

Effectiveness of interventions to improve digital health literacy in forced migrant populations: A mixed methods systematic review

Achille Roghemrazangba Yameogo, Carole Délétroz, Maxime Sasseville, Samira Amil, Sié Mathieu Aymar Romaric Da, James Plaisimond, Frédéric Bergeron, Sofia Tadlaoui, Patrick Bodenmann, Marie-Pierre Gagnon

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Achille Roghemrazangba Yameogo^{1,2} MSc; Carole Délétroz^{1,3} RN, PhD; Maxime Sasseville^{1,2} RN, PhD; Samira Amil^{2,4} RD, MSc; Sié Mathieu Aymar Romaric Da^{1,2} MSc; James Plaisimond^{1,2} MSc; Frédéric Bergeron⁵ MSI; Sofia Tadlaoui² MSc; Patrick Bodenmann^{6,7} MD, MSc; Marie-Pierre Gagnon^{1,2} PhD

¹ Faculté des Sciences Infirmières Université Laval Québec CA

² VITAM - Centre de Recherche en Santé Durable Quebec CA

³ Haute École de Santé Vaud, Haute école spécialisée de Suisse occidentale Lausanne CH

⁴ École de nutrition Université Laval Québec CA

⁵ Bibliothèque Université Laval Québec CA

⁶ Faculté de biologie et de médecine, Vice-Doyen Enseignement & Diversité University of Lausanne Lausanne CH

⁷ Département Vulnérabilités et Médecine Sociale, Unisanté Centre universitaire de médecine générale et santé publique Lausanne CH

Corresponding Author:

Achille Roghemrazangba Yameogo MSc

Faculté des Sciences Infirmières
Université Laval
1050 Av. de la Médecine
Québec
CA

Abstract

Background: Digital health literacy is seen as a health determinant that can influence health and well-being, health equity, and the reduction of social inequalities in health. However, digital health literacy is often limited among forced migrant populations. They do not always have the capacity and skills to understand and evaluate health information or to access and use digital health resources appropriately.

Objective: Our objectives are as follows: (1) identify effective interventions designed to improve digital health literacy among forced migrant populations, (2) define the categories and describe the characteristics of these interventions that are designed to enhance the capabilities of forced migrants or adapt digital health services to meet the needs and expectations of forced migrant populations.

Methods: We conducted a mixed methods systematic review according to the PRISMA 2020 checklist, involving an iterative process among authors. A medical information specialist assisted in developing a search strategy for the six most relevant databases (MEDLINE, Embase, CINAHL, Web of Science, Academic Search Premier, PsycINFO) and the Google Scholar search engine, covering studies published between 2000 and 2022. Pairs reviewers selected, individually and independently, titles, abstracts, and then full texts. Data extraction and quality assessment were performed by two reviewers and validated by a senior researcher. We employed narrative synthesis to provide a comprehensive overview of effective digital health literacy interventions for forced migrant populations, highlighting the success factors of these.

Results: A total of 1,232 studies were identified, with only 6 were finally selected for narrative synthesis. Studies were excluded due to irrelevance, lack of primary data, or low methodological quality. The analysis reveals a diverse methodological landscape with a predominance of qualitative approaches aimed at understanding the challenges and needs of forced migrants concerning digital health literacy. The main challenges were associated with cultural, linguistic, and practical contexts. Interventions targeted various groups, including the elderly, those with low literacy or education, and individuals with limited digital experience. We identified four effective intervention categories to enhance digital health literacy among forced migrants: training, social support, empowerment, and educational, technological, and infrastructural support. Overall, most studies have reported positive results in terms of improving digital health literacy among forced migrants.

Conclusions: This systematic review highlights the importance of improving digital health literacy among forced migrant

populations, which enables them to promote their health and well-being. In addition, it provides comprehensive knowledge about effective interventions conducted with these groups. These findings can inform policymakers, care providers, community-based organizations as well as forced migrant populations themselves on the need to address the issue of low digital health literacy among forced migrant populations. For the future, it is therefore essential for these stakeholders to develop innovative initiatives that rely on holistic approaches and are based on the specific needs of forced migrants to improve equity and health outcomes.

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Original Manuscript

Effectiveness of interventions to improve digital health literacy in forced migrant populations: A mixed methods systematic review

Achille Roghemrazangba Yameogo^{a,b}, MSc; Carole Délétroz^{a,c}, RN, PhD; Maxime Sasseville^{a,b}, RN, PhD; Samira Amil^{b,d}, RD, MD, MSc; Sié Mathieu Aymar Romaric Da^{a,b}, MSc; James Plaisimond^{a,b}, MSc; Frédéric Bergeron^e, MSI; Sofia Tadlaoui^b, MSc; Patrick Bodenmann^{f,g}, MD, MSc; Marie-Pierre Gagnon^{a,b}, PhD

^aFaculty of Nursing, Laval University, Quebec City, QC, Canada

^bVITAM - Centre for Research in Sustainable Health, Quebec, QC, Canada

^cSchool of Health Sciences Vaud (HESAV), University of Applied Sciences and Arts Western Switzerland (HES-SO), Switzerland

^dSchool of Nutrition, Laval University, Quebec City, QC, Canada

^eLibrary, Laval University, Quebec City, QC, Canada

^fDepartment of Vulnerabilities and Social Medicine, Unisanté, Lausanne, Switzerland

^gChair of Medicine for Vulnerable Populations, University of Lausanne, Switzerland

Abstract

Background

Digital health literacy is recognized as a key determinant of health, which can impact health and well-being, health equity, and the reduction of social health disparities. However, digital health literacy is often limited among forced migrant populations, who usually lack the skills to understand and evaluate health information or to access and use digital health resources appropriately.

Objective

We aimed to: (1) identify effective interventions designed to improve digital health literacy among forced migrant populations, (2) describe their categories and characteristics of these interventions, focusing on enhancing the capabilities of forced migrants or adapting digital health services to meet their needs.

Methods

We conducted a mixed methods systematic review according to the PRISMA 2020 checklist, involving an iterative process among authors. A medical information specialist assisted in developing a search strategy for the six most relevant databases (MEDLINE, Embase, CINAHL, Web of Science, Academic Search Premier, PsycINFO) and the Google Scholar search engine, covering studies published between 2000 and 2022. Pairs reviewers selected, individually and independently, titles, abstracts, and then full texts. Data extraction and quality assessment were performed by two reviewers and validated by a senior researcher. We employed narrative synthesis to provide a comprehensive overview of effective digital health literacy interventions for forced migrant populations, highlighting the success factors of these.

Results

A total of 1,845 studies were identified, with only 6 were finally selected for narrative synthesis. Studies were excluded due to irrelevance, lack of primary data, or low methodological quality. The analysis reveals a diverse methodological landscape with a predominance of qualitative approaches aimed at understanding the challenges and needs of forced migrants concerning digital health literacy. The main challenges were associated with cultural, linguistic, and practical contexts. Interventions targeted various groups, including the elderly, those with low literacy or education, and individuals with limited digital experience. We identified four effective intervention categories to

enhance digital health literacy among forced migrants: training, social support, empowerment, and educational, technological, and infrastructural support. Overall, most studies have reported positive results in terms of improving digital health literacy among forced migrants.

Conclusions

This systematic review highlights the importance of improving digital health literacy among forced migrant populations, which enables them to promote their health and well-being. In addition, it provides comprehensive knowledge about effective interventions conducted with these groups. These findings can inform policymakers, care providers, community-based organizations, as well as forced migrant populations themselves, on the need to address the issue of low digital health literacy among forced migrant populations. For the future, it is therefore essential for these stakeholders to develop innovative initiatives that rely on holistic approaches and are based on the specific needs of forced migrants to improve equity and health outcomes.

