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Addressing health literacy in the digital domain: insights from a literature review

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Abstract

Purpose – Promoting health literacy, i.e. the ability to access, collect, understand and use health-related information, is high on the health policy agenda across the world. The digitization of health-care calls for a reframing of health literacy in the cyber-physical environment. The article systematizes current scientific knowledge about digital health literacy and investigates the role of health-care organizations in delivering health literate health-care services in a digital environment.

Design/methodology/approach – A literature review was accomplished. A targeted query to collect relevant scientific contributions was run on PubMed, Scopus and Web of Science. A narrative approach was undertaken to summarize the study findings and to envision avenues for further development in the field of digital health literacy.

Findings – Digital health literacy has peculiar attributes as compared with health literacy. Patients may suffer from a lack of human touch when they access health services in the digital environment. This may impair their ability to collect health information and to appropriately use it to co-create value and to co-produce health promotion and risk prevention services. Health-care organizations should strive for increasing the patients' ability to navigate the digital health-care environment and boosting the latter's value co-creation capability.

Practical implications – Tailored solutions should be designed to promote digital health literacy at the individual and organizational level. On the one hand, attention should be paid to the patients' special digital information needs and to avoid flaws in their ability to contribute to health services' co-production. On the other hand, health-care organizations should be involved in the design of user-friendly e-health solutions, which aim at engaging patients in value co-creation.

Originality/value – This contribution is a first attempt to systematize extant scientific knowledge in the field of digital health literacy specifically focused on the strategies and initiatives that health-care organizations may take to address the limited digital health literacy pandemic.

Keywords Digital health literacy, Patient empowerment, Patient engagement, Co-creation, Co-production

Paper type General review

1. Introduction

Health literacy has been originally conceived of as the "*. . . the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions*" (Selden *et al.*, 2000, p. iv). Scholars have argued the limitation of this conceptualization of health literacy, maintaining that a focus should be put on the ability of people to factually contribute to health promotion and risk prevention services in light of the health-care system's demands and complexity (Pleasant *et al.*, 2016). Embracing this perspective, health literacy results from the combination of two components: (1) individual health literacy, i.e. the individual proficiency to use health-related information

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to navigate the health-care service system (Ancker *et al.*, 2020) and (2) organizational health literacy, i.e. the health-care organizations' capability to establish a co-creating relationship with people, engaging them in an effort aimed at health services' co-production (Palumbo, 2016a).

Health literacy is especially relevant in the cyber-physical environment enacted by the digitization of health care (Dunn, 2020). The transition toward Health 4.0 triggers a reconceptualization of the patient–provider relationship (Wang and Lin, 2021), exploiting advanced Information and Communication Technologies (ICTs) to make the patient an active agent in the process of value co-creation and service co-production (Cavallone and Palumbo, 2020). Health literacy assumes peculiar nuances in the digital environment, reframing both the way people collect, apply and use health-related information to make decisions (Robbins and Dunn, 2019) and the exchanges between patients and health-care providers (Taylor *et al.*, 2020). Hence, digital health literacy emerges as a new concept, which can be understood as "*. . . an extension of health literacy within the context of technology or electronic sources of information to understand and address any health problem*" (Zakar *et al.*, 2021, p. 4010). In particular, digital health literacy entails the ability to access and use ICTs and digital tools to co-design and/or co-deliver services intended to health promotion and risk prevention, contributing to the advancement of individual and collective well-being (Azzopardi-Muscat and Sørensen, 2019).

Research in the field of digital health literacy has burgeoned in the last few years, nurtured by the increasing pervasiveness of ICTs in the functioning of the health-care system (Meskó *et al.*, 2017). Scholars and practitioners interested in this research stream have paid attention to different topics, such as the importance of digital skills enabling people to access and use health information in the cyber-physical domain (Vaz de Almeida, 2021), the need for addressing disparities triggered by uneven digital health literacy skills of disadvantaged and/or underserved groups of the population (Smith and Magnani, 2019), and the contribution of digital health literacy in making people able to cope with unprecedented health challenges – e.g. the coronavirus disease (COVID-19) pandemic – which put individual and collective well-being under stress (Patil *et al.*, 2021).

Even though previous studies emphasized that promoting individual and organizational digital health literacy is an essential requisite for achieving better health outcomes and, consequently, for contributing to the sustainability of the health-care system (Rodriguez *et al.*, 2020), only few initiatives have been implemented across the world to enable people to navigate the digital health-care system effectively (Mein *et al.*, 2012; Palumbo, 2016b; Schmidt-Kaehler *et al.*, 2021). This prevents us from understanding comprehensively what are the factors that pave the way for an improvement of digital health literacy at the individual and organizational levels and to appreciate the implications of limited digital health literacy on the functioning of the health-care system (Putri *et al.*, 2020).

The article intends to fill this knowledge gap in the scientific literature, reporting the findings of a systematic review aimed at unveiling the state of the art of extant research in the field of digital health literacy. Drawing on the introductory notes reported above, three research questions (R.Q.) informed this paper:

RQ1. What are the main components of digital health literacy?

RQ2. What are the consequences of limited digital health literacy?

RQ3. What initiatives should be taken to foster digital health literacy at the individual and organizational levels?

The article is organized as follows. Section 2 provides some information about the methodological approach which was followed to collect, analyze and select relevant scientific

contributions to be included in this literature review. Findings are reported in Section 3, which provides some food for thought to answer the RQs reported above. Section 4 critically discusses the study results, envisioning the main conceptual and practical implications of this review. Lastly, Section 5 ends up the paper, pointing out some avenues for further developments.

2. Methods

The Scientific Procedures and Rationales for Systematic Literature Reviews (SPAR-4-SLR) protocol was followed to conduct this literature review (Paul *et al.*, 2021). The use of a systematic approach allowed us to deliver a comprehensive state of art overview of the research topic and, in light of it, to frame an agenda to advance scientific knowledge in the review domain being investigated (Paul and Criado, 2020). A pragmatic logic inspired our journey in the digital health literacy research field. More specifically, as depicted in Figure 1, our study protocol consisted of four main steps, each of which was further articulated in two sub-steps. The literature review kicked off with an assembling stage (step 1), during which a reliable set of scientific contributions representing the state of the art in the field of digital health literacy was collected. In the identification phase (sub-step 1a), the sources queried in order to build the initial dataset of scientific contributions included in this literature review were spotted. Following the approach taken in other studies aimed at investigating the individual ability to deal with health information available on the Internet (e.g. Wang *et al.*, 2019 and Hosseinzadeh *et al.*, 2021), three citation databases were queried: (1) Elsevier's Scopus, one of the richest scientific resources for conducting systematic literature review indexing more than 1.7 billion references dating back to 1970s; (2) Clarivate Analytics' Web of Science (WoS), a published-independent global citation database listing more than 1.9 billion cited references; and (3) the National Library of Medicine's PubMed, the leading citation database for biomedical literature indexing more than 32 million citations. The conjoint use of

