SAVONIA

University of Applied Sciences

THESIS – MASTER'S DEGREE
SOCIAL SERVICES, HEALTH AND SPORTS

DIGITAL HEALTH AND SOCIAL EQUALITY

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SAVONIA UNIVERSITY OF APPLIED SCIENCES

THESIS
Abstract

Field of Study Social Services, Health and Sports	
Degree Programme Master's Degree Programme in Health Care, Digital Health	
Author Changkai Zheng	
Title of Thesis Digital health and social equality	
Date 25.04.2025	Pages/Appendices 48/6
Client Organisation /Partners Savonia University of Applied Sciences	

Abstract

Technological innovation driven by digital technologies is rapidly changing the healthcare industry in the face of aging, chronic diseases, and the increasing pressure of limited medical resources. Telemedicine, health data management, and digital health services have transformed the global healthcare system. It is changing the healthcare industry and how personal health management is implemented by improving medical efficiency, optimizing patient experience, and reducing medical costs.

However, the popularity of digital health technologies has also raised concerns about digital health gaps caused by socioeconomic levels. Globally, digital inequality refers to gaps in digital skills, Internet connectivity, and technology access. Telemedicine, electronic health records, health tracking devices, and health apps are examples of gaps in the availability, utilization, and benefits of digital health technologies. These inequalities lead to significant differences in health outcomes and health services for different social groups, and these inequalities are often closely related to social group (internal factors) and economic policy geography (external factors) variables. These gaps are significant barriers to economic opportunities in the digital age. This article connects the perspectives of social inclusion and digital globalization while discussing the leading causes of the global digital gap.

Through a narrative literature review, this research investigated the connection between social equality and digital health. It also examined the causes of digital inequality, such as disparities in access to digital resources and abilities, and how these factors impact social equality. The study demonstrated that digital equality is hampered by socioeconomic reasons, limitations of networks and digital devices, vulnerable groups, and geographic discrepancies.

The research aims to close the digital gap and ensure equal access to digital resources. It offers verifiable evidence supporting improving socioeconomic conditions, creating targeted legislation, and enhancing educational possibilities. It seeks to create an ecosystem-based, sustainable digital health system.

Keywords
Digital equality, Digital health inequality, socioeconomic, social equality

CONTENTS

1 INTRODUCTION

Information technology's rapid advancement is fundamentally altering how healthcare is delivered. According to Abernethy, Adams, Barrett, Bechtel, Brennan, Butte, & Valdes 2022, One major factor driving this change in the 21st century is the incorporation of digital healthcare technologies, which are called “digital health.” The scope of healthcare has expanded to health technologies and health data analytics, which have improved service quality and efficiency. By encouraging contactless healthcare solutions and spurring digital transformation throughout the healthcare industry, the COVID-19 pandemic further expedited this trend (Fagherazzi et al. 2020, 2).

Although digital health has shown tremendous development potential, the social equity issues it has caused cannot be ignored. The development of digital health has been hindered. As stated in the Digital Health Strategy released by the World Health Organization in December 2024. Digital health technology development has not yet produced equal advantages for all populations; disparities in access to digital technology among different social groups limit its advancement. The purpose is to guarantee that all social groups have equitable access to digital health resources, so it is crucial to carry out a comprehensive and in-depth study.

The research topic is important for practical significance and follows the current phenomenon of society. This study adopts a literature review method to sort out existing research on digital health equity issues, systematically summarize its application status and challenges in different social groups, analyze the key factors affecting digital equity, and explore the path to inclusive digital health development. The study focuses on the combination of theory and practice, focusing on the discussion from the structural and social determinants perspective.

This study aims to review digital health practices and equity issues systematically, reveal the accessibility differences and usage barriers caused by digital health in different social groups, further analyze the interactive relationship between technological development and social structure, and provide theoretical support and practical reference for the optimization of digital health strategies. The goal is to clarify the equity challenges in the current digital health promotion, put forward suggestions to promote balanced resource allocation and technology accessibility, and construct a more inclusive and sustainable digital health ecosystem. In particular, the findings may contribute to improving national digital literacy programs and aligning with Finland’s digital health strategy toward 2030 (Lehto & Malkamäki 2023,9).

This research project, commissioned by Savonia University of Applied Sciences, aims to evaluate and promote the equitable development of digital health technologies in the region and provide basic support for the formulation and implementation of future research.

2 DIGITAL HEALTH

2.1 Digital health definition

Digital health uses digital technologies within the healthcare sector to enhance patient care, improve system efficiency, and promote personalized medicine (WHO, 2019). Its applications encompass electronically captured data, digital technologies, communications infrastructure, and various tools within the healthcare ecosystem to meet health needs (Abernethy et al. 2022,1). According to Lupton (2017, 14), digital applications include computerized health information, financial and communication systems, and telemedicine. Continuously evolve to support self-management and healthcare delivery (Abernethy et al. 2022,1).

Digital health provides unprecedented opportunities for personal and public health through artificial intelligence (AI), wearable devices, health data analysis, genomics, and mobile applications (Mathews, McShea, Hanley, Ravitz, Labrique & Cohen 2019,1). Technology provides unprecedented opportunities for personal and public health, continuously expanding dimensions, including remote diagnosis communication, guidance clinical care plans, and clinical support. The World Health Organization (WHO) published a thorough taxonomy of digital health in 2018, and digital technology has been promoting its effects on human health.

One emerging digital health innovation is the concept of digital twins (DT). Since its introduction in 2003, the concept has gained significant traction and was recognized by Gartner 2019 (Jones, Snider, Nassehi, Yon & Hicks 2020, 2). Further, in 2020, the global DT value will be evaluated at $3.1 billion and grow rapidly in the coming years (Singh, Fuenmayor, Hinchy, Qiao, Murray & Devine 2021,1). A system that represents a physical thing virtually and enables real-time data interchange and interaction between the digital and physical versions is known as a "digital twin." This technology makes predictive modeling, customized treatment plans, and process optimization possible, improving healthcare. The virtual environment facilitates several tasks, such as testing, optimization, and modeling (Jones et al. 2020, 1-2). Global access to highly individualized and reasonably priced healthcare treatments could be possible when digital twin technology develops further in the medical domain. For example, digital twins can help prevent stroke and ischemic heart disease (IHD) early on. (Singh et al. 2021, 12.)

2.2 Digital health system presentation

2.2.1 Electronic health records (EHRs)

Digital technologies for health or medical purposes have become deeply integrated into everyday life, including family, work, education, and social relationships (Lupton 2017, 14). This integration supports capturing, storing, and sharing electronic health data while enabling technology platforms for health management, diagnosis, treatment, and service provision (WHO, 2019). Electronic health records (EHRs) demonstrate their commitment to improving care effectiveness, efficiency, and continuity (Abernethy et al. 2022, 2). Natural language processing (NLP) in clinical settings is a technological achievement used to understand medical concepts, including diseases, treatments, and procedures, with varying degrees of success (Schickel, Tighe, Bihorac, Rashidi 2018, 10). For example, each label in clinical records is divided into categories like drugs and diseases, with related sub-categories such as drug names, dosages, routes of administration, adverse drug events, and disease severity (Schickel et al. 2018, 19). While many of these digital capabilities are still conceptual, their

potential to improve clinical practice is significant. Digital tools and data digitization help clinicians better understand patients' health information. (Abernethy et al. 2022, 2).