Keywords

Digital health literacy; forced migrant populations; refugees; immigrants; interventions; education; systematic review; mixed methods

Introduction

Forced migration, defined [1] as a non-voluntary and coerced movement caused by factors such as conflicts, persecution, human rights violations, climate change, natural disasters, and famine [2], is a

growing global phenomenon. In 2023, there were approximately 117.3 million forced migrants, including 68.3 million internally displaced people, 37.6 million refugees, and 6.9 million asylum seekers [3]. These populations face significant challenges in host lands or countries, including limited access to social and health services [4,5], due to precarious migration status, discrimination, language and cultural barriers, and low incomes [6-8]. These obstacles exacerbate their vulnerability and negatively impact their physical and mental health [6,9].

Digital health (or eHealth), based on the use of information and communication technologies (ICTs) for health [10,11], could be a promising avenue to address key challenges in accessing both health information and healthcare services. This approach proves particularly relevant for forced migrant populations (FMP), including internally displaced persons, refugees, asylum seekers, and economic, political, or climate migrants [2, 12-18]. These technologies can serve as both tools and sources of health information, enabling them to improve health and reduce healthcare costs [19, 20]. The Internet is a cost-effective or free alternative to search for web-based health information [21]. Accessing health information online can also overcome language barriers by allowing users to utilize either their native language or the language of the host country [22].

Smartphones and digital platforms are technological solutions that may assist FMP in navigating complex health systems in host countries [13, 18, 23]. These digital tools enable these populations who may be unfamiliar with the organization of health systems in host countries to locate doctors, clinics, and hospitals [18]. They also facilitate access to health services, including appointment scheduling and geolocation, particularly for services near their place of residence [18].

Digital technologies help forced migrants cope with migration-related stressors and challenges in host countries while enhancing their well-being. Their resilience has been consistently linked to social ties [18, 24]. Research demonstrates that maintaining connections with community members through digital platforms, along with transnational contact with family via social media and phone calls, fosters cultural belonging, emotional and social support, and inclusion, all of which help reduce isolation and stress [18, 24, 25].

Despite the opportunities offered by ICTs, some barriers may hinder FMP from accessing and using digital health technologies [26, 27]. Individual factors such as advanced age, cognitive impairment, and lack of digital skills exacerbate these challenges [28]. Moreover, the complexity of digital tools, language barriers, and the technical nature of healthcare systems, particularly the use of specialized medical jargon, can limit access to web-based information and services [29-31]. Faced with the flood of information on social media, forced migrants may lack the skills to search for, understand, and assess health-related information, particularly to differentiate between reliable and unreliable health information [32]. Notably, this issue also affects segments of the local population [33]. Finally, in low-resource environments where many forced migrants live, limited or inadequate infrastructure, such as poor internet connectivity and restricted access to digital devices, hinders access to online health information [31, 33]. These constraints render even the best digital health interventions ineffective.

Consequently, low digital health literacy (DHL), involving all the above obstacles, is an important issue among FMP [30, 34]. Norman and Skinner [35] define DHL as “the ability to search, find, understand, and evaluate health information from numerical, electronic sources and use the information to make decisions about one’s health.” With the continuous evolution of digital as well as the increasing complexity of society and health care systems, forced migrants require additional skills, such as the ability to identify information needs, locate credible web-based health information, and interact effectively with the digital health system to improve their health and well-being [36]. Several authors [36-39] point to the need to conceptualize DHL by considering dimensions such as context and the interactions between migrants and the digital health system. Low levels of DHL could lead to poor health outcomes [40] and exacerbate disparities in access to digital health services,

contributing to health inequalities between communities [33]. Low DHL is not conducive to achieving health equity.

To address these significant challenges, various initiatives aimed at promoting better health behaviors among FMP have been developed by different stakeholders [14, 37, 40]. A comprehensive understanding of these interventions to support DHL among FMP and their effectiveness is essential for policymakers to develop tailored programs and interventions. Reliable information on effective interventions that meet the needs of forcibly displaced individuals can facilitate informed decision-making regarding both the selection of interventions and their implementation. This evidence encompasses various types of interventions (training, education, etc.), their characteristics (target population, targeted factors, adaptability to individual specifics, effectiveness, etc.), as well as the main challenges or conditions necessary for their implementation. However, to our knowledge, limited literature exists on interventions that enhance the DHL of FMP, which underscores the interest in a mixed methods systematic review.

Objectives

The overall aim of the mixed methods systematic review is to assess the effectiveness of interventions aimed at improving DHL among FMP. To achieve this general objective, two specific objectives will be pursued:

- Identify interventions designed to improve DHL among FMP, including interventions aimed at creating enabling conditions or environments that cater to the needs and expectations of FMP limited by low levels of DHL, to facilitate their access to, and use of, digital health resources.
- Define the categories and describe the characteristics of these interventions that aim to improve the abilities of forced migrants or adapt digital health services to meet the needs and expectations of FMP, limited by low levels of DHL.

Methods

Study design

We conducted a mixed methods systematic review according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 checklist for systematic reviews [41]. We registered the review protocol on PROSPERO under number CRD42022373448. It was also published in JMIR Research Protocols [42]. The general research question of our review was: how effective are interventions to improve DHL among FMP, including internally displaced persons, refugees, asylum seekers, as well as economic, political, and climate migrants?

Eligibility Criteria

The eligibility criteria of our study were defined based on the PICOS (population, intervention, comparison, outcomes, and study design) model [1, 2, 43-45] and are described in Appendix 1. We included studies targeting FMP, including internally displaced persons, refugees, and asylum seekers, as well as political, economic, and climate migrants. In addition, we included all studies focused on interventions aimed at improving DHL among FMP. As for the types of studies, there were no restrictions. We included all quantitative empirical studies, qualitative or mixed methods studies, and studies with or without a control group. We considered only studies published in English, French, Italian, Portuguese, or Spanish. We excluded editorials, commentaries, conference abstracts, protocols, and test recordings.

Search Strategy

A librarian from Université Laval (FB), who specializes in medical information and is experienced in systematic reviews, developed the search strategy in collaboration with the research team. In an iterative process between the different authors, we conducted systematic literature research in the following relevant bibliographic databases: MEDLINE (OVID), Embase, CINAHL, Web of Science, Academic Search Premier, and PsycINFO. We also used the Google Scholar search engine. This systematic research covered the period from January 01, 2000, to December 15, 2022, because the concept of “digital health” appeared in the early 2000s [46]. The search terms used were based on a combination of two key concepts, which are “Digital Health Literacy” and “Forced Migrant Population.” We developed research terms for each of these concepts from the literature and thesauri. Specific details of the strategies are presented in Appendix 2. The search results were collated and uploaded into EndNote 20 (<https://endnote.com/>) to remove duplicates were removed manually. The database was then imported to the web-based collaboration tool Covidence (Veritas Health Innovation) [47], where further duplicates were removed using the automation function before the selection of studies was started.

Study Selection and Extraction

Pairs of independent reviewers (AY, CD, SA, SMARD, JP, ST) performed the study selection in Covidence [47], where the inclusion and exclusion criteria were added, first screening abstracts and titles, then the full text of relevant studies. Disagreements were resolved through discussion, and any remaining conflicts were resolved by a third reviewer (MPG). After study selection, we created a data extraction sheet using Excel and Microsoft Office, piloted it on three studies, and refined it for extraction. The final form included study characteristics, health issues, and DHL challenges, targeted population, interventions to improve DHL and their characteristics, and study results. Finally, two reviewers (AY, CD) extracted data, and a senior reviewer (MPG) validated them.

Quality data analysis

Quality assessment is used to describe the selected articles and to interpret the data in the synthesis. Two reviewers (AY, SA) independently assessed the quality of studies using the Mixed Methods Appraisal Tool (MMAT) [48]. Using five methodological quality criteria for different designs (qualitative research, randomized controlled trials, non-randomized studies, quantitative descriptive studies, and mixed methods studies), this tool allows the simultaneous assessment of the different types of studies selected, whether qualitative, quantitative, or mixed. To achieve a congruent understanding of the criteria, a pilot test preceded the independent quality assessment by the evaluators. Differences in judgment were discussed, where necessary, to reach a consensus.