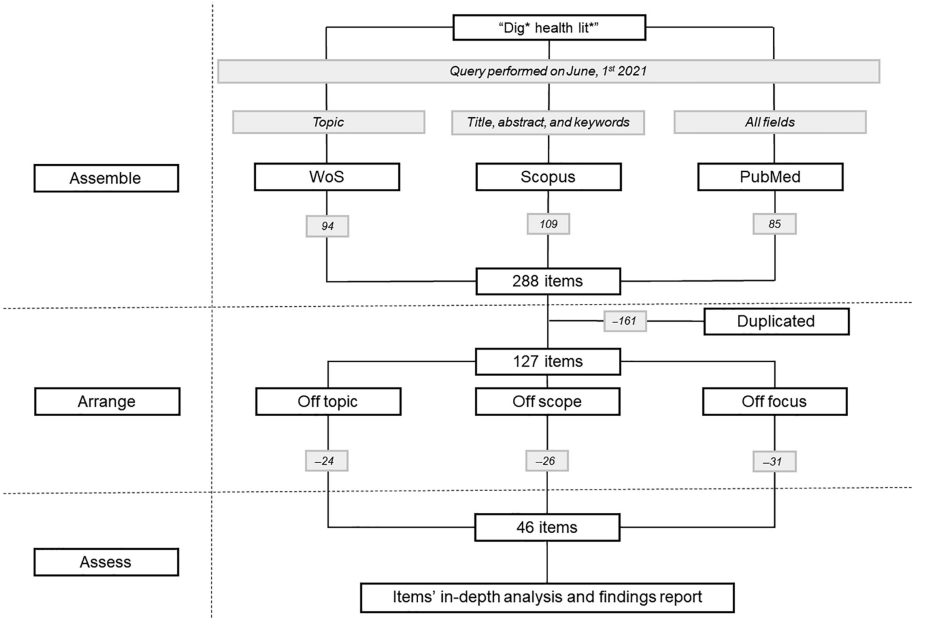

Figure 1.
The flowchart representing the study protocol

these three sources allowed us to obtain a comprehensive overview of the current scientific debate about digital health literacy.

The string to be run on the search engines of the citation databases was arranged during the assembling phase (sub-step 1b). Since we were interested in investigating the general capability of people to deal with health information available in the digital environment in order to contribute in the design and delivery of health promotion and risk prevention interventions, our attention was focused on digital health literacy exclusively, while more specific concepts concerning the individual proficiency to use electronic and mobile health services (e.g. e-health literacy and m-health literacy) were not taken into consideration (Xie, 2011; Ownby *et al.*, 2019). Going more into details, the string "*dig* health lit**" was used to assemble relevant contributions, with the asterisk (*) being used to account for any potential variations of digital health literacy-related concepts. The search string was run for "*Title, abstract, and keywords*" in Scopus, for "*Topic*" in WoS and for "*All fields*" in PubMed. No time constraints were set. Only articles which were either written in English or whose abstract was available in English were admitted in this literature review. The query was run on all the citation databases on June 1, 2021, and it delivered 288 records.

The arrange stage (step 2) followed, during which arrangements were made to screen the collected items (step 2a) and to select the contributions to be included in the final analysis (step 2b). First, the items were organized in an electronic worksheet, which was shared among the authors to conduct preliminary screening activities. The items were ordered by title, authors' surname and name, and publication year to facilitate the identification of duplicate records. A consistent part of the items was removed from the electronic worksheet (55.9%) as they were retrieved in more than one citation database. Hence, 127 records were retained. Next, the criteria for items' screening were devised. Three exclusion criteria were adopted: (1) the records which did not focus on digital health literacy, but indirectly touched it as a phenomenon involved in the digitization of health-care service delivery were rejected as "*off topic*"; (2) the records which provided insights into the assessment of digital health literacy, but did not discuss implications about the antecedents and/or the consequences of digital health literacy were discarded as "*off scope*"; and (3) the records which addressed conceptual and/or policy issues related to digital health literacy, but did not delve into its practical implications were retracted as "*off-focus.*" The authors independently screened the items, considering the criteria which were developed in the previous stage. Once the authors completed their individual analysis, a meeting was organized to discuss the results of screening activities and to settle inconsistencies. Authors agreed on the exclusion of 30 items, of which 10 were "*off topic*," 8 were "*off scope*" and 12 were "*off focus.*" There was a disagreement on the exclusion of 73 items. The authors carefully analyzed each item and presented their arguments supporting either the inclusion or the exclusion of the contested items. At the end of this stage, the authors agreed on the exclusion of 51 records, of which 14 were "*off topic*," 18 were "*off scope*" and 19 were "*off focus*." Hence, 46 items were included in this literature review.

The third and last stage involved assessing the items which passed the screening phase (step 3). On the one hand, the main bibliometric characteristics of the selected items were evaluated (step 3a), providing us with an overview of the body of literature which was analyzed in this study. On the other hand, the approach to report the study findings was crafted (step 3b). An interpretive, narrative approach was taken, which allowed us to shed light on the distinguishing attributes of digital health literacy and on its role in setting the conditions for value co-creation and service co-production in health care. The authors investigated each item involved in this literature review autonomously. An inductive manual coding approach was employed to classify the records and systematize key evidence. Once the individual analysis was accomplished, a meeting was held to discuss the outcome of

individual analyses. The discussion paved the way for achieving a consensus on the items' interpretation, inspiring the report of the study's results.

3. Findings

3.1 An overview of selected literature

As previously anticipated, this literature review relied on 46 contributions. Most of them consisted of articles published in peer reviewed journals (80.4%). Review articles (17%) represented a small portion of the investigated items. None of such reviews overlapped with the purpose of our study, being focused on issues indirectly related to digital health literacy, such as the requisites for developing a digital health-care ecosystem and the competencies that health professionals should possess to cope with the digital transformation of health care. Furthermore, 7 proceedings and 1 editorial were included in this literature review.

On average, the items were cited 7 times ($\sigma = 13.9$), ranging from a minimum of 0 citation to a maximum of 74 citations. Publication years ranged from 2015 to 2021. Most of the records were published between 2020 and 2021 (58.3%). Only 2 articles were signed by a single author, with most of them being co-authored by at least 2 scholars (95.8%). Even though more than 20 different sources were taken into consideration in this review, about 1 in 3 items (29.2%) were published either in the Journal of Medical Internet Research or in the International Journal of Environmental Research and Public Health.

3.2 Unveiling the digital health literacy concept

Health care is not exempt from the effects of digitization on value creation models and service delivery approaches. The transition toward digital health implies a massive recontextualization of health promotion and risk prevention activities: preserving a people-centered perspective, the relationships among patients, caregivers and health-care providers are framed in the cyber-physical domain, with major implications on the design and delivery of health services (Machleid *et al.*, 2020). Such a recontextualization derives from a complex interdisciplinary process involving different sectors, such as medicine, management, engineering, organization studies and informatics, which concomitantly intervene in the reconfiguration of health care (Moody, 2015). Moreover, it requires that patients, informal caregivers and health-care providers develop tailored skills and competencies to navigate the digital health-care system and to overcome unprecedented barriers to a timely and appropriate access to care (Crawford and Serhal, 2020).