2.2.2 Mobile health (mHealth)

Mobile health (mHealth) leverages mobile applications to collect and provide healthcare information and data (Sama, Eapen, Weinfurt, Shah, & Schulman 2014, 1). It is beneficial for individuals to monitor health data, track health information, improve healthcare services, enhance clinical treatment adherence, and assist in chronic disease management (Marcolino et al. 2018, 1). mHealth devices primarily consist of medical tools connected to smartphones via wired or wireless technology (Marcolino et al. 2018, 4). The most widely used mHealth applications focus on fitness and self-monitoring, particularly exercise, diet, and weight management (Fox & Duggan 2010, 13; Sama et al. 2014, 5).

The most popular mobile health interventions are behavior change interventions that use text messages (Marcolino et al. 2018, 8). These interventions facilitate patient-provider communication, decision support, and client education (Marcolino et al. 2018, 4). Mobile health behavior change approaches can improve self-monitoring and engagement and significantly impact health outcomes compared to traditional intervention models (Sama et al. 2014, 1). Mobile devices can enhance communication between patients and providers through text message reminders, voicemails, and videos, promoting disease management (Marcolino et al. 2018, 4-7).

For example, mobile health has significant applications in preventing cardiovascular disease and treating patients with chronic illnesses such as heart failure and diabetes (Sama et al. 2014, 1). Symptom monitoring using peak flow meters and text messages for asthma management can improve cough and nighttime symptoms and reduce daily medication doses. Additionally, recording respiratory symptoms with a mobile phone during exercise training can increase walking distance in cardiac rehabilitation (Marcolino et al. 2018, 5). These applications span a wide range, from health monitoring between individuals and healthcare systems to appointment reminders and health records at the point of care (Barton 2012,1). Recording and tracking data may also increase patient motivation to self-manage (Marcolino et al. 2018,7). This shift allows diagnosis and chronic disease management outside the traditional physician's office or hospital setting (Stein-Hubl, Muse, & Topol 2015,1).

2.2.3 Wearable devices

Wearable devices and mobile health are not the same concepts, but they are closely related. The ubiquitous sensor technology in wearable devices can track and combine various biometrics, such as blood pressure, emotional stress and anxiety levels, sleep stages, and continuous electrocardiogram (ECG) heart rhythm monitoring. Healthcare professionals, researchers, family members, and social networks can all access and share the data produced by these devices (Steinhubl et al. 2015, 2). Due to the widespread availability of affordable health applications, self-monitoring tools and applications have expanded faster than traditional telehealth interventions. These elements offer an adaptable, scalable, portable, and compatible platform with other systems (Sama et al. 2014, 2). Creating mobile health research data presents numerous challenges for the National Institutes of Health (NIH) (Steinhubl et al. 2015, 2).

2.2.4 Telemedicine and Telehealth

Telemedicine and telehealth provide medical services at a distance but differ in scope and application. Telemedicine refers specifically to remote medical services, where healthcare professionals use electronic communication to exchange medical information between sites, thereby improving the clinical health status of patients through remote health assessments, diagnoses, interventions, consultations, monitoring, and information sharing (Darkins & Cary 2000, 4; Kvedar, Coye & Everett 2014, 1). It involves healthcare providers utilizing digital technologies to communicate with patients, make clinical diagnoses, and provide healthcare, especially in remote or underserved areas (Lupton 2017,14; WHO 2022, 34). Typically, consultations are conducted through real-time interactive video and electronic data transmission (Kvedar et al.2014, 2). It is made possible by digital health platforms that provide online prescriptions, video consultations, health monitoring, and other services that make healthcare more convenient and accessible (WHO 2022, 34).

Telehealth, on the other hand, is a broader concept that includes remote medical services, health education, self-management support, and disease prevention (Kvedar et al. 2014, 2; Lupton 2017, 14). Telehealth consumers can access personalized health education and coaching and participate in online discussions or support groups via the Internet or wireless devices. These resources give patients more ways to take charge of their health and well-being (Kvedar et al. 2014, 2). Additionally, telehealth allows medical knowledge to be obtained across geographic borders (Kvedar et al. 2014, 2).

2.2.5 AI in clinical decision making and disease diagnosis

Artificial intelligence (AI) in healthcare primarily involves clinical decision-making, health service management, predictive medicine, and patient data analysis (Secinaro, Calandra, Secinaro, Muthurangu & Biancone 2021,18; Sharma & Kshetri 2020, 3). AI systems aid in lowering the inherent errors in diagnosis and therapy that occur in healthcare settings. To help with real-time health risk alarms and health result projections, these systems gather useful data from sizable patient populations (Jiang, Jiang, Zhi, Dong, Li, Ma & Wang 2017,1). There are primarily two types of AI devices. Structured data, including genetic, medical imaging, and patient data, is analyzed by machine learning (ML) approaches. ML algorithms try to forecast the likelihood of disease outcomes or cluster patient features. To enhance and augment structured medical data, the second category, known as natural language processing (NLP), gathers information from clinical records. NLP programs convert unstructured text into machine-readable, structured data, understanding, interpreting and generating human language. (Jiang et al. 2017, 2; Alowais, Alghamdi, Alsuhebany, Alqahtani,Alshaya, Almohareb & Albekairy 2023,1.)

AI is having a significant impact on clinical and disease diagnosis decision-making. Using X-ray and CT images to differentiate COVID-19 from pneumonia meets the critical prerequisite of rapid and effective management of COVID-19 cases (Al Kuwaiti et al. 2023, 5). AI is frequently utilized in radiology and pathology to improve human interpretation of magnetic resonance imaging (MRI) or diagnostic X-rays. (Abernethy et al. 2022, 3; Alowais et al. 2023, 4). A study conducted in South Korea by Alowais et al.2023, 4 showed that artificial intelligence was more sensitive than radiologists in diagnosing breast cancer masses. The IBM Watson for Oncology AI system can assist in diagnosing cancer (Jiang et al. 2017, 2). Neuroimaging techniques, including MRI and CT scans, are essential

for disease assessment to assist in stroke diagnosis (Secinaro et al.2021,11). AI accuracy relies on the volume and quality of data to find important illness detection patterns. Healthcare systems can diagnose, forecast, or categorize diseases using these instruments. (Alowais et al.2023,3.)