Data Synthesis and Analysis

We used narrative synthesis [49] as a method, regardless of the type of study (e.g., quantitative, qualitative, or mixed), to provide a descriptive synthesis of the results of the included studies. We report the study characteristics and methods used in Table 1 with a quantitative approach. We report the qualitative analysis results in the form of themes. The relevant data from the included studies have been summarised and analyzed in narrative format, with findings grouped or themed wherever applicable: 1) description of target groups and settings, level of study intervention, and DHL challenges; 2) interventions to improve DHL; 3) effectiveness of interventions to improve DHL.

Results

Selection process

The bibliographic searches identified 1845 publications. After removing duplicates, 1232 publications were screened from which 613 were excluded based on title or abstract because they did not meet the inclusion criteria. At the end of this first selection, 82 studies were selected for a review of the full text. At the end of the full texts review, we excluded 76 studies, thus leaving six studies [50], [51], [52], [53], [54], and [55] included in our systematic review. The selection process, also known as the PRISMA flow diagram, is presented in Figure 1, which shows how we went from 1,845 identified studies to only 6 relevant studies for our review.

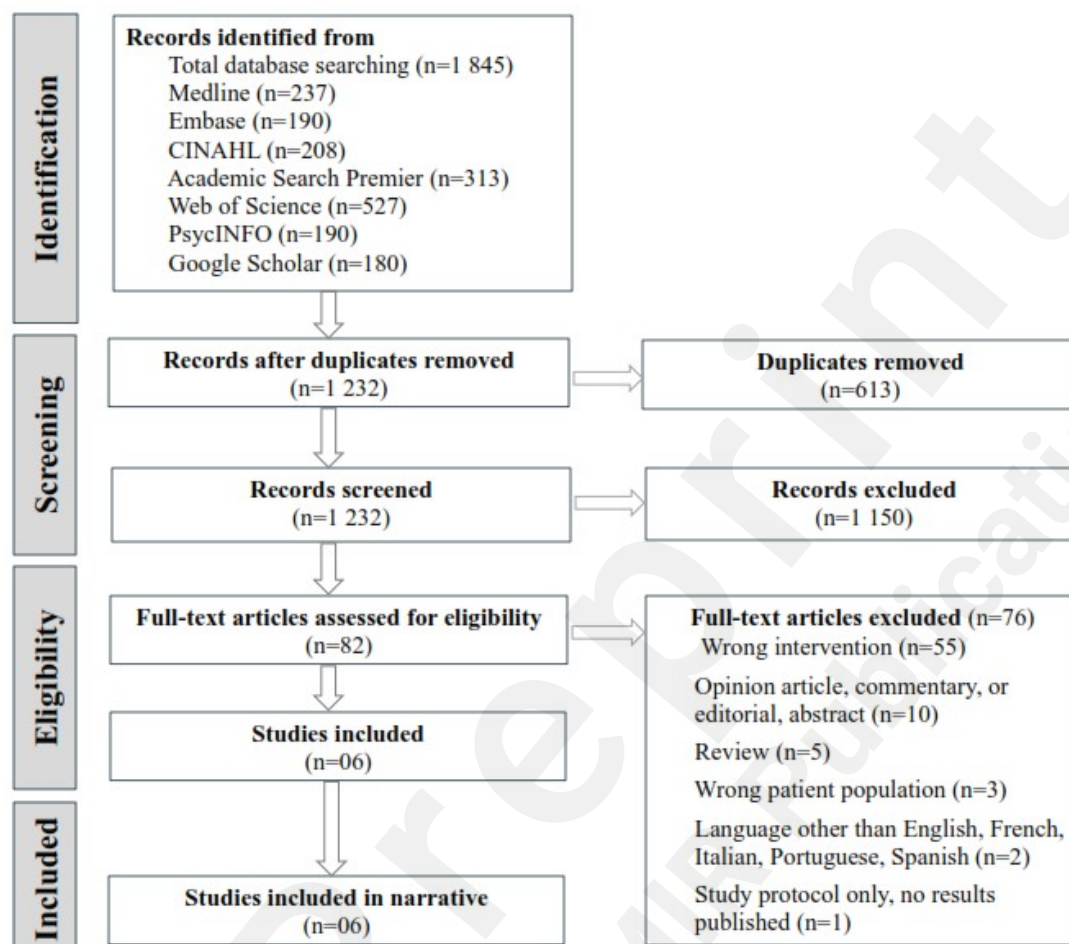


Figure 1: Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 flow diagram template for our Systematic Review.

Characteristics of included studies

The main characteristics and methods used in the included studies are presented in Table 1. The six studies were published in various journals. The oldest was published in 2017 [51] and the most recent in 2021 [55]. Two studies [50, 52] were published in 2019, followed by one study in 2020 [53], and finally another in 2018 [54]. For the country of implementation, two studies were conducted in the United States of America (USA), two in Europe (1 in Greece and 1 in Spain), one in Australia, and one in the Middle East, specifically in Israel.

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Table 1: Characteristics of included studies

Study reference	Objective	Country	Study Population (sample size)	Study Design	Challenges of DHL target population
Fernández - Gutiérrez et al. 2019 [50]	To evaluate the effectiveness of a mHealth intervention to improve the cognitive and social skills that enable migrants to access and use health services.	Spain (Strait of Gibraltar)	Immigrants, 18 –65 years of age, and non-Spanish nationality (Sub-Saharan Africa, China, Eastern Europe, Morocco, and South America) (93)	Quasi-experimental design: one group only, pre-post measurements	Measure of health literacy (HL): The mean value obtained using the European survey questionnaire (HLS-EU Q16) was 9.55 (SD 4.35), corresponding to a problematic level of health literacy. With scores ranging from 0 to 16 points, the questionnaire established three levels of health literacy: inadequate (0-8), problematic (9-12), and sufficient (13-16).
Guttman et al. 2017 [51]	1) To introduce Ethiopian immigrants, mainly those with low/no literacy, both in Hebrew and Amharic, to using a new health information website with an interface that does not require reading skills. 2) To explore how they would respond to the experience of using the website, its relevance to their lives, and current and potential barriers they might anticipate for future use.	Israel	Israeli Ethiopian immigrants, cultural and linguistic minorities facing sociocultural and health disparities (n=225)	A qualitative study on 2 phases: 1) health topics selection (discussions with Tene Briut staff and interviews with Ethiopian community members and practitioners), 2) Qualitative descriptive study (Face-to-face interviews with Ethiopian immigrants to learn about their observations and an analysis and discussion of the findings)	No measure. Low health literacy skills to browse online health information.
Johnson	To develop and	USA	Immigrant and	Ripple effects	No measure. Low health

Study reference	Objective	Country	Study Population (sample size)	Study Design	Challenges of DHL target population
Rhonda et al. 2019 [52]	implement a Peer Language Navigator (PLN) program to improve health literacy in immigrant communities.	(Alaska)	refugee communities in Anchorage, Alaska (not specified)	mapping: a participatory method of qualitative evaluation of the program	literacy level because of limited English proficiency. Most of residents are unfamiliar with where or how to obtain health services.
Kim et al. 2020 [53]	To develop a website that helps populations with LEP increase health literacy and improve healthcare service access.	USA	Refugees from the Karen ethnic community with LEP and low health literacy (n=22)	A mixed methods study comprising 3 phases: 1) Needs assessment with community leaders and service providers (qualitative in-depth interviews). 2) Adapted content development from credible sources and tested each item using multiple readability tests (quantitative study). 3) Revision of each item to lower the readability and retest its readability (quantitative study)	No measure. Limited English proficiency. Limited readability of information in English. Low/no skills in researching health information navigating the health system in English.
Millard et	To understand the	Australia	Elderly	Qualitative	No measure. Age-b

Study reference	Objective	Country	Study Population (sample size)	Study Design	Challenges of DHL target population
al. 2018 [54],	increasingly important role of digital citizenship (the ability to participate in society online) in supporting the well-being of aging migrants.	(Western Australia)	migrants in Perth, Western Australia, taking part in an "Internet café" to improve their Internet skills and well-being (n=15)	study (participant observation, social network mapping, ethnographic and life history interviews)	digital divide: participants had little experience with digital communication technologies before coming to the Internet café.
Riza et al. 2021 [55]	To test the potential of using the electronic algorithm in low-resource primary care settings with the help of health professionals in the settlements to help improve the health status of migrants and refugees, increase health literacy, and facilitate their integration into the host communities.	Greece	Migrants and refugees residing in Reception and Identification Centres (n=82)	Quantitative descriptive study	No measure. Cultural, linguistic, and practical obstacles. Many participants had difficulty understanding medical information and did not know where to go for medical help for specific health problems.