In this context, digital health literacy arises as "*... the result of the increasing social permeation of digital media and their use*" in the design and delivery of care (Bittlingmayer *et al.*, 2020, p. 174). Mirroring the health literacy concept, digital health literacy is understood as a twofold construct, which applies to both the spheres of health services' provision (Dratva *et al.*, 2019). On the one hand, it concerns the patients and informal caregivers' ability to use ICTs and digital resources to access, collect, understand and process available health information and to effectively interact with health-care providers in the cyber-physical domain (van der Vaart and Drossaert, 2017). The better the individual digital health literacy skills, the greater the patients and informal caregivers' ability to function in the digital environment, to exchange data through web-based artifacts with the providers of care and to actively participate in the co-design and co-delivery of health services (van der Vaart *et al.*, 2019). On the other hand, digital health literacy entails the health-care providers' capability to accomplish a transition toward a digital-based and people-centered approach to the provision of health promotion and risk prevention services, which is based on the patients' needs and ensure a fair and not discriminated access to care (Smith and Magnani, 2019).

As graphically depicted in Figure 2, digital health literacy results from the patients, informal caregivers and health-care providers' ability to build co-creating partnerships within the cyber-physical domain. Enacting a patient–provider exchange augmented by ICTs and digital technologies and directed toward co-creation, digital health literacy is conducive to (1) improving the individual and collective willingness to engage with health promotion and risk prevention initiatives; (2) enhancing the patients and informal caregivers' control over technological tools available to boost the delivery of health services; and (3) sustaining the health-care providers' motivation to exploit ICTs in order to advance the timeliness and the appropriateness of care (Kemp *et al.*, 2021).

For this to happen, patients and informal caregivers should develop the functional, relational and critical skills (Weinbergh *et al.*, 2007) which underpin their capability to retrieve and use relevant health information in the digital environment (Dadaczynski *et al.*, 2021) and to partner with health-care professionals by collecting and sharing personal health-related data (Abdolkhani *et al.*, 2019). Besides, the providers of care should be encouraged to get a greater awareness of the importance of digital health literacy to achieve a durable viability of health services' provision and to adopt a precautionary approach in interacting with patients through ICTs. This is possible by stimulating health-care professionals to acquire adequate information on the special information needs of different socio-demographic categories of patients (Amoah *et al.*, 2021), to arrange proper infrastructures to host their exchanges with patients and informal caregivers (Latulippe *et al.*, 2020) and to improve the quality of health information delivered to patients and informal caregivers via ICTs and digital tools (Park and Min, 2020).

3.3 The implications of limited digital health literacy

Digital health literacy has an empowering role. As previously anticipated, it increases the patients and informal caregivers' dexterity in navigating the digital health-care system and in handling the ICT-based channels of communication with health-care providers. Alongside enabling patients and informal caregivers to participate in health-related decision making, this permits them to be involved in the co-design and co-delivery of health services, enacting value co-creation (Dunn and Conard, 2018). This is especially true when disadvantaged and/or underserved groups of the population are concerned, such as people suffering from disabilities or those living with multiple chronic conditions, who may struggle to access

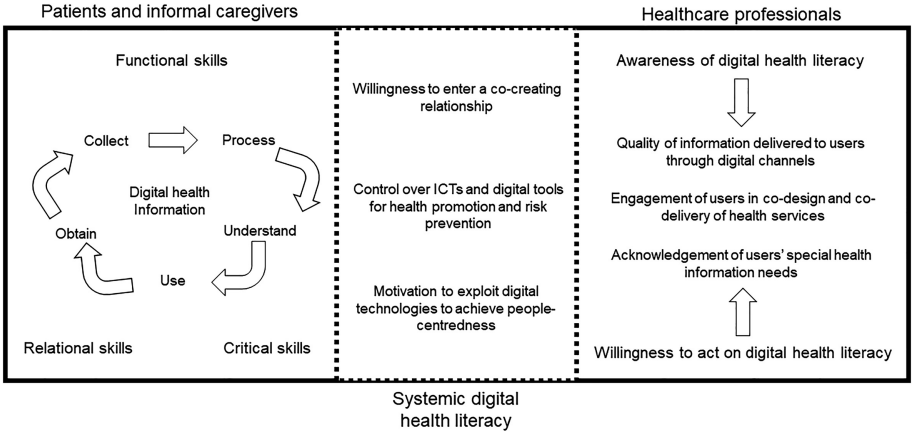

Figure 2.
The conceptualization of digital health literacy as a twofold construct

health care and to get a comprehensive and patient-centered provision of health promotion and risk prevention services (Bocevska *et al.*, 2018).

From this standpoint, inadequate digital health literacy may have major implications at the individual and the collective levels (Lindquist *et al.*, 2011). First, people with low digital health literacy skills may experience difficulties in assessing the reliability of digital health information and, consequently, may be unable to effectively use it for the purposes of health promotion and risk prevention (Pisl *et al.*, 2021). Second, those living with poor digital health literacy are expected to meet obstacles in exploiting ICTs and digital tools to access timely and relevant information about health-related issues, such as data and news available on social media (Kor *et al.*, 2021). Third, limited digital health literacy prevents people from fully complying with guidelines and prescriptions delivered by health-care providers through ICTs and digital platforms to promote individual and collective well-being (Patil *et al.*, 2021). These circumstances have severe drawback on health status (Papp-Zipernovszky *et al.*, 2021). Furthermore, such backlash is especially critical when extraordinary health challenges are faced, like the Covid-19 pandemic (Zakar *et al.*, 2021).

Digital-based functional, relational and critical digital health literacy skills are required to avoid these problems and to achieve the proficiency that is required to be actively involved in co-creating value with health-care providers in a cyber-physical environment (Pohl and Trill, 2016). Actually, engaging in health services' co-production people who live with poor digital health literacy may enact value co-destruction in the health-care system, due to the increased risks of misinterpretation of health information (Liu *et al.*, 2020). More specifically, misinterpretation impairs the individual ability to understand the causation processes which lead to improvements in the health status, to identify and use risk prevention services and to access health promotion initiatives to cope with health-related challenges (Pickles *et al.*, 2021). Alongside endangering the individual ability to deal with digital health information and to collaborate with health-care professionals in a perspective of service co-production (Benedicta *et al.*, 2020), limited digital health literacy may also have indirect negative effects on the functioning of the health-care system (Kor *et al.*, 2021). People with limited health literacy may share their misinterpreted health information via digital channels and web-based repositories, paving the way for the diffusion of untrustworthy news which nourish value co-destruction and are harmful for the sustainability of the health-care system (Bellander and Nikolaidou, 2017).