Surgery Assisted by Robots First performed in 1987, the laparoscopic cholecystectomy marked the beginning of minimally invasive surgery (Lanfranco, Castellanos, Desai, & Meyers 2004, 2). Numerous medical specialties can benefit from robotic-assisted surgery, such as urology, colorectal surgery, cardiothoracic surgery, orthopedics, maxillofacial surgery, and neurosurgery (Secinaro et al. 2021, 3). These developments have increased accuracy, shortened recovery time, and enhanced results for patients (Lanfranco et al. 2004, 2).

2.3 Digital health evolution

Mobile-based healthcare services have rapidly increased as a result of digital technology. Related research is expanding the scope of digital health applications (Park, Park & Lee 2022, 2). By the 2010s, the digitization of healthcare had become inevitable, and the amount of medical knowledge was growing rapidly (Meskó et al. 2017, 6-7). The investment in the digital health field is vast, and the corporate structure is robust, with an increase of $1.6 billion from 2016 to 2017. There are 300,000 healthcare applications, and more than 200 new applications are added daily (Mathews et al.2019, 1). The healthcare sector has benefited from the growth of digital health. The continuous updating of hospital information systems (HIS), following the electronic health records (EHR) or medical records systems, clinical decision support systems (CDSS), biological databases, and disease diagnosis applications have forced medical professionals to have higher technical skills. Consumer-centric healthcare, such as remote monitoring and communication, can benefit significantly from digital health operations technology, such as the dispensing of drugs. (Mosa, Yoo & Sheets 2012, 2.) On the other hand, using smartphones for clinical communication can provide the flexibility to securely access patient information anytime, anywhere (Mosa et al. 2012, 7).

Immersive data health improves the efficiency of healthcare services, enhances personalized medicine, improves health outcomes, and revolutionizes areas where healthcare resources are scarce. Traditional healthcare is increasingly being replaced by digital technologies (Meskó, Drobni, Bényei, Gergely & Győrffy 2017, 3; Imison, Castle-Clarke, Watson, & Edwards 2016, 16; Awad,Trenfield, Pollard, Ong, Elbadawi, McCoubrey, & Basit 2021). In the future, the investment model in competent healthcare will continue to grow. According to Martin, Amaya, Torres, Artola, García, García-Navarro & Macía 2023,1-2, the global AI industry market will have a 43.8% compound annual growth rate (CAGR) from 2019 to 2025, from $1.4 billion in 2018 to $17.8 billion in 2025. Nevertheless, in 2020, the market size in North America and Europe differed significantly, with North America exceeding $1.15 billion and Europe exceeding $700 million. North America and Europe are close to exceeding the global budget value, with a CAGR of 44.2% and 43.9%, respectively, from 2021 to 2027.

"Digital health" has become a broad umbrella encompassing applications within the healthcare ecosystem, technology, communication infrastructure, and electronically collected data (WHO Western Pacific 2024). Medical management, personal health, general health plans, and the creation of new knowledge and insights in real time have all benefited from applications that mechanically and digitally record and capture physical states, experiences, and narratives. (Meskó et al. 2017, 4.) Digital

health is revolutionizing the biomedical sciences, medicine, and healthcare by redefining the instruments required to create a healthy future. Self-management, healthcare, and biomedical research heavily rely on cloud computing, artificial intelligence (AI), machine learning, blockchain, digital diagnostics and treatments, telemedicine, and consumer-facing mobile health applications. Together, these developing digital technologies serve as the cornerstone of digital health. (Abernethy et al. 2022.)

The range of digital innovations and diagnostic tools digital health enables is astonishing. For example, smartphone-based photoplethysmography combined with deep neural networks is now used to detect diabetes. Modern technologies, such as smartphone-connected electrocardiograms and genome sequencing provide patients and healthcare professionals with sophisticated diagnostic capabilities. (Meskó et al.2017, 2.) In addition, AI applications in pathology and radiology contribute to more accurate and timely diagnoses by supporting human diagnostic image interpretation, particularly in oncology and renal disease (Abernethy et al.2022, 4). Applications that monitor vital signs have also increased the efficiency with which clinicians can diagnose and manage patient care (Imison et al. 2016, 20).

2.4 Digital health ecosystem

The digital health ecosystem is described as a network of interdependent and connected digital communities by Iyawa, Herselman & Botha (2016,6). These communities comprise various stakeholders, healthcare organizations, and digital health devices, all operating within a digital health environment. The ecosystem enables patients to handle their health and their families' health through information and communication technologies that can help monitor and improve their health status (Abernethy et al. 2022, 6). Digital health initiatives can increase access to health information, encourage service demand, and enable targeted communications with individuals through health promotion messages and reminders. By offering more direct clinical options via decision support tools or telemedicine consultations with other medical specialists, these interventions can also help healthcare personnel. (WHO 2019, 28; Park et al.2022, 2.)

Digital technologies can significantly impact the (SDoH). Digital tools are crucial in screening for and identifying factors influencing patients' SDoH, reminding healthcare providers to address these factors during patient visits, and connecting patients with relevant community services (Abernethy et al. 2022, 7). By addressing SDoH and systemic factors, digital health can reduce missed appointments, help patients access the care they need, and minimize losses in systemic care capacity (Abernethy et al. 2022, 7). At the ecological and environmental level, emerging digital health technologies also address environmental factors such as climate change and air condition (Abernethy et al. 2022, 7), improving the efficiency of public health efforts. Telemedicine and health information exchange (HIE) systems further support patient care coordination, especially during natural disasters. For example, digital health screenings can detect lead in drinking water, addressing health impacts related to environmental issues within the context of SDoH. (Abernethy et al. 2022, 7-8.)

Digital health refers to integrating technology into the healthcare system to enhance the quality, efficiency, and accessibility of healthcare services (Park et al. 2022,12). In South Korea, regional medical facilities are influenced by geographical disparities, with only a few regional hospitals providing trauma and emergency services at the county level. In contrast, medical facilities in the capital are more comprehensive. For trauma and emergency patients, the time required for treatment is critical. Digital health can narrowly bridge the gap between urban and rural medical infrastructure, providing better treatment and management for critically ill patients. (Park et al. 2022,12.) Instance: During the COVID-19 pandemic, it is imperative to compensate for the soaring infection rates and overburdened healthcare systems; digital health provides platforms where patients can proactively monitor and control their health status remotely in real-time (Park et al. 2022, 12). Digital health is essential in contemporary healthcare because it allows patients to communicate and receive care from anywhere.

2.5 Digital health ethics

Vayena, Haeusermann, Adjekum, and Blasimme (2018, 5-6) highlight the growing importance of "data justice" and "digital exclusion" are becoming increasingly important. The booming digital health industry has raised many ethical concerns. Data protection and privacy issues are becoming increasingly prominent, particularly under the Europen General Data Protection Regulation (GDPR). Although the GDPR is intended to protect personal health information, its implementation is often inconsistent. In addition, the distribution of digital health technologies varies globally, with telehealth and electronic health records (EHRs) being particularly prevalent. In contrast, many digital health systems operate across borders or rely on third-party data processors. Case studies show that informed consent is often compromised because consumers are often unaware of how their data is being used.