Regarding the methods used, half (3/6, or 50%) of the studies used qualitative approaches. One of three studies used face-to-face interviews conducted with Ethiopian immigrants in Israel to explore their experiences of using a website [51]. Ripple effects mapping, a participatory qualitative assessment method, was used to assess the effects of the Peer Language Navigator program in the USA [52]. The last method [54] combines qualitative methods (participant observation, social network mapping, ethnographic interviews, and life history interviews). They were used to understand the important role of digital citizenship, including the ability of older migrants to participate in society online to improve their well-being. Then, two studies (33.3%) used quantitative methods. The first tested the use of electronic algorithms to help migrants and refugees improve their ability to understand medical information, assess health status, and navigate the health system [55]. The second examined the level of DHL of migrants and assessed the effectiveness of the mHealth intervention aimed at improving the cognitive and social skills that enable access to and use of health services [50]. Finally, only one study used mixed methods (16.67%), combining interviews to assess the needs of the community and quantitative methods

to test and validate the readability of the website's content [53].

Description of target groups, level of intervention implementation, and digital health literacy challenges among forced migrant populations

Table 2 shows that the studies were conducted either at the individual, community, or societal level or simultaneously at all three levels. The target populations were mainly immigrants and refugees. Their number varied in the studies from 15 [54] to 225 [51] (median=82). The populations under review faced some challenges related to DHL (see Table 1). Only one study [50] measured the level of DHL among participants before the implementation of the intervention.

Table 2: Interventions to improve digital health literacy

Study reference	Action level	Target population	Interventions to improve DHL
Education and training			
Fernández-Gutiérrez et al. 2019 [50]	Community	Immigrants in Spanish (from sub-Saharan Africa, China, Eastern Europe, Morocco, and South America)	e_SaludAble, a culturally appropriate mobile application containing health information developed for migrants in Spain. e_SaludAble features a main menu in six languages, with six sections arranged in a scrolling tree structure designed to promote access and facilitate navigation of the socio-medical system to promote and maintain well-being. In their mother tongue, participants were trained and made aware of the basic content and how to use it. The aim was to improve the cognitive and social skills that enable migrants to access and use health services.
Guttman et al. 2017 [51]	Individual, community, and societal	Israeli Ethiopian immigrants, cultural and linguistic minorities, facing sociocultural and health disparities.	Creation of a website with health information presented through videos in Amharic. The website opens with a video explaining the site and how to use it. It has an audiovisual interface with pictures and voice to enable simple navigation among health topics without reading/typing skills. Topics can be heard orally when the “mouse” is moved over a picture/title. The hierarchical design enables navigating from a general topic to specific topics (e.g., symptoms explained with cultural metaphors). Topics are women’s health, nutrition, and diabetes.
Education and social support			
Johnson Rhonda et al. 2019 [52]	Community	Immigrant and refugee communities in	The Peer Language Navigator (PLN) program is an intervention aimed at enhancing health literacy among immigrant and refugee communities in Anchorage, Alaska. This program trains individuals

		Anchorage, Alaska, USA	from these communities about health and wellness topics as well as how to obtain health information from reliable online sources. PLNs serve as navigators to share health information resources with their respective communities.
Riza et al. 2021 [55]	Individual	Migrants and refugees residing in Reception and Identification Centres in Greece	IT-based electronic algorithm designed to assess the health status of migrants and refugees residing in Reception and Identification Centres (RICs) in Greece. This intervention involves the use of portable electronic devices, such as tablets, to administer a structured questionnaire that collects data on various health-related aspects, including health literacy, mental health, vaccination history, lifestyle habits, and the presence of diseases. Upon completion of the questionnaire with the help of health professionals, a report can be downloaded stating the health issues in which further action is required, and guidance is given as to where to look for help (healthcare system navigation information).
Enabling and education			
Kim et al. 2020 [53]	Community	Refugees from the Karen ethnic community with LEP and low health literacy, in the USA	Development of a web-based health information website specifically designed to assist populations with LEP in increasing their health literacy and improving access to healthcare services. This website is characterized by simplified content, i.e., information presented in a clear, easy-to-read, and easy-to-understand manner. It is an educational and informative resource aimed at providing accessible health information tailored to the needs of immigrants and refugees, particularly the Karen refugee community from Burma.
Educational, technological, infrastructure, and social support			
Millard et al. 2018 [54],	Individual, community, and societal	Elderly migrants in Perth, Western Australia	Establishment of an Internet Café that provides digital literacy training specifically for older migrants in Perth, Western Australia. It is based on a social learning approach where participants could develop their digital skills at their own pace by using the Internet and digital technologies, guided by the staff of the organization and fellow patrons (peer learning). By fostering a community of practice, the intervention aimed to improve participants' confidence, autonomy, and access to social networks and essential services through technology.

The remaining five studies' participants exhibited personal characteristics that defined their low level of DHL.

At the individual level, the study by Riza et al. [55], which is the only one in this category, individually and directly targeted migrants and refugees residing in Reception and Identification Centers in Greece. They faced cultural, linguistic, and practical barriers. Most of them had difficulty understanding medical information and did not know where to seek medical help for a specific health problem.

At the community level, there were three studies. The study by Fernández-Gutiérrez et al. [50] specifically targeted population groups of immigrants of non-Spanish nationality (Sub-Saharan Africa, China, Eastern Europe, Morocco, and South America) in a particular region (the border area of southern Spain). This study is the only one to have pre-assessment participants at the level of DHL before the implementation of the intervention. Health literacy is measured using the European Health Literacy Survey questionnaire (HLS-EU-Q16), which assigns scores ranging from 0 to 16 points. This questionnaire classifies health literacy into three levels: inadequate (0-8), problematic (9-12), and sufficient (13-16). Analysis of the results showed a problematic level, with an average of 9.55 [standard deviation, 4.35] among these groups. The study by Johnson Rhonda et al. [52] specifically targeted immigrant and refugee populations in Anchorage, Alaska, in the USA. Most of these people were newcomers and had little or no English language skills, which is a handicap in understanding online health information, navigating the health system, and accessing appropriate care. In their study, Kim et al. [53] specifically targeted immigrants and refugees with LEP, particularly the Karen ethnic community from Burma in Asia. They had problems with readability, which is defined as finding the right health information in an accurate, reliable, and easy-to-understand format, which indicates the specific DHL needs of a particular community group.

Finally, two interventions were simultaneously conducted at the individual, community, and societal levels. The intervention in the study by Guttman et al. [51] directly targeted Ethiopian immigrants in Israel with little or no reading skills, thus implying difficulties in accessing online health information. In their efforts, they also involved Ethiopian immigrant organizations and encouraged the use of the website in community contexts. At the societal level, the website was designed to link national information about the specific needs of the immigrant community. As for the study by Millard et al. [54], it directly targeted older migrants to improve their essential digital skills. Most of these migrants had little or no experience in the use of digital communication technologies before coming to the Internet café. The intervention functions as a community of practice where participants learn from each other in a supportive social environment, helping to bridge the digital divide within society.