3.4 The interventions to address limited digital health literacy

Scientific literature has discussed various interventions intended to address the shortcomings generated by the pandemic of limited digital health literacy. Such initiatives are generally aimed at promoting the development of functional, relational and critical skills that are essential to enable patients, informal caregivers and health-care professionals to establish co-creating relationships in the cyber-physical context and to partner in the co-provision of health services. The advancement of functional digital health literacy concerns all the spheres involved in the design and delivery of health services. Users (i.e. patients and informal caregivers) should be involved in tailored educational activities, which are directed at providing them with the basic skills to use digital resources and ICTs in order to achieve a greater awareness of their health conditions and to consciously participate in the co-design and co-delivery of care (Beaton *et al.*, 2021). Moreover, patients and informal caregivers benefit from a greater capability to access reliable and dependable sources of health information on the Internet, where they can find adequate insights to better understand the health-related topics they are dealing with (Liobikienė and Bernatonienė, 2018). Rather than encouraging self-management of care, education initiatives and sources of information should be oriented to creating awareness about the health challenges faced,

allowing patients and informal caregivers to take informed decisions to improve their health status (Fernandez-Luque and Staccini, 2016). Providers (i.e. health-care professionals) should develop adequate functional digital health literacy skills, too. This is crucial to enable the providers of care to assist users in navigating the digital health-care system, minimizing misunderstandings and inappropriate use of health services (Montero Delgado *et al.*, 2020). Training activities delivered to health-care professionals in order to enhance their functional skills are primarily intended to enhance their capability to deliver concise and clear information to people through digital channels (Adil *et al.*, 2020), to achieve an increased consciousness of the patients' information needs (Jimenez *et al.*, 2020) and to exploit available digital tools in order to empower and engage people in value co-creation (George *et al.*, 2021). Functional competencies are especially relevant for those categories of health-care professionals who manage most of the direct interactions with patients and informal caregivers, such as general practitioners (Traver *et al.*, 2016) and nurses (Nelson and Carter-Templeton, 2016). The greater the digital health literacy skills of such providers, the greater their effectiveness in empowering patients for the purpose of value co-creation.

In addition to initiatives focused on functional digital health literacy, relational competencies should be promoted to increase the patients and informal caregivers' ability to navigate the digital health-care system and to encourage health-care professionals to co-produce health services in collaboration with users. Relational skills are critical to enable patients, informal caregivers and health-care professionals to fully take advantage of technological advancements, which enable remote consultations and permit people to get in contact with the providers of care even when the former are unable to do so physically (Barsom *et al.*, 2021). Service exchanges are hosted in digital environments, which activate a friendly environment where health-care professionals, patients and informal caregivers may interact in order to achieve a continuum of care which is consistent with the specific needs and expectations of the cared for (Furstrand *et al.*, 2021). Digital health settings pave the way for the creation of personal learning networks, which are crucial to nurture the patients and informal caregivers' relational digital skills (Konstantinidis *et al.*, 2017) and to ensure the access to timely and relevant information about issues related to health promotion and risk prevention (Sykes *et al.*, 2020).

Lastly, yet importantly, specific initiatives should be addressed to improving the critical digital health literacy skills of patients and informal caregivers, increasing their ability to discriminate across the multiple sources of information they can retrieve on the Internet. Specifically, IT systems and tools (e.g. dedicated websites, applications and social media) can significantly enhance the social support information networks for individuals who possess limited health literacy (Bickmore and Paasche-Orlow, 2012). In this context, gamification represents a critical approach to train people in developing adequate critical skills to cope with the complexity of health-related issues and to advance their proficiency in assessing the reliability of health information (Gonzalez-Rodríguez *et al.*, 2020). Moreover, innovative technologies (e.g. artificial intelligence and machine learning) should be carefully exploited to assist patients and informal caregivers in navigating the digital health-care system (Dunn and Hazzard, 2019) and to maximize their ability to retrieve trustful information from the Internet (Conard, 2019).

It is worth noting that an integrated approach should be adopted in crafting these interventions, which are intended to comprehensively promote the functional, relational and critical digital health literacy skills conducive to the establishment of a co-creating partnership between health-care professionals, patients and informal caregivers (Benis *et al.*, 2021). Such an integrated approach permits health-care professionals to handle digital health literacy and to undertake specific initiatives which are intended to put the patient at the center of interventions aimed at enhancing the quality of health promotion and risk prevention

services (Limaye *et al.*, 2015), acknowledging the special needs of underserved or underprivileged groups of people (Adawi *et al.*, 2018; Gann, 2020).

4. Discussion

The increasing pervasiveness of digital tools and ICTs in health-care makes digital health literacy a priority for health-care organizations and, in general, for the appropriate and viable functioning of the health-care systems (Stephanie and Sharma, 2020; Emmert-Streib, 2021). Digital health literacy is a dynamic and systemic batch of competencies, which consists of patients, informal caregivers and health-care professionals' functional, relational and critical skills (Paige *et al.*, 2018). It sets the conditions for building a people-centered and comprehensive approach to care in the digital environment (Kemp *et al.*, 2021), which can be realized through the promotion of a co-creating exchange between patients, informal caregivers and health-care providers (Palumbo, 2021). Focusing on the digital health literacy of patients and informal caregivers and overlooking health-care professionals' skills may have severe negative implications on the provision of digital health services, preventing the establishment of co-creating partnerships for the design and delivery of care. People with adequate digital health literacy may feel constrained by the conventional, provider-led approach to care embraced by health-care professionals with limited digital health literacy, paving the way for untrustworthy relationships and lesser willingness to co-produce health services (Marston *et al.*, 2021). Besides, promoting the health-care professionals' digital health literacy competencies without addressing the functional, relational and critical skills of patients and informal caregivers may determine increased risks of value co-destruction (Palumbo, 2017a). In this circumstance, health-care professionals may be willing to engage in the co-design and co-delivery of care people who do not have adequate competencies to navigate the digital health-care system, and this is likely to generate negative effects on the health outcomes achieved by patients and informal caregivers (Palumbo and Manna, 2018).

As reported in Figure 3, an ecosystem approach should be adopted to promote digital health literacy in the health-care domain. Patients, informal caregivers and health-care professionals should be concomitantly involved in a series of initiatives intended at