Ethical considerations in the digital health sector have been discussed for over two decades, beginning with early debates about electronic health records (EHRs) when the technology was still conceptual. As digital health and advances in information and communication technologies continue to develop, ethical frameworks have become increasingly important (Nebeker, Torous, and Bartlett Ellis 2019, 2). Core ethical principles such as justice must always guide innovation. Figure 1 shows that ethical assessments cover four main areas: privacy, access and availability, data management, and risk-benefit balance. The framework ensures that digital health tools promote fairness, autonomy, and justice for all users. (Nebeker et al. 2019, 4). A solid ethical foundation is essential to foster innovation while maintaining individual rights, social trust, and equitable access.

The explosive growth of data and increased digital connectivity make the concept of complete data anonymization impractical, and privacy protection has become an increasingly complex challenge. Data security remains a major ethical issue, with cyberattacks, database breaches, and ransomware attacks making the news. According to Vayena et al. 2018, 5, the USA Department of Health and Human Services reports that millions of medical records in the United States have been compromised. In the illegitimate market, EHRs are worth as much as credit card information, and data breaches are becoming more frequent. For example, in May 2017, ransomware attacked healthcare databases in more than a hundred countries (Vayena et al. 2018, 5). Therefore, the public must be

assured that strong security measures will be implemented through clear policies and effective technology—adopting advanced security technologies, systematic monitoring and evaluation, and transparent accountability mechanisms.

Ethical and legal concerns in digital health have been exacerbated by automated data mining and machine learning in clinical and public health decision-making. It is currently primarily utilized as a vital tool by health care practitioners. Digital technologies such as AI-assisted diagnosis, treatment planning, and surgical robots bring up complex accountability issues. AI may increase the efficacy of medical interventions, but it also limits the ability of human clinicians to step in. Consequently, mistakes (such as misdiagnosis or erroneous epidemic estimates) will make accountability more difficult. (Vayena et al. 2018, 5.)

A trustworthy digital health ecosystem requires strong privacy protections, transparency, accountability, equitable benefit sharing, and user control over their data. Establishing trust is an intricate procedure that cannot be dependent on just a single element. It must be fostered through the joint achievement of these goals. (Vayena et al. 2018, 5.) Innovative informed consent models, while important, are not sufficient on their own. Clear messaging about how individuals and communities benefit from digital health innovations must be provided. Strong oversight mechanisms must be established to protect the public interest and maintain accountability under public scrutiny.

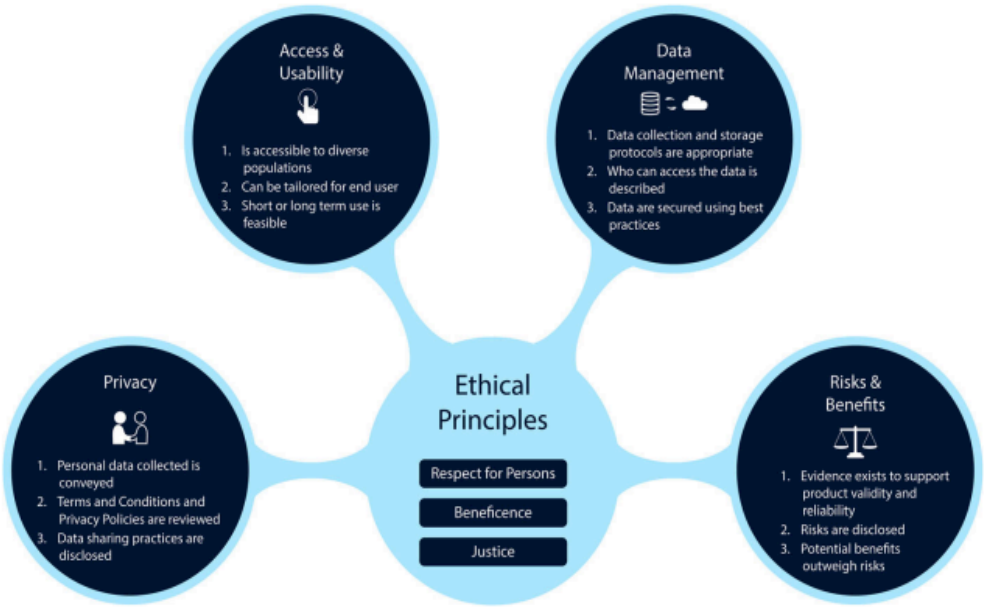

Figure 1: Ethical principles framework (Nebeker, Torous & Bartlett Ellis 2019, 4)

3 SOCIAL EQUALITY

3.1 Social and health equality intertwin

Social equity was an important concept in sociology in the 20th century, which aimed to correct the power imbalance between- "disadvantaged" and "disadvantaged groups." It focuses on recognizing, respecting, and ensuring equal status for different identities, histories, and values (Friedman, Law, Bennett, Ives, Thorn & Wilson, 2018). The core of equity is justice, which is often controversial when applied to social issues. Megahd, El Kayaly, and Ammar (2024, 36) pointed out that health affects human well-being. In the words of Aristotle, health care is essential for individuals to "flourish" as human beings. Social, economic, and environmental factors affect overall well-being - including psychological, social, physical, emotional and spiritual health. As a result, healthcare organizations and executives place a high premium on health equity. (Megahd et al. 2024, 36; WHO March 2025, 5.)

A moral ideal based on the distributive justice ethical principle, health equity is normative (Braveman & Gruskin 2003, 3). Everyone should have the equal opportunity to stay healthy as much as possible, which is called health equity. It requires eliminating poverty, discrimination, and powerlessness that impede health. Reducing and eliminating health inequities and associated factors that negatively impact excluded or marginalized groups is what health equality means for measuring purposes (Braveman 2022, 1.) A fair and equal chance to be healthy is known as health equity, and it necessitates the eradication of poverty, other health related obstacles, and their facts, such as precarity and limited access to decent, fair jobs, housing, education, and healthcare. "Health equity entails removing social and economic obstacles to health, such as discrimination and poverty." (Popham, McMaster, Cumbers & McCartney 2019, 5.)

Access to medical care determines a person's health. Socioeconomic circumstances influence people's health, and poverty and social exclusion can have a significant effect on health or cause early death. Social justice and equality impact individuals' lifestyles, risk of illness, and early mortality. Social and economic policies greatly influence the ability of children to grow and develop fully. (Taylor & Francis 2014, 174.) A crucial social justice component is health equality, which seeks to eradicate disparities in healthcare access and health outcomes brought on by more significant social, economic, and political issues. According to Braveman 2022, health equality is about addressing socioeconomic determinants of health that impact people's opportunities and results, such as financial limitation, discrimination, lack of necessary services, and health inequities. Achieving health equity requires a long and challenging journey to eliminate these structural barriers that prevent certain groups from achieving optimal health. According to Megahd et al. 2024, 36, during the COVID-19 storm, structural deficiencies in the healthcare structure and deep inequities in health drivers have led to widespread disparities and discrimination that have prevented certain groups from achieving well-being. Equity in healthcare has received increased attention.