Interventions to improve digital health literacy

For the improvement of DHL among targeted FMP, we identified four categories of educational interventions: training, social support, empowerment (enablement), and finally, technological, infrastructural, and social support (see Table 2).

In the category of training, two studies were involved: the first intervention consisted of the use by groups of immigrants in Spain of a culturally appropriate mobile application (e_SaludAble) containing health information [50]. e_SaludAble featured a main menu in six languages, with six sections spread across a drop-down tree structure designed to facilitate access and navigation

through the social and health system to promote and maintain wellness. Thus, depending on the mother tongue and nationality, the groups of participants were trained and sensitized on the basic content and its use. The goal was to improve immigrants' cognitive and social skills to access and use health services. The second intervention involved the creation of a website with videos in Amharic that presented health information [51]. The website opened with a video explaining what the site was and how to use it. It also had an audio-visual interface with audio images and voices, allowing for simple navigation through health themes without the need for reading skills. The purpose of the website, designed to be accessible, was to promote access by individuals to online health information. It was considered a community resource.

Social support is the second category with two interventions identified. The "Peer Language Navigator (PLN)" program [52] aimed to improve skills to understand and evaluate health information for immigrant and refugee communities in Anchorage, Alaska. The program trained members of these communities on health and well-being issues, as well as how to obtain health information from trusted online sources. These trained individuals, initially known as PLNs, served as navigators to share relevant health information with their respective communities and helped their peers access health care and services. The second intervention is an electronic algorithm designed in the form of a questionnaire to assess health status [55]. It aimed to help migrants and refugees residing in Reception and Identification Centres (RICs) in Greece conduct a health self-assessment by answering a personalized questionnaire with the help of health professionals. This tool offered them specific information about their health status, health problems, and tips on where to seek help in the health care system.

The third category is enabling (empowerment), which aims to strengthen the capacities and autonomy of individuals and communities by making resources (both individual and collective) available and accessible [56]. The goal is to enable these individuals to take control of their lives, their decisions, and their environment. As such, the intervention included the development of a health information website aimed at providing accessible and adapted information to immigrants and refugees. The content was simplified to present clear, easy-to-read, and easy-to-understand information [53]. This website was specifically designed to help immigrants and refugees with LEP, particularly the Karen ethnic community. It aimed to increase their competence to understand health information, navigate the health system, and make informed decisions about their health.

The last category of intervention is technological, infrastructural, and social support, for which one intervention [54] is described. This intervention involved the creation of an Internet café that helped older immigrants in Perth, Western Australia, improve their essential digital skills. It was based on a social learning approach where participants evolve at their own pace and learn from each other. Older immigrants were guided by the organization's staff and peers in the community in their learning. By fostering a community of practice, the intervention aimed to improve confidence, maintain support networks, access essential services, and support older immigrants' autonomy to participate in society online and improve their well-being.

Effectiveness of interventions to improve digital health literacy

All interventions presented in the six studies aimed at improving DHL among FMP were evaluated. As shown in Table 3, overall positive results were found in five studies. One study, however, had mixed results.

Table 3: Main study results

Study reference	Main outcome	Secondary outcomes
Fernández-Gutiérrez et al. 2019 [50]	Positive results: A significant improvement in individuals' health literacy was observed after the intervention, with the mean rising from a problematic level of 9.55 (standard deviation: 4.35) to a sufficient level of 14.03 (standard deviation: 2.68).	The differences between pre- and post-intervention scores were statistically significant for both men and women and for participants of all nationalities, except the Chinese group.
Guttman et al. 2017 [51]	Positive results: The experience was generally rewarding, and most participants reacted with enthusiasm and excitement. Some were even overwhelmed by the new opportunity to access detailed health information. Other participants expressed that the website was “designed for them”, addressed their concerns, that the language used was respectful, and that the images represented their culture.	Analysis of participants' apprehensions about using the website generated several conceptual developments: (1) the addition of culturally-focused elements to the Technology Acceptance Model (TAM), (2) the identification of users' needs according to their conceptions of their capabilities, (3) the highlighting of ways in which an information site can offer socio-cultural benefits in addition to providing relevant information, including intergenerational communication, and (4) the proposal for the integration of the website into the wider communication infrastructure of a linguistic minority.
	Negative results: the experience was also marked by apprehension, even frustration, about future use. Participants with low or no literacy skills expressed the need for support and training for future use. Some felt it was too difficult and said they didn't think they could use it. Others felt the website wasn't for them, due to their age and the perception that it was too late for them to learn.	
Johnson Rhonda et al. 2019 [52]	Positive results: The Peer Language Navigator program has proven its effectiveness in providing understandable health information to hundreds of new English language learners in Anchorage, Alaska, while guiding them to reliable health and wellness resources they can use for themselves, their families, and their community.	PLNs improve their health literacy, enabling them to become a credible and useful resource for others. At the end of the training, over 90% of PLNs reported feeling confident or very confident in their ability to find health information using an Internet search.
		PLNs became leaders in their communities and changed their name to Peer Language Navigators.
		The PLNs' contact logs showed that they communicated with many people in their respective communities. The most recent cohort, made up of five PLNs,

		provided health information to over 150 people over six months.
		The PLNs' work reached not only individuals but also community organizations and events.
Riza et al. 2021 [55]	Positive results: The application of an electronic algorithm has helped to identify gaps in the understanding of health concepts, such as understanding medical information in leaflets, and it has provided them with useful links to tools to increase their knowledge in several thematic areas. Using the interactive map, the study participants had the opportunity to locate points of care that they could access to seek professional help for a medical issue	67.1% of respondents encountered difficulties in understanding medical information, and 57.3% didn't know where to seek medical help for a specific health problem.
		Four main areas of health problems were identified: (A) mental health concerns, (B) vaccinations, (C) obesity, and (D) dental hygiene, where the assistance of a healthcare professional is required.
		The "Roadmap and Toolbox" section of the project website gave respondents access to numerous resources and tools to enhance their knowledge in several thematic areas."
Kim et al. 2020 [53]	Positive results: The average reading level of the original 99 subjects was assessed at 10.84 (SD = 3.26). After revisions, we were able to lower the readability level to 8.56 (SD = 2.96), corresponding to a drop of around two grade levels on average.	Web-based health website: A total of 99 health information topics (40 for hospitals, 37 for primary health services, and 22 for Medicaid) were identified, and appropriate content was developed.
		Most of the feedback received during the post-development evaluation was positive, particularly concerning the health information available on the site.
		However, average scores could not be reduced below the recommended level for grade 7, as recommended by leading organizations such as the American Medical Association and the National Institutes of Health.
Millard et al. 2018 [54],	Positive results: With appropriate educational, technological, infrastructural, and social support, digital literacy for elderly migrants can significantly enhance their ability to maintain and expand	Older migrants want to connect with members of their support networks, whether local or remote, online or offline.
		When they have access to the tools

	dispersed support networks, as well as to engage socially and access health services. The “Internet café”, which fosters social learning environments and the creation of communities of practice, contributes to the development of digital literacy among elderly migrants, enabling them to benefit from greater autonomy, i.e., increased motivation and the ability to use the Internet for information and communication.	and skills of new technologies and the Internet, elderly migrants benefit from increased direct access to their social networks, as well as to information, services, and personal interests, even at a distance.
		As they become more digitally literate, elderly migrants feel a greater sense of autonomy and social participation.
		Social learning environments, which function as communities of practice, are proving to be effective means of developing digital literacy and digital citizenship.
		These communities of practice can be supported by qualified ICT and social service professionals, in collaboration with individuals and other members of their respective care networks.

In the category of training, two culturally appropriate interventions were identified and had different results. The study by Fernández-Gutiérrez et al. [50] was successful. The results showed that health literacy improved significantly after the intervention, with the average rising from 9.55, considered problematic, to 14.03, deemed sufficient. The training and awareness raising significantly improved their required cognitive and social skills on the use of the culturally appropriate mobile application (e_SaludAble), enabling them to access health information and health services. These results were valid for both men and women as well as participants of all nationalities, except for the Chinese group. The authors explain this result by the fact that the decision-making process of Chinese people is not always individual, but rather it is influenced by family, peer groups, or community leaders [50]. Thus, the performances of Chinese participants showed different results from those of other nationalities.

