et al., 2022.

Programs for digital equity should be further implemented. The Digital Access Coordinator program which Rodriguez spoke about is built with significant areas within the context of digital health equity such as digital literacy and broadband access according to Rodriguez, 2024. Healthcare organizations can improve the quality of

care and clinical outcomes by facilitating patient portal registration and encouraging the use of digital technologies such as continuous glucose monitoring (Rodriguez, 2024). This is a systemic approach that empowers patients but also helps bridge the digital divide, so that all patients, regardless of their background, can benefit from digital health technologies.

Training health professionals on digital health literacy is another important element of enabling the patient. Continuous education and training on digital health literacy will arm health professionals with a sound foundation on which the future of their practice can be anchored through successful integration of the use of these digital tools in health care. According to Machleid et al., "Advancements in patient-centered care entail neither reevaluating traditional relationships by itself nor a reconsideration of communication skills alone: an imperative to update education as a means for training providers in the modern, accelerating context of technological evolution" (Machleid et al., 2020). Prepared health professionals will equip other caregivers with the competencies that will help steer their patients in using better and digital resources.

More so, there is an emerging role of the digital navigator in healthcare as an asset. According to Wisniewski et al., the patient can be helped by digital navigators in customizing and troubleshooting the digital health tool; hence, data quality and improved therapeutic alliance are ensured (Wisniewski et al., 2020). It is especially helpful to chronic patients because treatment can be more tailor-made when the patient needs special handling in managing his health digitally (Schooley et al., 2020). The presence of a digital navigator in the team allows providers to administer services that are specific and tailored to the needs of an individual patient.

6.3. Policy Makers

To achieve these requirements, developers have to work in a multifaceted manner that takes into consideration a user-centered design that embeds health literacy principles while including engagement with the target populations for their specific needs during development. There are several major approaches through which this can be accomplished; for instance, use of the UCD principle requires a focus on understanding the needs, preferences, and challenges of intended users. This has been known to enhance the use and performance of health applications in their involvement throughout the entire stages, including design, development, and testing. For instance, it has been researched that UCD-based application development has the possibility of fulfilling user requirements with more chances of using it for more extended periods, increasing the engagement and satisfaction rates (Schnall et al., 2016; Griffin et al., 2019). By incorporating feedback from diverse user groups, including those with low health literacy, developers can create applications that are more intuitive and easier to navigate.

Health literacy levels should also be considered during the development of an app. In fact, research has established that health literacy has a great impact on the effective use of health information technologies (Mackert et al., 2016; König, 2023). Developers should assess the literacy demands of their applications using established tools, such as Kreuter's message checklist and the Suitability Assessment of Materials instrument, to ensure that content is appropriate for users with varying literacy levels (Chen & Carbone, 2017). This ranges from simplifying the language use, clear visuals, as well as contextually pertinent information that speaks to everyday life to users. Targeted interventions and education programmers can help bridge the digital divide, especially among older people and among low health literacy populations. Digital health literacy empowerment campaigns can further enhance the way such populations utilize health information technologies (Ernsting et al., 2017).

For example, through provision of learning materials that particularly indicate exactly how to use the health applications, the confidence levels as well as competence at the user's end to adopt and sustain their use rise appreciably (Jang, 2023). Developing exciting, beautiful, and valuable interfaces would also be another focus of developers in this direction. In fact, design aspects such as the ease of using and the look-and-feel of a health application indeed matter to the decision of a user to remain interested in that application, more so for less technological users (Lau et al., 2021; Kadirvelu et al., 2023). Setting user experience as the cornerstone of the design process, developers will be able to create applications that are both functional and fun to use.

7. Emerging Trends and Future Directions

Advancements in technology, particularly artificial intelligence, machine learning, and wearable devices, will dramatically change digital health literacy. Digital health literacy is defined as the ability to seek, evaluate, and

apply electronic sources of health information in order to be more effective in health (Wang et al., 2021; Perestelo-Pérez et al., 2020). The integration of AI and machine learning into health platforms could increase accessibility and personalized health information, making the abilities of users interact and be informed about health content enhanced. For instance, in terms of navigation of health content, AI-based tools could assist with improvement while at the same time filtering out the existing misinformation that could be life-determining, for example, in the case of COVID-19 (Kumar, 2024).

Besides that, wearable devices have transformed the approach to health monitoring and management by allowing the user real-time access to health information. This personal access to their health metrics is likely to be empowering in ensuring that users take more active roles in managing their health. Several studies indicate that users of wearable technology are more health literate because they are more concerned about how to understand their health data and make informed decisions (Davaris et al., 2022; Moon et al., 2021). However, it is important to consider that access to technology does not represent meaningful use; disparities in digital health literacy can block many of the potential benefits (Moon et al., 2021; Vollbrecht et al., 2020).

Training programs aimed at the improvement of digital health literacy are important in this scenario. Such programs may empower people, particularly those belonging to the underprivileged sections, with the appropriate knowledge to make effective use of digital health resources (Hyman et al., 2020; Meherali et al., 2020). Tailored interventions that consider the needs of different populations have been found to improve health literacy outcomes considerably (Bevilacqua et al., 2021; Peralta et al., 2021). For instance, an example of such training is the ACCESS program that showed how digital health competencies in aging adults can be improved, thus facilitating better retrieval of information on health from reliable sources (Bevilacqua et al., 2021). Last but not the least is the use of social media in promoting health literacy. As youth, especially the younger generation, increases the tendency to look upon social media for health information, educational programs that utilize such resources can promote self-directed learning and raise health literacy among children and adolescence (Ayar et al., 2021). However, it is critical that these platforms are designed to be inclusive and accessible to all users, particularly those with lower health literacy levels, to avoid exacerbating existing health disparities (Moon et al., 2021; Goto et al., 2019).

Conclusion

Digital health literacy or DHL is one of the prime developments in the present modern health scenario. It helps develop an individual's capability to navigate the large and complicated digital health ecosystem properly. By bridging information access with meaningful utilization, DHL can empower the individual while enabling public health resilience as well. DHL faces incredibly important issues that touch very critical problems: digital divides, the spread of misinformation, literacy gaps-which in these times are highly impactful disproportionately on vulnerable populations. All that underlines the potential transformation with informed decision-making, improving patient engagement, and improving health equity. In fact, the integration of more recently advanced technologies such as artificial intelligence and wearable devices opens new avenues for growth and effectiveness by DHL. These tools can enable tailoring health interventions, sifting information, and providing timely views to further empower the user in charge of his health. That however requires parallel investment in education, infrastructure, and policy frameworks to ensure that these benefits are equitably shared among the people brought on by digital health technologies. This is only possible through governments, healthcare providers, technology developers, and communities joining hands in ending existing disparities and improving DHL. Such strategies that are led by stakeholders, including education initiatives, culturally inclusive digital platforms, and community-based programs, play a great role in ensuring that every individual has access to DHL. Supportive policies developed by policymakers must integrate DHL into health and educational systems, ensuring that citizens become digitally literate.

Author Contributions

The original draft was prepared by the first author and the study supervisor by corresponding author, who also makes important critical adjustments. All authors reviewed the manuscript and gave their approval for submission and pledging to accept responsibility for all aspects of the work.

Conflict of Interest

The authors declare no conflicts of interest related to this study.

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