3.2 Health inequality phenomenon

Health inequalities are preventable and unfair differences in health status between the general population and specific groups. These disparities, shaped by social determinants beyond individual control, violate ideals of social justice (Megahd et al. 2024; McCartney, Popham, McMaster, & Cumbers 2019, 5). Because they are preventable, national efforts should focus on implementing policies to eliminate these inequalities (Braveman 2006, 4). In its 2023 report, The Changing Landscape of Health and Social Equality, the WHO analyzes how equity trends have shifted since the COVID-19 pandemic, examining changes by age, socioeconomic status, sex, gender, and possibly ethnicity and immigrant status. The pandemic has created lasting vulnerabilities, resulting in widespread and uneven impacts on individual's health, economic, and social well-being. (WHO 2023, 9.) Health disparities are significantly impacted by the SDoH. Instead of relying on medical explanations, discuss how a person's life and environment affect their degree of health. Differences in everyday living situations between nations are shaped by political systems, societal conventions, economic policies and institutions, development ambitions, and social programs. (WHO, SDoH; Catalyst 2017; Abernethy et al. 2022, 7.) According to numerous research, SDoH is responsible for 30–55% of health outcomes and it is also responsible for 15% of premature mortality (Abernethy et al. 2022, 7).

Braveman (2006, 4) proposed four definitions of fairness in healthcare: equal utilization, distribution based on needs, accessibility, and health outcomes. Nonetheless, these definitions draw attention to a fundamental "incompatibility" between the concept of "needs" and their true significance, which fuels the continuation of disparities in health and healthcare systems. The WHO also examined in 2023 how health, economic, and social capital contribute to the widening health disparities in Europe (WHO 2023, 22). Health equity is still a significant challenge in this digital age, especially as we strive to modernize healthcare and ensure that resources are distributed fairly. Health equity focuses on unjust disparities to eradicate the systemic disparities in health outcomes between socioeconomic and other groups (Braveman & Gruskin 2003, 2-3). In March 2024, the Health and Welfare of Finnish Institute (THL) highlighted health inequalities. While the overall health of Finns is improving, the distribution of health across the population is becoming increasingly unequal. Inequalities between socioeconomic groups exist in nearly all areas of health and well-being. (THL 2024.)

3.3 Digital health inequality factors

The digital age has exposed obvious social equity issues. In December 2024, the Digital Health Strategy, Lesotho's Ministry of Health collaborated with WHO to discuss implementing digital health solutions, and strategic goals for the Digital Health Strategy 2025-2030 were proposed. Economic development, infrastructure construction, digital skills, and coverage of remote communities are not uniform worldwide, posing a threat to digital equality. In addition to cultural and policy environments, there are also apparent gaps in digital health among different social classes, regions, and groups. (Hui, Patil, Satav, Shah, Panwar, Salim & Pinnock 2022; Richardson, Lawrence, Schoenthaler & Mann 2022; WHO 2024.)

It is imperative to evaluate the dangers associated with digital health technology to avoid needless losses and highlight the significance of defining precise guidelines for its use. The WHO (Heponiemi, Gluschkoff, Leemann, Manderbacka, Aalto & Hyppönen 2023,2) states that institutional support is necessary for the successful adoption of AI to create a national eHealth or digital health strategy and action plan, which frequently calls for more resources and improved capacity. A 2022 WHO study

highlighted that digital health technologies have the chance to improve the standard of healthcare services and the capacity of medical personnel to deliver treatment; these tools are poorly known, especially by people with underlying conditions. This situation underscores significant digital health inequalities, with certain groups—particularly vulnerable populations—facing barriers to benefiting from digital health solutions.

In Finland, Lahtiranta 2017 reported that around 28% of the population is estimated to be internet illiterate. Suggests that over a quarter of the Finnish population is at risk of becoming digitally excluded, potentially falling outside the reach of modern healthcare. In November 2016, Finland's population was estimated at 5.5 million, meaning that more than 500,000 people are at risk of becoming digital orphans. In 2022 study by Mielonen, Kuusisto, Kinnunen, Kemppi,and Saranto examined the experience of implementing e-health for the elderly, finding that while digital services are usable for those under 65, older individuals face challenges due to physical and cognitive declines (Kaihlanen, Virtanen, Buchert, Safarov, Valkonen, Hietapakka & Heponiemi 2022, 2) consistent with Van Deursen et al.2017, 18 findings, which highlight how aging can affect the usability of digital services for the elderly.

Socioeconomic status significantly affects an individual's health. Digital health technologies (DHTs) may lead to new forms of inequality because digital health transformation cannot be seamlessly integrated into all applications. (Badr et al. 2024, 1.) Digital inequalities are evident at various individual and macro levels, such as economic activity and social capital (Robinson et al. 2015, 1-2). Social health and well-being (SDOH) also play a crucial role in shaping digital inequalities (Qureshi, Clarke& Kiemde 2022, 9-10). In addition to high-income countries, some case studies and policy frameworks in developing countries provide important insights into understanding global digital health inequalities. For example, India's National Digital Health Mission (NDHM) emphasizes mobile health projects, highlighting challenges of infrastructure gaps, low digital literacy, and limited affordability in implementing digital health at scale. (Gudi,Lakiang, Pattanshetty, Sarbadhikari & John 2021, 2-3.) It illustrates how socioeconomic and geographic barriers interact differently in low-resource settings, adding comparative depth to the analysis. The digital divide model explains digital inequality at three levels: access, skills, and outcomes. It also explores how social determinants interact with technology to create gaps in digital health participation.

Health Solutions is actively addressing challenges in health equity research. Compared to other groups, African Americans are less likely to own a computer, phone, or tablet, which limits their access to digital health services. Likewise, there are differences in how people with various educational backgrounds use electronic health records (EHR) and online health services. (Badr et al. 2024, 4.) Barriers to technology adoption include concerns about risks and benefits, trust issues, gaps in literacy or digital skills, and general apprehension (Badr et al. 2024, 4). Furthermore, using digital health devices correlates with socioeconomic status, with significant differences observed between high- and low-income groups (Woolley, Bright, Ayres, Morgan, Little, & Davies 2023, 13).

Van Deursen et al.2017,19 also emphasize that women, the elderly, the less educated, and the unemployed often lack the necessary skills to participate in online activities. Access and the caliber of digital participation are both impacted by this digital divide. According to Rydzewski (2025, 2) skill gaps impact people's capacity to locate information, make purchases, and communicate digitally,

while infrastructure constraints like geography, income, and education can restrict access to computers and the internet. Additionally, those with less education are more likely to be marginalized since they are less active in social, political, and cultural arenas (Van Deursen et al.2017, 19). The social determinants of health (SDoH) framework states that broader individual income, education, and social status are key drivers of health inequalities, which also influence access to information technologies (ICTs) and internet infrastructure (Richardson et al. 2022, 2.) Rydzewski (2025, 3) highlights that higher-income and higher-education groups generally have better access to digital services, while individuals from disadvantaged backgrounds—particularly those in low-income families or unserved regions struggle to access and use digital health tools effectively. As VanDeursen et al. 2017 conclude, using digital tools and navigating effectively are essential, and the digital divide is getting more expansive due to gaps in digital abilities, particularly among marginalized populations.