The results were mixed in the study by Guttman et al. [51]. Most participants reacted enthusiastically to their experience of using the website. They were delighted by the new possibility to choose detailed health information. They argued that the site addressed their concerns, that the language was respectful, and that the images represented their culture. Other participants, on the other hand, had a negative experience. Some felt that the site was too difficult and that they needed support and training for future use. Other participants thought that the website was not for them because they were too old to learn and didn't think they could use it.

All interventions in the other categories have been successful in improving DHL among FMP. The Peer Language Navigator (PLN) program in the study by Johnson Rhonda et al. [52] demonstrated a beneficial effect in providing understandable health information to hundreds of new English learner migrants. This program guided them to reliable health and well-being information, enabling them to use it to make informed decisions to manage their health, that of

their families, and their communities. The peer navigators improved their skills in understanding information and navigating the health system, allowing them to serve as credible and useful resources for others. More than 90% of them said they were confident or very confident in their ability to find such health information through an internet search.

The study by Riza et al. [55] demonstrated the effectiveness of the electronic algorithm as a tool to improve health literacy. It helped to understand health information and identify areas that need attention, such as mental health support, advice on vaccination, weight management (obesity), and dental care. In addition, the results highlighted gaps in the health of immigrants and refugees. Finally, the algorithm made it possible to provide health information and resources tailored to their personal needs (useful links), strengthening their ability to make informed decisions to better manage their health.

Positive results were also observed in the study by Kim et al. [53] about making a website more accessible for migrants with LEP. The average reading level of the information was lowered from 10.84 (standard deviation = 3.26) to 8.56 (standard deviation = 2.96), i.e., about two school levels lower, on average. The information on the website was accessible, easy to read, and easy to understand. Most of the feedback received during the post-development evaluation was positive about the understanding of information by immigrants and refugees with LEP.

The study by Millard et al. [54] was also successful. It demonstrated that the intervention of the Internet café, involving social learning places and communities of practice, has fostered the development of digital literacy and digital citizenship among older migrants, allowing them to maintain their support networks, access to essential information and services, as well as enjoy greater autonomy and social participation. The Internet café has improved motivation and ability to use the web for information and communication purposes, such as connecting with members of their support networks, whether local or remote, online or offline.

Quality assessment of the included studies

Table 4 shows the quality of the studies included in our mixed methods systematic review. Although specific to each approach, whether qualitative or quantitative, five criteria were used to assess study quality. Overall, most studies met 80% (n=4) [51], [52], [53], [54] or 100% (n=2) [50], [55] of the quality criteria. On the other hand, some limitations were noted in these studies that do not call into question the quality of the results.

For qualitative studies, the main shortcomings were related to the limitations of generalization of the results. These studies targeted communities in specific contexts such as Ethiopian migrants in Israel [51], migrants and refugees in Alaska [52], and elderly migrants in Western Australia [54]. In addition, the shortcomings were related to the sample size and the selection of participants, thus limiting the representativeness of the results [52, 54]. Some researchers [51] did not have access to the participants' responses in the original language and the participants did not have enough time during the interview to "skim through" all the topics and choose them.

Regarding the two quantitative studies [50, 55], selection biases were also noted, and difficulties in accessing certain categories of targeted populations that are difficult to reach were reported in the study by Riza et al. [55]. Additionally, the Fernández-Gutiérrez et al. study [50] highlights certain limitations associated with the use of the HLS-EU-Q16 questionnaire: the reduction of the number of items from 47 to 16 leads to a considerable loss of information.

Finally, the mixed-method study by Kim et al. [53], focused on a specific group in a single geographic location, i.e., ethnic Karen refugees from Burma with LEP in a geographic region of

the United States. Therefore, the results from this study cannot be generalized.

Table 4: Quality of included studies

Included studies	Value (%)
Fernández-Gutiérrez et al., 2019 [50]	5 (100)
Guttman et al., 2017 [51]	4 (80)
Johnson Rhonda et al., 2019 [52]	4 (80)
Kim et al., 2020 [53]	4 (80)
Millard et al., 2018 [54]	4 (80)
Riza et al., 2021 [55]	5 (100)

Discussion

This systematic review explored the effectiveness of interventions aimed at improving DHL in FMP. The importance of gaining skills is well established for populations with low DHL, such as forced migrants [57-59]. These skills enable FMP to promote their health and well-being. These people can use digital tools such as the internet, smart and connected objects, mobile applications, and online platforms, to access relevant health information, care, and health services online or remotely. In the age of digital technology and artificial intelligence, it is a major determinant of health for populations [60]. Due to the context of the vulnerability of forced migrants [42], it is essential to support the development of their skills to search, find, understand, and especially, critically evaluate health information. This also includes the ability to apply or create health information for communication and interaction with the health system, to maintain or improve quality of life. Thus, these populations represent important targets for the development of interventions that support their DHL, as well as for evaluating the effectiveness of these interventions.

The existing literature on the subject is quite recent and rare, but it has been growing in recent years [61]. This period coincides with the advent of the COVID-19 pandemic, which marks the beginning of the accelerated shift toward the use of digital tools to access information, care, and health services around the world [30, 62]. This has been the catalyst for the rapid adoption of digital health technologies [61, 63], which has potentially led to an increase in studies and initiatives aimed at strengthening the digital health skills of populations in general, particularly forced migrants.

The analysis of the six included studies shows methodological and diversified richness. The DHL of FMP is a sensitive topic that requires special attention to individuals' cultural and social contexts, personal characteristics, and environment [42]. The qualitative approaches used focused on participants' experiences, which allowed for an in-depth understanding of their contextual and cultural challenges and specific DHL needs [64, 65]. In general, qualitative approaches capture the complex realities of vulnerable populations, which are often overlooked in quantitative studies [66]. Understanding the specific challenges and needs has made it possible to tailor interventions to the specific realities of FMP. Conversely, quantitative studies, such as that of Fernández-Gutiérrez et al. [50], have provided empirical data on the health literacy levels of migrants and refugees, which is essential for assessing the effectiveness of interventions [67].

The geographical diversity of the studies, ranging from the United States to Australia, including European and Middle Eastern countries, also highlights varied cultural contexts that influence the results and methods of interventions. These countries have been among the countries that have

received the most FMP in the world in recent years [68]. Adapting interventions to the cultural context of individuals is essential for their success in these host countries [69]. Although the results of the various studies are promising in terms of transferability, it is crucial to consider cultural differences and specific local conditions when adapting interventions. The results of our systematic review show that the main target groups identified varied greatly. These groups included older people, people with lower levels of literacy or education, and people with little or no experience with digital tools. The challenges related to DHL were therefore varied and mainly related to cultural, linguistic, and practical contexts. The individual characteristics of these groups made them more vulnerable and made it more difficult to access health information and services. Previous research indicates that age, level of education, experience, and digital literacy influence the level of DHL of individuals [33, 64, 70]. As a result, these populations faced significant barriers to DHL, highlighting clear DHL needs among these immigrant and refugee groups.

In our research, only one study conducted a screening assessment of DHL needs, highlighting a lack of systematic assessments of digital health skills in this context [71]. The results showed that these populations often have problematic levels of DHL among FMP, highlighting the importance of designing interventions tailored to the specific needs of these groups. The categories of interventions identified (education and training, education and social support, empowerment and education, and educational, technological, infrastructural, and social support) to improve DHL among FMP reflect integrated and multidimensional approaches. Each type of intervention has its strengths and weaknesses, illustrating the complexity of the needs of FMP. Overall, the various interventions were successful. However, those that target certain categories such as older migrants and less educated migrants require increased attention and more robust approaches. The effectiveness of most interventions was found to be contingent upon their cultural and linguistic adaptation to individuals' personal characteristics and specific DHL needs. For some authors [65, 69, 72], adapting interventions to the cultural context of populations is essential for their success, as it is a form of communicating, respecting cultural values, and adjusting actions considering the needs of individuals as well as the diversity of contexts, especially in contemporary societies. This approach not only recognizes the unique challenges faced by FMP but also leverages their cultural strengths to foster resilience and improve their DHL. Our research has identified a multitude of cultural and linguistic adaptation considerations.