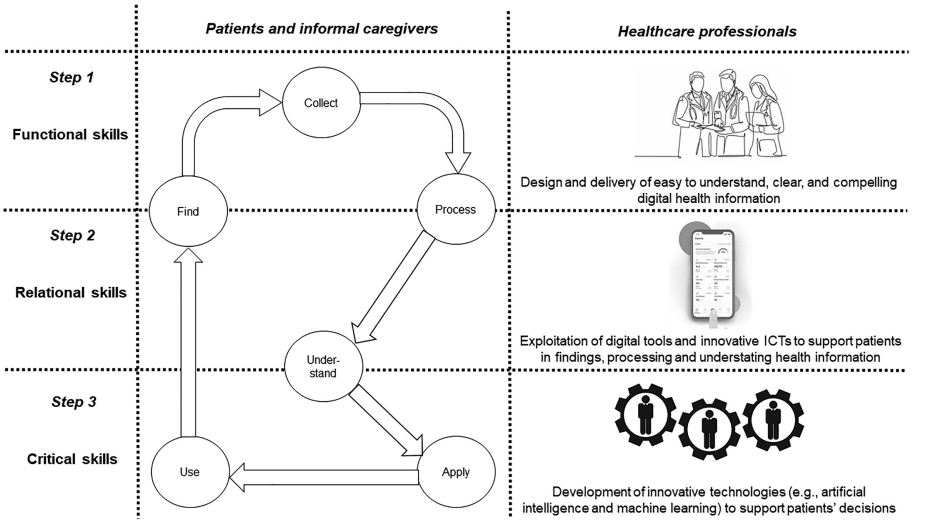

Figure 3.
An overview of the study findings

increasing their awareness of the challenges brought by the digitization of health care and at soliciting their willingness to partner for the provision of effective health promotion and risk prevention services. *Inter alia*, the application of innovative technologies to the health services' provision – such as e-health and m-health applications, tools led by artificial intelligence and machine learning, virtual and augmented-reality solutions and blockchain – put conventional health services' delivery models under stress, requiring brand new approaches to care. Even though these digital solutions pave the way for a greater participation of people in designing and delivering health services, targeted initiatives are required to make value co-creation possible in a cyber-physical health-care setting.

The development of functional skills can be understood as the first step to enable users and providers in the new digital-based context of care, conferring them with the capabilities that are needed for actively partaking in health services' co-production by leveraging available technologies (Patrício *et al.*, 2020). Next, relational skills should be nurtured, making patients, informal caregivers and health-care professionals able to exploit their functional competencies in order to establish co-creating relationships, which are essential in a perspective of value co-creation. Lastly, yet importantly, critical skills should be enhanced in an attempt to increase the patients and informal caregivers' capability to critically assess the health information available on the Internet and to properly use them in order to take informed decisions when participating in the co-production of health promotion and risk prevention services.

Inability to do so may undermine the viability of health-care systems. Inadequate digital health literacy by the side of patients and informal caregivers entails inappropriate access to care and inconsistent health decisions, which have negative drawback on individual health status. The exacerbation of health conditions triggered by this enacts a spiral of growing health-related cost, which is not financially sustainable by health-care systems (Palumbo, 2017b). Furthermore, limited digital health literacy by the side of providers is not consistent with the health policy orientation toward people-centeredness (Chao *et al.*, 2009; Sentell *et al.*, 2021). Poor digital health literacy skills are thought to bind health-care professionals to traditional approaches to care, which are based on a bio-medical interpretation of health services' delivery and understand the patient as the object – rather than the subject – of care. This may negatively affect the social and political sustainability of health-care systems, with major negative implications on the institutional legitimacy of health-care organizations. From this standpoint, digital health literacy should be conceived of as an essential ingredient of the recipe for the sustainability of health-care systems, setting the conditions for a shift toward people-centeredness and value co-creation.

Sticking to these considerations, digital health literacy configures itself as an artifact which is consistent with a shared economy approach, enabling patients and informal caregivers to participate in the functioning of health-care organizations in order to reduce costs and curtail environmental impacts (Mackrill *et al.*, 2017). From this standpoint, digital health literacy can be understood as a fundamental ingredient of the recipe for sustainability in health care, which has been the focus of health policymaking at the international level (Borgonovi *et al.*, 2018). Hence, it is not surprising that the EU4Health program drawn by the European Commission aims at strengthening health-care systems through the development of digital tools and services and stimulating a digital transformation of health-care system. In this scenario, an adequate level of digital health literacy is essential to accomplish the digital transformation of health-care in a perspective of enhanced sustainability.

5. Limitations, avenues for further research and conclusions

Findings should be read considering the main limitations which affected this literature review. First, the breadth of this research was constrained by the use of only three citation

databases to retrieve relevant scientific contributions. Nevertheless, since Scopus, WoS and PubMed provided us with a comprehensive overview of the state of the art in the field of digital health literacy, it is possible to claim the reliability of the research findings. Second, our literature review was focused on digital health literacy, while it did not account for overlapping concepts, such as e-health literacy and m-health literacy. Even though this reduced the comprehensiveness of our research, it allowed us to provide a clear-cut account of extant scientific debate on the digital health literacy research domain, enhancing the interpretation of our study results. Lastly, the narrative approach used to report the research findings may be affected by subjective biases. However, it enabled us to delve into the items included in this literature review, improving the report of the distinguishing attributes of digital health literacy.

Further research is required to push forward what we currently know about the contribution of digital health literacy to the viability of health-care systems. Future developments should be aimed at operationalizing the functional, relational and critical digital skills that patients, informal caregivers and health-care professionals should possess to enter co-producing efforts and establish co-creating relationships in the health-care environment. Besides, additional research is needed to better understand the implications which arise from limited digital health literacy: this will advance our awareness of the importance of measures aimed at promoting digital health literacy to enhance the functioning of the health-care system. Finally, there is the need for theoretical developments intended to provide us with a comprehensive conceptualization of digital health literacy, stressing its difference as compared with other constructs, such as health literacy and e-health literacy.

Research implications are twofold. From a theoretical perspective, this literature review frames digital health literacy as a fundamental ingredient of the recipe for sustainable health-care systems. Contributing to reducing costs generated by inappropriate access to care, digital health literacy concurs to strengthening the financial sustainability of health-care systems. Furthermore, by enabling value co-creation and health services' co-production, it pushes forward the social and political sustainability of health-care institutions. From a practical point of view, the study findings recommend that a systemic approach should be adopted to address the pandemic of limited digital health literacy in most of world countries. This systemic approach should be based on a conjoint intervention on patients, informal caregivers and health-care professionals' skills, promoting their functional, relational and critical competencies in a perspective of people-centeredness and value co-creation in the digital health-care environment.

References

Abdolkhani, R., Gray, K., Borda, A. and DeSouza, R. (2019), "Patient-generated health data management and quality challenges in remote patient monitoring", *JAMIA Open*, Vol. 2 No. 4, pp. 471-478.

Adawi, M., Amital, H., Mahamid, M., Amital, D., Bisharat, B., Mahroum, N., Sharif, K., Guy, A., Adawi, A., Mahagna, H., Abu Much, A., Watad, S., Bragazzi, N.L. and Watad, A. (2018), "Searching the Internet for psychiatric disorders among Arab and Jewish Israelis: insights from a comprehensive infodemiological survey", *PeerJ*, Vol. 14 No. 6, p. e4507.

Adil, A., Usman, A. and Jalil, A. (2020), "Qualitative analysis of digital health literacy among university students in Pakistan", *Journal of Human Behavior in the Social Environment*, Vol. 31 No. 6, doi: 10.1080/10911359.2020.1812462.

Amoah, P., Leung, A., Parial, L., Poon, A., Tong, H.Y., Ng, W.I., Li, X., Wong, E.M.W., Kor, P.P.K. and Molassiotis, A. (2021), "Digital health literacy and health-related well-being amid the COVID-19 pandemic: the role of socioeconomic status among university students in Hong Kong and Macao", *Asia-Pacific Journal of Public Health*, Vol. 33 No. 5, doi: 10.1177/10105395211012230.