On May 19, 2024, For the Europe, the Digital Health Advisory Group (DHAGE) discussed digital health (DH) in the healthcare industry, assisting challenges from different perspectives in the theme of Harnessing Digital Health Analyzing Economic Impact in Healthcare Systems. The Finnish Ministry of Health also mentioned concerns about health data in the mental and digital health discussion on July 27–28, 2023. AI initiates catastrophe disasters for healthcare industry workers because AI makes the working environment unfamiliar and challenging. It hinders the relationship between people and weakens the foundation of people.

3.4 Challenges and opportunities for healthcare professionals

Digital health competency development supports healthcare workers, caregivers, and allied health professionals. According to Jarva et.all (2022, 3), Digital health services could improve fair access to healthcare, as well as improve disease prevention, diagnosis, and rehabilitation. However, without systemic governance, digital health technologies may contribute to widening existing inequalities (Jarva et al. 2022, 8-9; Saithibvongsa & Yu 2018, 4–5).

To address these challenges, In the European Region, the WHO has emphasized the importance of strengthening efforts for capacity building and digital literacy, particularly among healthcare professionals. To guarantee the acceptance and application of digital health technology, one of its main goals for the 2023–2030 period is to improve the digital competencies of the health workforce (Borges do Nascimento, Abdulazeem, Vasanthan, Martinez, Zucoloto, Østengaard, & Novillo-Ortiz, 2023,1). While healthcare professionals in Nordic countries generally demonstrate strong digital skills and integrate digital health tools into their daily practice, the global healthcare industry continues to experience a shortage of digital expertise (Jarva et al. 2022, 2; Borges do Nascimento et al. 2023, 1–2).

Byrne (2021, 2-3) draws attention to worries about healthcare applications of AI, citing research from the Institute of Medicine (IOM) that cautions that AI algorithms could inadvertently perpetuate healthcare disparities. Nurse anesthetists, for example, must be conscious of how AI affects clinical judgment and seek to guarantee that AI-powered medical technology fosters equity and inclusivity. Therefore, investing in healthcare professionals' digital skills is essential to achieving equitable and successful digital health integration.

Personal and psychological barriers continue to pose significant challenges to adopting digital health technologies among healthcare professionals. Common barriers include resistance to change, difficulties in understanding new technologies, fear of technology, age-related factors, education level, professional experience, low literacy, poor writing skills, language barriers, and reluctance to adopt new systems. Low expectations, distrust in healthcare technology, and poor adherence to digital tools hinder widespread implementation. However, healthcare professionals' perceived usefulness of digital health solutions and willingness to engage with these technologies are frequently cited as critical factors influencing successful adoption. (Borges do Nascimento et al. 2023, 14.)

The challenges associated with digital health adoption are particularly pronounced in less developed regions, where infrastructure and technological limitations create substantial barriers. The most cited challenges include inadequate internet connectivity, lack of essential technology, insufficient medical equipment, compatibility issues with existing workflows, slow connection speeds, difficulties in integrating medical technologies, interoperability concerns, lack of standardized systems across healthcare facilities, unreliable power supply, and insufficient data storage capacity. (Borges do Nascimento et al. 2023,14.)

3.5 The role of healthcare professionals in digital health

In digital health, healthcare professionals' (HCPs') roles have changed dramatically, necessitating the acquisition of new skills to meet new problems. Research identifies critical issues that require digital health literacy and abilities to address, including the digital gap, patient integrity, and safety concerns. HCPs need proficiency in digital technologies to ensure ethical, the quality of patient care, alongside strong interpersonal and communication abilities for effectively integrating these tools into health prevention, diagnosis, and treatment. Additionally, openness to digital innovations and a supportive work environment can enhance positive experiences with digital health. (Jarva et al. 2022, 3.)

To successfully operate in digital healthcare, HCPs must develop advanced communication, consultation, and evaluation skills (Kaihlaniemi, Liljamo, Rajala, Kaakinen, & Oikarinen, 2023, 2; Konttila, Siira, Kyngäs, Lahtinen, Elo, Kääriäinen, & Mikkonen 2019, 13). Through consultations, asking targeted questions, and providing peer support, they greatly help patients take care of themselves. Additionally, patients must receive correct, up-to-date, and understandable information to help them navigate their treatment process. (Kaihlaniemi et al. 2023, 2; Jarva et al. 2022, 5.)

HCPs additionally require a solid grasp of the GDPR and other privacy frameworks. Digital competency frameworks emphasize the need for fundamental IT skills, electronic health data management, digital communication proficiency, and an awareness of technology use's ethical, legal, and security implications. (Kaihlaniemi et al. 2023, 10.) In addition to technical skills, healthcare professionals must be able to recognize problems, make independent clinical decisions, and apply their expertise to ensure safe and effective patient care. The growing use of digital health technologies, especially in distance care, means that experts have to make difficult decisions and deal with more vulnerable patients. (Konttila et al. 2019,13.)

4 RESEARCH PURPOSE

This study explores the reasons for gaps in the advancement of digital health interventions and proposes some fundamental questions and solutions. The focus is on the following questions: What challenges are faced in promoting social equity in digital health development? It also highlights the leading causes of this inequality and its significant impact on health outcomes. The research in this article is based on the research question:

Research question:

What challenges are faced in promoting social equity in digital health development?

5 LITERATURE REVIEW

5.1 Literature review approach

Literature reviews have long been a key method for providing an overview of current and historical knowledge across various fields. The studies included in a literature review are typically selected from peer-reviewed sources. (Aromataris & Pearson 2014, 1.) The Literature reviews form the foundation of research by contributing to knowledge development and establishing guidelines for practice (Snyder 2019, 7). When evaluating the collective evidence in a specific research area is challenging, literature reviews become even more critical as a research method. Well-conducted reviews provide a strong basis for advancing knowledge and promoting theoretical development. (Snyder 2019, 1.)

As pointed out by Aromataris et al. (2014, 1), literature review plays several important roles in academic research. First, it systematically sorts out the basic knowledge of the research topic and provides researchers with an overall understanding of a specific field. Second, literature reviews may investigate the evolution of knowledge and show how scholarly concepts and research findings have changed over time by examining the body of current literature. Researchers can better define their future research priorities by reflecting on previous study findings, opposing viewpoints, or unsolved problems. In addition, a literature review also helps to determine whether the academic community is reaching a consensus or still has differences on a specific topic. It also promotes a deeper understanding of the theoretical system by exploring the internal connections between core concepts. These functions together provide a solid foundation for new research and reasonably illustrate the necessity of further exploration.