The first consideration mentioned in the studies was the consideration of appropriate language and medical terms in the design and implementation of interventions. It is an essential part of cultural adaptation [73]. Therefore, linguistic and cultural differences in information understanding and health services are major barriers to individuals' engagement, involving cognitive, affective, behavioral, and contextual dimensions [69]. Our research has demonstrated the effectiveness of education and training. This category has resulted in the organization of training and information sessions in English [52, 53] the mother tongue [50], or local or preferred language [51] of FMP. In addition, in some interventions such as website creation [54], the level of medical language has been lowered to support populations with LEP in their empowerment and education. As a result of the different interventions, the cognitive (understanding and evaluating information, informed decision-making) and social (communication, collaboration, and social support) skills of the targeted FMP improved significantly. These results are consistent with Michie et al. [43, 44] who found in their review that education, training, and empowerment are categories of intervention that improve the abilities, opportunities, and motivation of individuals to change their behaviors, particularly in the context of managing their health and well-being, including the use of digital tools. Language is not limited to a simple vector of communication, but it also conveys cultural values, beliefs, and norms that influence the

perception, appropriation of messages, and behavior of individuals [69], and more attention should be paid to medical terminology choice. In sum, an intervention that considers the specific language and language needs of individuals can play a crucial role in improving their level of DHL.

The second consideration in the included studies was the social support provided by family, peers (competent community members), professionals, and community organizations on forced migrants populations. Social support is often cited as an effective method to strengthen individual and community engagement as well as networks [74]. It helped build social capital, which was essential for individuals' well-being and engagement. FMP were in a collaborative learning environment with peers, professionals, and community organizations, which provided an opportunity to share knowledge and experiences to address DHL challenges [75]. In addition, institutional and organizational efforts have been made to address gaps in access to relevant health information. Community peers or family members acted as mediators between FMP and existing resources, allowing information and tools to be adapted to the specific needs of these groups, considering cultural, linguistic, and technological barriers [75].

The third consideration relates to the level of implementation of the interventions presented in the included studies, a factor that directly influences the first two considerations. The studies analyzed identified three levels of intervention (individual, community, and societal). Two studies [51, 54] combined these three levels, highlighting the specificities of interventions to improve DHL among FMP. The importance of a multi-level approach to supporting DHL among FMP is clear, so it is essential that interventions are tailored and contextualized, considering their realities and needs [76, 77]. This strategy has the immense advantage of offering holistic and integrated interventions, considering the key dimensions that influence the DHL of FMP in host countries.

This approach thus has broader implications, i.e. implications that go beyond the individual framework, encompassing the community, institutions, and society [78]. Such interventions allow FMP to better understand their options, access community and institutional services, and improve their engagement and DHL.

This study has several strengths, including the systematic analysis of the diversity of approaches and methods adopted in the six included studies, which provides insights into interventions to improve the DHL of FMP. The variety of approaches and methods used allows for a rich and nuanced understanding of the challenges faced by these groups as well as the effectiveness and impact of interventions. The interventions were found to be culturally and linguistically appropriate to FMP, thereby enhancing their effectiveness. In addition, several studies have demonstrated positive results in improving DHL, highlighting the concrete impact of these initiatives on improving the health and well-being of participants.

However, the methods adopted have significant limitations. The heterogeneity in study settings and designs limits the possibility of combining results. The focus on FMP may have excluded relevant interventions targeting other groups that could be relevant to improving DHL in forced migrants.

Given that the studies analyzed focus on specific populations in particular contexts, generalizing the results to other groups or regions could prove problematic. Data are lacking in certain regions, such as Africa and South America. Moreover, most studies did not include comparison groups or had short-term, if any follow-ups, making it difficult to assess the long-term efficacy and comparative effectiveness of interventions. In addition, some studies suffer from selection bias (Johnson, Rhonda et al., 2019; Riza et al. 2021) and limited sample sizes (Millard et al., 2018), which may affect the robustness of the conclusions. Finally, most studies have not systematically

measured the level of DHL among participants before the implementation of interventions, which may limit the ability to accurately assess the effectiveness and impact of interventions.

For future research, it is important to develop effective, tailored, and acceptable interventions for FMP. These interventions should be centered on their needs and evidence-based, while also considering their values, preferences, and digital health capabilities.

Studies should adopt approaches that enable a deep understanding of the specific challenges faced by FMP, particularly regarding their DHL. To achieve this, it is recommended to include diverse and representative samples from different countries, cultures, languages, and educational levels. This will help better understand variations in DHL and design tailored interventions. Ethically, studies must adopt inclusive approaches, considering the specific barriers faced by vulnerable groups of FMP, such as older adults, those with lower education levels, the less affluent, individuals with limited digital experience, or those living in low-resource settings (e.g., rural areas). Furthermore, it is crucial to consider the social, economic, cultural, and environmental determinants of health, which influence DHL. An intersectional analysis of these factors would provide a better understanding of inequalities and help propose more equitable solutions.

The use of mixed methods is recommended to generate reliable knowledge and support informed decision-making in the development of tailored interventions. Qualitative approaches can offer an in-depth analysis of individual experiences and the challenges faced by FMP in host countries. Quantitative methods, on the other hand, will allow for the study of the impact and effectiveness of interventions, particularly by measuring the level of DHL before and after their implementation. Additionally, longitudinal follow-up with participants could strengthen the assessment of the long-term impact of these interventions.

To maximize their impact on a larger scale, interventions should adopt holistic and multi-level approaches, integrating actions at the individual, community, and societal levels:

- At the individual level, this involves, for example, strengthening digital health skills through education and tailored, accessible training. By integrating feedback mechanisms and continuous learning, interventions can ensure that FMP remain competent and confident in their use of digital health technologies.
- At the community level, partnerships with local organizations and community leaders can facilitate support for FMP while fostering their ownership of the interventions. Community-based digital literacy programs can create peer support networks, enhancing long-term adaptability and confidence in using digital tools
- Finally, at the societal level, inclusive public policies and accessible digital infrastructure are necessary to create an enabling environment for improving DHL. Policies should prioritize the development of user-friendly, culturally adapted digital solutions, while ensuring continuous access to updated resources, enabling FMP to remain proficient in the use of digital health tools over the long term

By adopting these recommendations and strategies, future research will be better equipped to address the DHL needs of FMP while overcoming the methodological and contextual challenges associated with these issues. Moreover, emphasizing digital resilience in interventions ensures that forced migrants are not only able to navigate current digital health systems but are also prepared to adapt to future technological advancements, thereby fostering their long-term empowerment and inclusion.

Conclusion

This study highlights the crucial importance of improving DHL among FMP, a need that has intensified in a global context marked by the accelerated digitization of healthcare services. The results of our research reveal that, while most interventions are effective, significant challenges persist, requiring targeted and context-adapted strategies. The positive effects observed underscore the potential of culturally and linguistically adapted interventions to improve the health and well-being of these FMP.

However, addressing these challenges requires more than isolated actions; it necessitates a collaborative and multisectoral approach that ensures interventions are contextually adapted, whether they involve training, social support, or technological resources. Developing of innovative solutions tailored to the specific needs of FMP remains essential to strengthen their DHL. These efforts must rely on integrated approaches, bringing together healthcare systems, service providers, technology developers, decision-makers, and community organizations. To ensure the effectiveness of interventions, future research must prioritize rigorous methodologies, including systematic evaluation of DHL levels before and after interventions, as well as greater diversity and representativeness of the studied samples.