Ancker, J., Grossman, L. and Benda, N. (2020), "Health literacy 2030: is it time to redefine the term?", *Journal of General Internal Medicine*, Vol. 35 No. 1, pp. 2427-2430.

Azzopardi-Muscat, N. and Sørensen, K. (2019), "Towards an equitable digital public health era: promoting equity through a health literacy perspective", *European Journal of Public Health*, Vol. 29 No. 3, pp. 13-17.

Barsom, E., Meijer, H., Blom, J., Schuuring, M., Bemelman, W. and Schijven, M. (2021), "Emergency upscaling of video consultation during the COVID-19 pandemic: contrasting user experience with data insights from the electronic health record in a large academic hospital", *International Journal of Medical Informatics*, Vol. 35, doi: 10.1016/j.ijmedinf.2021.104463.

Beaton, L., Williams, I. and Sanci, L. (2021), "Exploring adolescent and clinician perspectives on Australia's national digital health record, My Health Record", *Australian Journal of Primary Health*, Vol. 27 No. 2, pp. 102-108.

Bellander, T. and Nikolaidou, Z. (2017), "Building health knowledge online: parents' online information searching on congenital heart defects", *Literacy and Numeracy Studies*, Vol. 25 No. 1, pp. 4-19.

Benedicta, B., Caldwell, P. and Scott, K. (2020), "How parents use, search for and appraise online health information on their child's medical condition: a pilot study", *Journal of Paediatrics and Child Health*, Vol. 56 No. 2, pp. 252-258.

Benis, A., Tamburis, O., Chronaki, C. and Moen, A. (2021), "One digital health: a unified framework for future health ecosystems", *Journal of Medical Internet Research*, Vol. 23 No. 2, p. e22189.

Bickmore, T.W. and Paasche-Orlow, M.K. (2012), "The role of information technology in health literacy research", *Journal of Health Communication*, Vol. 17 No. 3, pp. 23-29.

Bittlingmayer, U., Dadaczynski, K., Sahrai, D., van den Broucke, S. and Okan, O. (2020), "Digital health literacy-conceptual contextualization, measurement, and promotion", *Bundesgesundheitsblatt, Gesundheitsforschung, Gesundheitsschutz*, Vol. 63 No. 2, pp. 176-184.

Bocevska, A., Savoska, S., Ristevski, B., Blazheska-Tabakovska, N. and Nedelkovski, I. (2018), "A comparison of accessible e-learning projects for improving of digital health literacy", *Sofia: The 12th Information Systems and Grid Technologies (ISGT2018) Conference*, 16-17 November.

Borgonovi, A., Adinolfi, P. and Palumbo, R. (2018), "Framing the shades of sustainability in health care: pitfalls and perspectives from western EU countries", *Sustainability*, Vol. 10 No. 12, p. 4439.

Cavallone, M. and Palumbo, R. (2020), "Debunking the myth of industry 4.0 in health care: insights from a systematic literature review", *The TQM Journal*, Vol. 32 No. 4, pp. 849-868.

Chao, S., Anderson, K. and Hernandez, L. (2009), *Toward Health Equity and Patient-Centeredness: Integrating Health Literacy, Disparities Reduction, and Quality Improvement*, Institute of Medicine, Washington, DC.

Conard, S. (2019), "Best practices in digital health literacy", *International Journal of Cardiology*, Vol. 292 No. 1, pp. 277-279.

Crawford, A. and Serhal, E. (2020), "Digital health equity and COVID-19: the innovation curve cannot reinforce the social gradient of health", *Journal of Medical Internet Research*, Vol. 22 No. 6, p. e19361.

Dadaczynski, K., Okan, O., Messer, M., Leung, A., Rosário, R., Darlington, E. and Rathmann, K. (2021), "Digital health literacy and web-based information-seeking behaviors of university students in Germany during the COVID-19 pandemic: cross-sectional survey study", *Journal of Medical Internet Research*, Vol. 23 No. 1, p. e24097.

Dratva, J., Juvalta, S., Gemperle, M., Händler-Schuster, D., Scheermesser, M. and Klamroth-Marganska, V. (2019), "Digital health literacy of health care profession students", *European Journal of Public Health*, Vol. 29 No. 4, p. ckz185.069.

Dunn, P. and Conard, S. (2018), "Digital health literacy in cardiovascular research", *International Journal of Cardiology*, Vol. 269 No. 1, pp. 274-275.

Dunn, P. and Hazzard, E. (2019), "Technology approaches to digital health literacy", *International Journal of Cardiology*, Vol. 293 No. 1, pp. 294-296.

Dunn, P. (2020), "Special issue on digital health literacy: introduction", *International Journal of Cardiology*, Vol. 299 No. 1, pp. 301-302.

Emmert-Streib, F. (2021), "From the digital data revolution toward a digital society: pervasiveness of artificial intelligence", *Machine Learning and Knowledge Extraction*, Vol. 3 No. 1, pp. 284-298.

Fernandez-Luque, L. and Staccini, P. (2016), "All that glitters is not gold: consumer health informatics and education in the era of social media and health apps. Findings from the yearbook 2016 section on consumer health informatics", *Yearbook of Medical Informatics*, Vol. 1 No. 1, pp. 188-193.

Furstrand, D., Pihl, A., Orbe, E., Kingod, N. and Søndergaard, J. (2021), "Ask a doctor about coronavirus': how physicians on social media can provide valid health information during a pandemic", *Journal of Medical Internet Research*, Vol. 23 No. 4, p. e24586.

Gann, B. (2020), "Combating digital health inequality in the time of coronavirus", *Journal of Consumer Health on the Internet*, Vol. 24 No. 3, pp. 278-284.

George, T., DeCristofaro, C. and Kershner, S. (2021), "Graduate nursing students' awareness of digital resources for patient education", *The Journal for Nurse Practitioners*, Vol. 17 No. 7, doi: 10.1016/j.nurpra.2021.03.014.

Gonzalez-Rodríguez, C., Herzog-Cruz, D. and Gonzalez-González, C. (2020), "Conversational game to improve digital health literacy", *Salamanca: Eighth International Conference on Technological Ecosystems for Enhancing Multiculturality*, 21-23 October.

Hosseinzadeh, M., Ahmed, O.H., Ehsani, A., Ahmed, A.M., Hama, H.K. and Vo, B. (2021), "The impact of knowledge on e-health: a systematic literature review of the advanced systems", *Kybernetes*, Vol. 50 No. 5, pp. 1506-1520.

Jimenez, G., Spinazze, P., Matchar, D., Koh Choon Huat, G., van der Kleij, R., Chavannes, N. and Car, J. (2020), "Digital health competencies for primary healthcare professionals: a scoping review", *International Journal of Medical Informatics*, Vol. 143 No. 1, p. 104260.

Kemp, E., Trigg, J., Beatty, L., Christensen, C., Dhillon, H., Maeder, A., Williams, P.A.H. and Kocwara, B. (2021), "Health literacy, digital health literacy and the implementation of digital health technologies in cancer care: the need for a strategic approach", *Health Promotion Journal of Australia*, Vol. 32 No. 1, pp. 104-114.