Literature reviews are crucial for defining research problems, synthesizing findings, and examining variable relationships (Snyder 2019, 2). Traditional or narrative literature reviews often serve these functions effectively. However, independent reviewers' systematic reviews apply a rigorous methodology to minimize subjective interpretation and errors, making them more reliable than traditional literature reviews (Snyder 2019, 2; Whittemore & Knafl 2005, 2). According to Aromataris et al. 2014, 3, systematic reviews frequently utilize the PICO framework (Population, Intervention, Comparison, and Outcome) to formulate answerable research questions. Literature reviews can be categorized into narrative, systematic, meta-analysis, and qualitative approaches (Whittemore & Knafl 2005, 1). Their development and application are integral to evidence-based practice.

A literature review component of a completed research report is revised from its proposal-stage version. It aims to demonstrate how the conclusions relate to existing knowledge (Knopf 2006, 3). A literature review consists of two key elements: first, a concise summary of research findings or claims, and second, an evaluation of their accuracy and completeness, presenting reasoned judgments on what is correct, incorrect, uncertain, or missing (Knopf 2006, 2). This article adopts the structure of a narrative literature review, synthesizing relevant research to provide a cohesive analysis of the topic.

5.2 Narrative review methodology

The categories of literature reviews are editorials, commentaries, and review articles. Narrative literature reviews fall into this category because they are based on a review of a small number of papers (Green, Bart, Claire, Johnson, & Alan Adams 2006, 103). The comprehensive nature of these articles is inherently biased, providing a broad perspective on the topic. Review articles are typically shorter than full review articles and require the author to have expertise in the review content (Green et al. 2006, 103-104). Theory development is the most ambitious objective of a literature review study. These evaluations look at the literature to evaluate the viability of current hypotheses, frequently contrasting two or more opposing theories rather than introducing a novel theoretical viewpoint. This process takes a significant step in the level of abstraction. At the same time, the narrative literature review method has certain limitations. There are also some limitations to the narrative literature review method. The problem is the subjective nature of study selection, interpretation, and synthesis. It also includes that due to the lack of strict inclusion criteria or quantitative summary methods, researcher bias may affect narrative reviews, affecting the neutrality and reproducibility of research results. The generalizability of research results is limited. The lack of empirical data or real-world case validation reduces the direct applicability of the conclusions in practical applications. (Baumeister, Roy & Mark Leary 1997, 313- 314).

In summary, a review is a biased narrative synthesis that relies on the expertise of reviewers to integrate a large amount of information into a readable format. Reviews often stimulate scholarly dialogue among journal readers by comprehensively synthesizing previously published information. (Green et al. 2006, 103–104.) The literature review serves as a database from which authors can assess the validity of previously held beliefs. Articles that seek to develop or assess theories are frequently published in prestigious review journals. As a result, the authors of these reviews must understand that the job is to create or assess theoretical frameworks and gather and describe previous research findings. (Baumeister, Roy & Mark Leary 1997, 313–314.)

5.3 Criteria for inclusion and removal

The approach ensures the selected literature's relevance, scientific, and high-quality standards and provides strong support for the research questions. Writing a narrative overview is to conduct a preliminary literature research. The aim of searching the literature is to understand the field of ongoing research. It helps to refine the theme and objectives of the overview. (Green et al. 2006, 107.) The literature's inclusion criteria cover several important topics. Understanding the connection between social equality and digital health is the aim of the literature review. With an emphasis on the primary obstacles to equitable access to digital health services, the research topic must be connected to the growth of digital health, health equality, and the impact of digital health on medical accessibility. "What challenges are faced in promoting social equity in digital health development?" is the research question that guides this study. The search keywords are locked. The research is at the Savonia University of Applied Sciences Library, which provides free databases for investigation.

A literature review guarantees the scope and depth of the study. The literature selection process assists in narrowing the research's applicability by establishing inclusion and exclusion criteria. Inclusion criteria specify the key elements of the evaluation, while exclusion criteria can be selected based on their applicability to the search objectives. (Ferrari, Rossella 2015, 232.) Literature pub-

lished within 5 years from 2015 to 2025 is preferred regarding time range and keeping the data timeliness and update. Early studies with important theoretical contributions are also considered. In terms of research subjects, we focus on the barriers faced by different socioeconomic groups, especially marginalized groups (such as the elderly, people with impairments and modest incomes) in using digital health services. The effect of digital health on health equity should be covered in the research. Peer-reviewed journal papers serve as data sources to guarantee the study's validity. English-language research publications improve the research's reach and breadth.

On the contrary, we excluded irrelevant or low-quality studies by setting strict exclusion criteria. First, research not involving digital health, health equity, or medical accessibility—such as papers focused solely on technology development without addressing health equity—was excluded. Secondly, literature that did not align with the research type was omitted. Additionally, studies published before 2020 were generally not considered. Research that examines only a single digital health technology without addressing its impact on equitable medical accessibility was also excluded. Below table 1 clearly outlines the categories of study data inclusion and exclusion.

Furthermore, studies with unreliable data sources, a lack of transparency, or unverifiable data reports were deemed unqualified. By establishing explicit inclusion and exclusion criteria, we ensured a more efficient, systematic, and scientific screening and analysis of relevant literature. This approach allows for a deeper exploration of the challenges affecting equitable medical accessibility in digital health development and provides theoretical support for potential solutions.

Categories	Year	Language	Research theme
Inclusion	After 2015	English	Digital health relates social equality or health equality
Exclusion	Before 2015	Not available English	Digital health technology without social equality, or health equality

Table 1: Inclusion and exclusion categories

5.4 Selection process for research

The literature review approach entailed finding, examining, and assessing published research. EBSCOhost and PubMed were used to choose argumentative research. Everything from the date to the keywords and their combinations to the number of records found in each search was methodically recorded. If the retrieved articles satisfied the research criteria, they were manually selected based on their citations to pertinent publications. (Ferrari, Rossella 2015, 232.) Citations were restricted from the same research group or journal to maintain variety. A refinement process was carried out once an extensive collection of articles was gathered, and each stage was methodically documented in the references.

A personal account was used to access the Savonia Library database, and keyword searches followed Boolean logic using "AND" and "OR" operators. The initial search in CINAHL Ultimate included the following terms: ("Digital health" OR "Digital health technology," OR "Telemedicine" OR "Telehealth" OR "mHealth") AND ("Social equality" OR "Health equality" OR "Health inequality" OR "Equitable healthcare access") AND ("Challenge" OR "Difficult") AND ("Digital health intervention" OR "Reduce health inequality"). The inclusion criteria were restricted to English-language publications from 2015 to 2025. This search yielded two (n=2) studies that met the inclusion criteria. In PubMed, the search terms used were: ("Digital health" OR "Digital medicine" OR "Electronic health" OR "eHealth" OR "Telehealth" OR "Telemedicine") AND ("Social inequality" OR "Social injustice") AND ("Reducing inequality" OR "Preventing inequality"). The initial search retrieved 135 (n=135) studies. When limited to English-language publications from 2015 to 2025, 130 (n=130) studies remained. After screening titles and abstracts, 95 (n=95) studies were excluded as irrelevant. Additionally, 14 (n=14) studies were inaccessible and thus excluded, and 2 (n=2) studies were removed due to overlap with CINAHL. The full texts of the remaining 19 (n=19) studies were reviewed, and after the final analysis, 8 (n=8) studies were selected as the final materials based on their alignment with the research topic. Table 2 clearly shows the PubMed and CINAHL Ultimate research term.