Promoting DHL among FMP is not only a public health imperative but also a societal issue. It serves as a cornerstone for their successful integration into host societies, the optimization of healthcare services, and the reduction of health inequalities. By investing in inclusive and evidence-based interventions, it is possible to improve the DHL of the entire population, including FMP. Such initiatives not only address the immediate needs of FMP but also pave the way for a more equitable, accessible, and resilient society for all. Through collective effort and shared commitment, the promise of digital health can become a reality for everyone, regardless of their origin or circumstances.

Abbreviations

DHL: Digital health literacy

FMP: Forced migrant populations

HLS-EU: European Health Literacy Survey Questionnaire

ICT: Information and communication technologies

IDP: Internally displaced persons

JMIR: Journal of Medical Internet Research

LEP: Limited English proficiency

PICOS: Population, intervention, comparison, outcomes, setting or context

PLN: Peer Language Navigator

Authors' Contributions

Achille R. Yameogo designed, developed, and supervised the study, contributed to the development of search strategies, drafted the study selection guide, coordinated study selection, data extraction, and quality assessment, and wrote the manuscript. **Carole Délétraz** contributed to the study design, data extraction, quality assessment, and critical revision of the manuscript. **Maxime Sasseville** participated in the study design and manuscript revision. **Samira Amil, Sié Mathieu Aymar Romaric Da, James Plaisimond, and Sofia Tadlaoui** were involved in study

selection and manuscript revision. **Frédéric Bergeron** developed the search strategies, performed the literature search, prepared the studies (including duplicate removal), and managed their transfer to COVIDENCE. **Marie-Pierre Gagnon and Patrick Bodenmann** guided the initial idea and study design and contributed to the manuscript revision. All authors read and approved the final manuscript.

Competing Interests Statement

The authors declare no competing interests that could have influenced the work reported in this paper.

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Data Availability

Data relating to the eligibility criteria for the studies in this research are available in Multimedia Appendix 1, and those relating to the research strategy in Multimedia Appendix 2. All data generated or analyzed during this study are included in the submission of the results manuscript in the form of Tables 1 and 2. The PRISMA 2020 [Preferred Reporting Items for Systematic Reviews and Meta-Analyses] flowchart is provided as a figure. Databases created during the data extraction process can be supplied on reasonable request.

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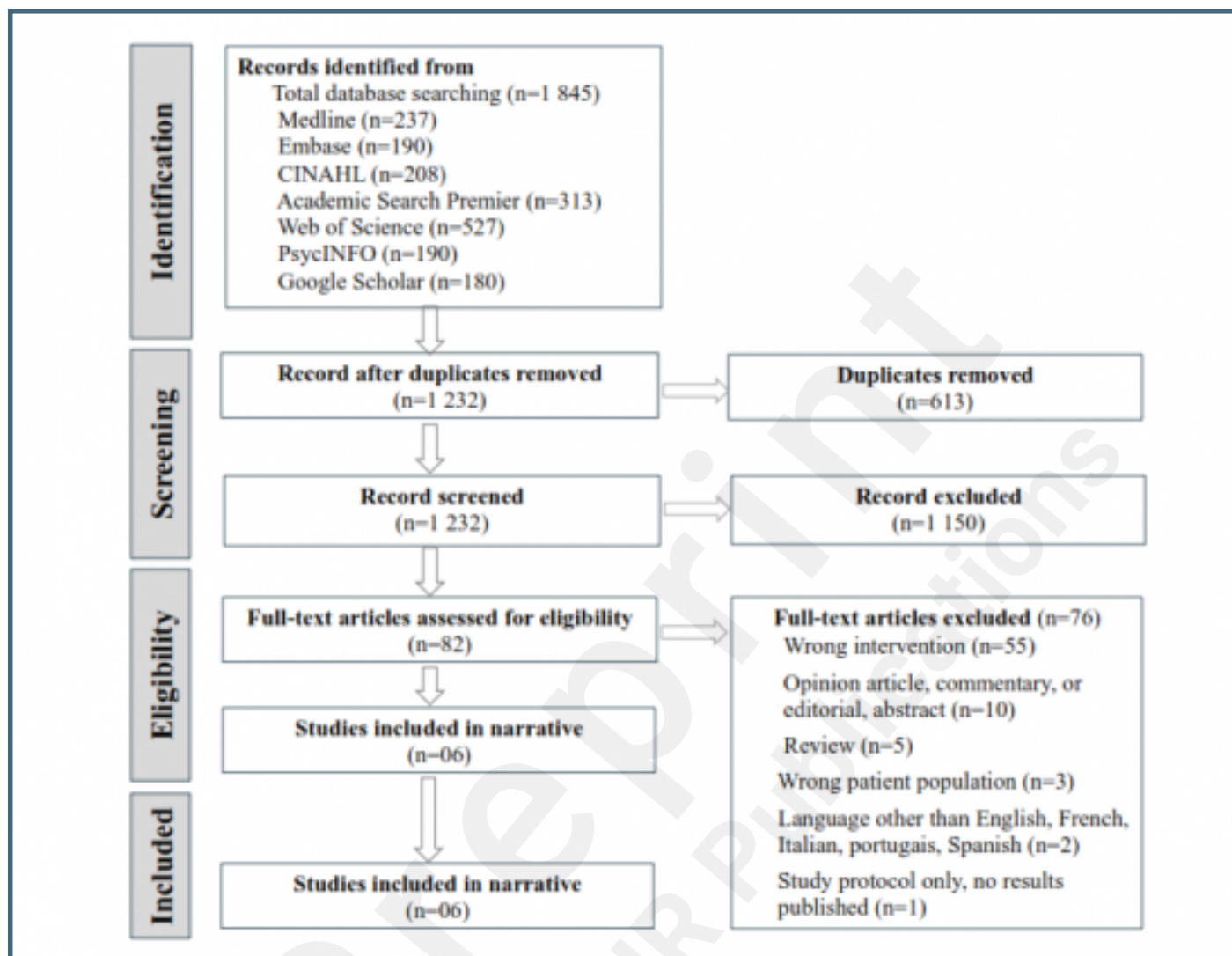
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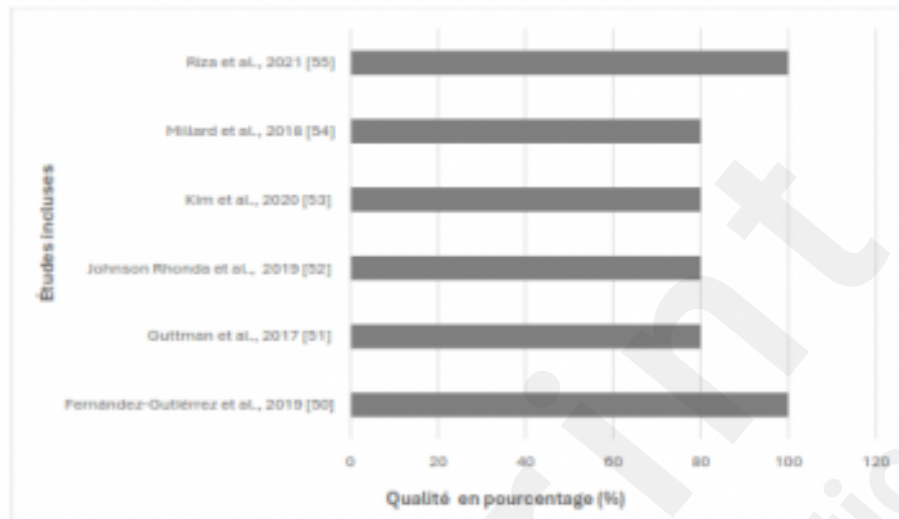
Supplementary Files

Figures

PRISMA 2020 checklist flow diagram.



Quality of Included Studies.



Multimedia Appendixes

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