Konstantinidis, S., Wharrad, H., Windle, R. and Bamidis, P. (2017), "Semantic web, reusable learning objects, personal learning networks in health: key pieces for digital health literacy", *Studies in Health Technology and Informatics*, Vol. 238 No. 1, pp. 219-222.

Kor, P., Leung, A., Parial, L., Wong, E., Dadaczynski, K., Okan, O., Amoah, P.A., Wang, S.S., Deng, R., Cheung, T.C.C. and Molassiotis, A. (2021), "Are people with chronic diseases satisfied with the online health information related to COVID-19 during the pandemic?", *Journal of Nursing Scholarship*, Vol. 53 No. 1, pp. 75-86.

Latulippe, K., Hamel, C. and Giroux, D. (2020), "Integration of conversion factors for the development of an inclusive ehealth tool with caregivers of functionally dependent older persons: social justice design", *JMIR Human Factors*, Vol. 7 No. 3, p. e18120.

Limaye, R., Deka, S., Ahmed, N. and Mwaikambo, L. (2015), "Designing eLearning courses to meet the digital literacy needs of healthcare workers in lower- and middle-income countries: experiences from the Knowledge for Health Project", *Knowledge Management and E-Learning*, Vol. 7 No. 4, pp. 601-615.

Lindquist, L.A., Jain, N., Tam, K., Martin, G.J. and Baker, D.W. (2011), "Inadequate health literacy among paid caregivers of seniors", *Journal of General Internal Medicine*, Vol. 26 No. 5, pp. 474-479.

Liobikienė, G. and Bernatonienė, J. (2018), "The determinants of access to information on the Internet and knowledge of health-related topics in European countries", *Health Policy*, Vol. 122 No. 2, pp. 1348-1355.

Liu, P., Yeh, L.L., Wang, J.Y. and Lee, S.T. (2020), "Relationship between levels of digital health literacy based on the Taiwan digital health literacy assessment and accurate assessment of online health information: cross-sectional questionnaire study", *Journal of Medical Internet Research*, Vol. 22 No. 12, p. e19767.

Machleid, F., Kaczmarczyk, R., Johann, D., Balčiūnas, J., Atienza-Carbonell, B., von Maltzahn, F. and Mosch, L. (2020), "Perceptions of digital health education among European medical students: mixed methods survey", *Journal of Medical Internet Research*, Vol. 22 No. 8, p. e19827.

Mackrill, J., Marshall, P., Payne, S.R., Dimitrokali, E. and Cain, R. (2017), "Using a bespoke situated digital kiosk to encourage user participation in healthcare environment design", *Applied Ergonomics*, Vol. 59, pp. 342-356.

Marston, C.A., Matthews, R., Renedo, A. and Reed, J.E. (2021), "Working together to co-produce better health: the experience of the collaboration for leadership in applied health research and care for Northwest London", *Journal of Health Services Research and Policy*, Vol. 26 No. 1, pp. 28-36.

Mein, E., Fuentes, B., Soto Más, F. and Muro, A. (2012), "Incorporating digital health literacy into adult ESL education on the US-Mexico border", *Rhetoric, Professional Communication, and Globalization*, Vol. 3 No. 1, pp. 162-174.

Meskó, B., Drobni, Z., Bényei, E., Gergely, B. and Győrffy, Z. (2017), "Digital health is a cultural transformation of traditional healthcare", *mHealth*, Vol. 3 No. 1, p. 38.

Montero Delgado, J., Merino Alonso, F., Monte Boquet, E., Ávila de Tomás, J. and Cepeda Díez, J. (2020), "Key digital skills for healthcare professionals", *Educacion Medica*, Vol. 21 No. 5, pp. 338-344.

Moody, L. (2015), "User-centred health design: reflections on D4D's experiences and challenges", *Journal of Medical Engineering and Technology*, Vol. 39 No. 7, pp. 395-403.

Nelson, R. and Carter-Templeton, H. (2016), "The nursing informatician's role in mediating technology related health literacies", *Studies in Health Technology and Informatics*, Vol. 225 No. 1, pp. 237-241.

Ownby, R., Acevedo, A. and Waldrop-Valverde, D. (2019), "Enhancing the impact of mobile health literacy interventions to reduce health disparities", *Quarterly Review of Distance Education*, Vol. 20 No. 1, pp. 15-34.

Paige, S.R., Stellefson, M., Krieger, J.L., Anderson-Lewis, C., Cheong, J. and Stopka, C. (2018), "Proposing a transactional model of eHealth literacy: concept analysis", *Journal of Medical Internet Research*, Vol. 20 No. 10, p. e10175.

Palumbo, R. and Manna, R. (2018), "What if things go wrong in co-producing health services? Exploring the implementation problems of health care co-production", *Policy and Society*, Vol. 37 No. 3, pp. 368-385.

Palumbo, R. (2016a), "Designing health-literate health care organization: a literature review", *Health Services Management Research*, Vol. 29 No. 3, pp. 79-87.

Palumbo, R. (2016b), "Contextualizing co-production of health care: a systematic literature review", *International Journal of Public Sector Management*, Vol. 29 No. 1, pp. 72-90.

Palumbo, R. (2017a), "Toward a new conceptualization of health care services to inspire public health. Public national health service as a common pool of resources", *International Review on Public and Nonprofit Marketing*, Vol. 14 No. 3, pp. 271-287.

Palumbo, R. (2017b), "Examining the impacts of health literacy on healthcare costs. An evidence synthesis", *Health Services Management Research*, Vol. 30 No. 4, pp. 197-212.

Palumbo, R. (2021), "Leveraging organizational health literacy to enhance health promotion and risk prevention: a narrative and interpretive literature review", *Yale Journal of Biology and Medicine*, Vol. 94 No. 1, pp. 115-128.

Papp-Zipernovszky, O., Horváth, M., Schulz, P. and Csabai, M. (2021), "Generation gaps in digital health literacy and their impact on health information seeking behavior and health empowerment in Hungary", *Frontiers in Public Health*, Vol. 9, doi: 10.3389/fpubh.2021.635943.

Park, J. and Min, J. (2020), "Exploring Canadian pharmacy students' e-health literacy: a mixed method study", *Pharmacy Practice*, Vol. 18 No. 1, p. 1747.

Patil, U., Kostareva, U., Hadley, M., Manganello, J., Okan, O., Dadaczynski, K., Massey, P.M., Agner, J. and Sentell, T. (2021), "Health literacy, digital health literacy, and COVID-19 pandemic attitudes and behaviors in U.S. college students: implications for interventions", *International Journal of Environmental Research and Public Health*, Vol. 18 No. 6, p. 3301.

Patrício, L., Sangiorgi, D., Mahr, D., Čaić, M., Kalantari, S. and Sundar, S. (2020), "Leveraging service design for healthcare transformation: toward people-centered, integrated, and technology-enabled healthcare systems", *Journal of Service Management*, Vol. 31 No. 5, pp. 889-909.

Paul, J. and Criado, A.R. (2020), "The art of writing literature review: what do we know and what do we need to know?", *International Business Review*, Vol. 29 No. 4, p. 101717.

Paul, J., Lim, W., O'Cass, A., Wei Hao, A. and Bresciani, S. (2021), "Scientific procedures and rationales for systematic literature reviews (SPAR-4-SLR)", *International Journal of Consumer Studies*, Vol. 45 No. 4, doi: 10.1111/ijcs.12695.

Pickles, K., Cvejic, E., Nickel, B., Copp, T., Bonner, C., Leask, J., Ayrem, J., Batcup, C., Cornell, S., Dakin, T., Dodd, R.H., Isautier, J.M.J. and McCaffery, K. (2021), "COVID-19 misinformation trends in Australia: prospective longitudinal national survey", *Journal of Medical Internet Research*, Vol. 23 No. 1, p. e23805.

Pisl, V., Volavka, J., Chvojkova, E., Cechova, K., Kavalirova, G. and Vevera, J. (2021), "Dissociation, cognitive reflection and health literacy have a modest effect on belief in conspiracy theories about Covid-19", *International Journal of Environmental Research and Public Health*, Vol. 18 No. 10, p. 5065.

Pleasant, A., Rudd, R., O'Leary, C.P.-O., Allen, M.A.-L., Myers, L., Parson, K. and Rosen, S. (2016), *Considerations for a New Definition of Health Literacy*, National Academy of Medicine, Washington, DC.

Pohl, A.-L. and Trill, R. (2016), "Digital health literacy as precondition for sustainable and equal health care – a study focussing the users' perspective", in Li, H., Nykänen, P., Suomi, R., Wickramasinghe, N., Widén, G. and Zhan, M. (Eds), *Building Sustainable Health Ecosystems*, Springer, Cham, pp. 37-46.

Putri, K., Abdullah, Z., Istiyanto, S. and Anumudu, C. (2020), "The antecedents and consequences of e-health literacy in the pharmaceutical industry: an agenda for future research", *International Journal of Applied Pharmaceutics*, Vol. 12 No. 6, pp. 1-6.

Robbins, D. and Dunn, P. (2019), "Digital health literacy in a person-centric world", *International Journal of Cardiology*, Vol. 290 No. 1, pp. 154-155.

Rodriguez, J., Clark, C. and Bates, D. (2020), "Digital health equity as a necessity in the 21st century cures act era", *Journal of the American Medical Association*, Vol. 323 No. 23, pp. 2381-2382.

Schmidt-Kaehler, S., Dadaczynski, K., Gille, S., Okan, O., Schellinger, A., Weigand, M. and Schaeffer, D. (2021), "Health literacy: Germany in the digital race to catch up introduction of technological innovations is not sufficient", *Gesundheitswesen*, Vol. 83 No. 5, pp. 327-332.

Selden, C.Z., Ratzan, S. and Parker, R. (2000), *Current Bibliographies in Medicine*, National Institutes of Health, Bethesda, MD.

Sentell, T., Foss-Durant, A., Patil, U., Taira, D., Paasche-Orlow, M.K. and Trinacty, C. (2021), "Organizational health literacy: opportunities for patient-centered care in the wake of COVID-19", *Quality Management in Health Care*, Vol. 30 No. 1, pp. 49-60.

Smith, B. and Magnani, J. (2019), "New technologies, new disparities: the intersection of electronic health and digital health literacy", *International Journal of Cardiology*, Vol. 292 No. 1, pp. 280-282.

Stephanie, L. and Sharma, R. (2020), "Digital health eco-systems: an epochal review of practice-oriented research", *International Journal of Information Management*, Vol. 53, p. 102032.

Sykes, S., Wills, J., Frings, D., Church, S. and Wood, K. (2020), "Multidimensional ehealth literacy for infertility", *International Journal of Environmental Research and Public Health*, Vol. 17 No. 3, p. 966.

Taylor, C., Ancuta, C., Nagy, O., Delavega, M., Gordeev, A., Jankova, R., Kalyoncu, U., Lagunes-Galindo, I., Morovic-Vergles, J., Silva de Souza, M.P.G., Rojkovich, B., Sidiropoulos, P. and Kawakami, A. (2020), "Treatment satisfaction, expectations, patient preferences and characteristics, including digital health literacy (DHL), and the impact of suboptimal disease control in a large international cohort of patients with rheumatoid arthritis (RA)", *Annals of the Rheumatic Diseases*, Vol. 79 No. 1, pp. 996-997.

Traver, M., Basagoiti, I., Martinez-Millana, A., Fernandez-Llatas, C. and Traver, V. (2016), "Experiences of a general practitioner in the daily practice about Digital Health Literacy. The real needs", *Orlando: FL: Annual International Conference of the IEEE Engineering in Medicine and Biology Society*, 16-20 August.

van der Vaart, R. and Drossaert, C. (2017), "Development of the digital health literacy instrument: measuring a broad spectrum of health 1.0 and health 2.0 skills", *Journal of Medical Internet Research*, Vol. 19 No. 1, p. e27.

van der Vaart, R., van Driel, D., Pronk, K., Paulussen, S., te Boekhorst, S., Rosmalen, J. and Evers, A.W.M. (2019), "The role of age, education, and digital health literacy in the usability of internet-based cognitive behavioral therapy for chronic pain: mixed methods study", *JMIR Formative Research*, Vol. 3 No. 4, p. e12883.

Vaz de Almeida, C. (2021), "Digital health literacy: a future healthy choice", *International Journal of Mobile Devices, Wearable Technology, and Flexible Electronics*, Vol. 11 No. 1, pp. 1-11.

Wang, W.T. and Lin, Y.L. (2021), "Exploring social networking sites and problem-based learning in healthcare education in Taiwan: a difference analysis", *Kybernetes*, published on-line ahead of print. doi: 10.1108/K-08-2020-0535.

Wang, Y., McKee, M., Torbica, A. and Stuckler, D. (2019), "Systematic literature review on the spread of health-related misinformation on social media", *Social Science and Medicine*, Vol. 240 No. 1, p. 112552.

Weinberg, D.B., Lusenhop, R.W., Gittell, J.H. and Kautz, C.M. (2007), "Coordination between formal providers and informal caregivers", *Health Care Management Review*, Vol. 32 No. 2, pp. 140-149.

Xie, B. (2011), "Older adults, e-health literacy, and collaborative learning: an experimental study", *Journal of the American Society for Information Science and Technology*, Vol. 62 No. 5, pp. 933-946.

Zakar, R., Iqbal, S., Zakar, M. and Fischer, F. (2021a), "COVID-19 and health information seeking behavior: digital health literacy survey amongst university students in Pakistan", *International Journal of Environmental and Public Health*, Vol. 18 No. 8, pp. 4009-4029.

Zakar, R., Iqbal, S., Zakar, M. and Fischer, F. (2021b), "COVID-19 and health information seeking behavior: digital health literacy survey amongst university students in Pakistan", *International Journal of Environmental Research and Public Health*, Vol. 18 No. 8, p. 4009.

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