Data Base	**Key terms “AND “and “OR “**
CINAHL Ultimate	“Digital health" OR "Digital health technology," OR "Telemedicine" OR "Telehealth" OR "mHealth" AND: "Social equality" OR "Health equality" OR "Health inequality" OR "Equitable healthcare access" AND: "Challenge" OR "Difficult" AND "Digital health intervention" OR "Reduce health inequality"
PubMed	"Digital health" OR "Digital medicine" OR "Electronic health" OR "eHealth" OR "Telehealth" OR "Telemedicine" AND "Social inequality" OR "Social injustice" AND "Reducing inequality" OR "Preventing inequality"

Table 2: Data Base search by "AND" and "OR"

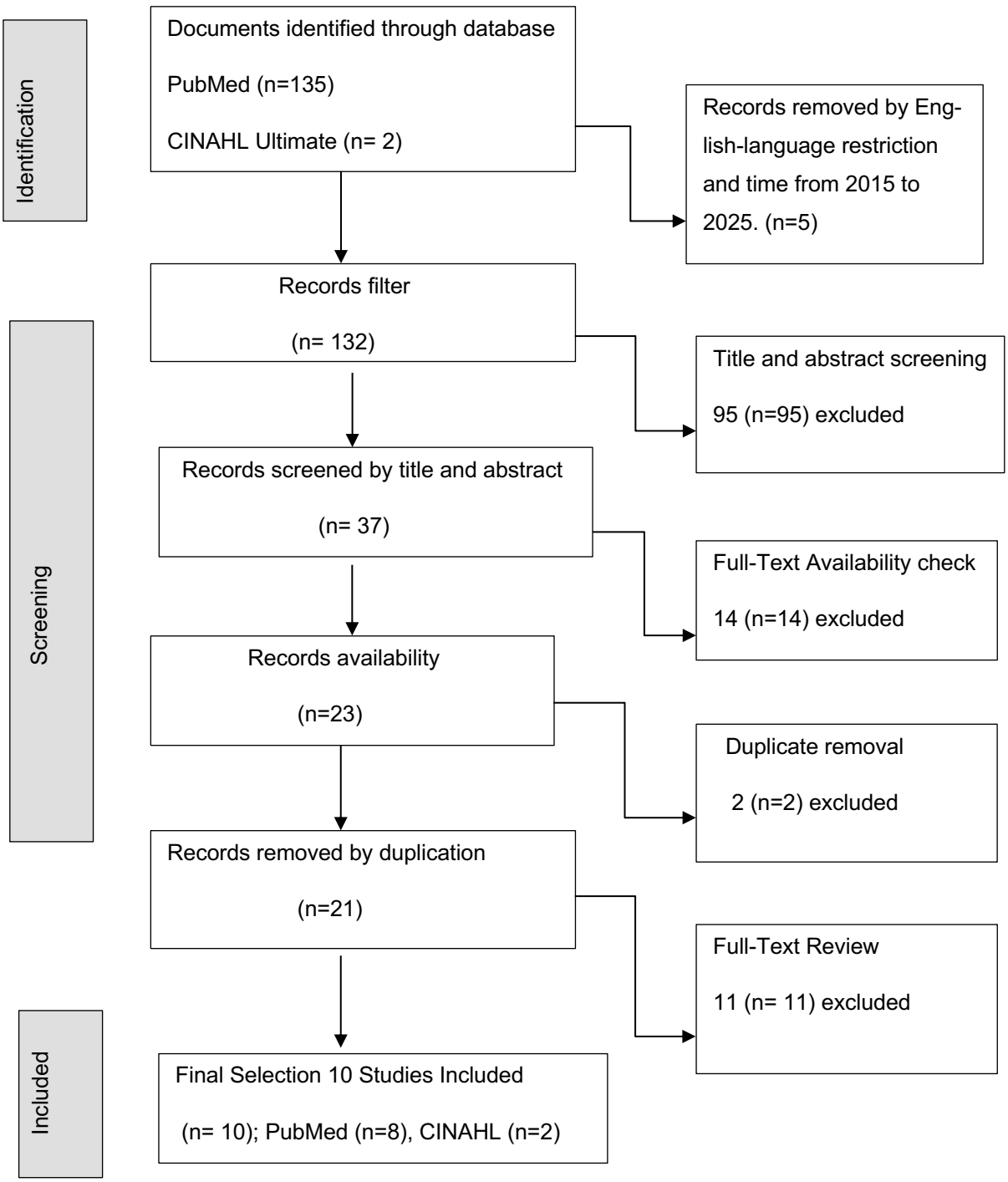

Figure 2: Literature selection process

6 DATABASE ANALYSIS

6.1 Socioeconomic position causes the digital health disparity

Digital health literacy is significantly influenced by socioeconomic status (SES) (Estrela, et.al. 2023, 6). At the individual and community levels, disparities in socioeconomic status, culture, and environment are the main manifestations of inequality, which is frequently made worse by digital health treatments. SES affects a person's ability to pay for Internet connection and smart devices, which are necessary for digital health services. (König, Krukowski, Kuntsche, Busse, Gumbert, Gemesi, Neter 2023, 2). Higher-income people tend to be more digitally literate because they have easier access to smart gadgets, the Internet, and health-related resources (Estrela et al. 2023, 6). On the other hand, financial limitations frequently restrict low-income people from using digital health services (König et al. 2025, 2–3). Many struggle to afford smartphones or Internet subscriptions and lack opportunities for technology training and support (Estrela et al. 2023, 6; Piers, Williams, and Sharpe 2023, 91)

According to research, using digital health devices poses several difficulties for diabetics' treatment due to the inability to pay for essential technologies such as smart blood glucose meters and activity monitors, which is a huge barrier for many diabetic patients, particularly those with lower incomes. Even when provided by the National Health Service (NHS), not all patients have free access to these devices. (Turnbull, Lucas, Hay, & Cabral 2021, 2–3.) Further limiting access to critical health information is that people from lower socioeconomic backgrounds sometimes have hectic job schedules that provide little time for learning digital health technologies. These gaps might be addressed by offering low-income groups technical skills and reasonably priced digital health services. (Estrela et al. 2023, 6.) SES similarly impacts the efficacy of digital interventions. Digital technologies have the capacity to assist individual control weight and promote healthy habits, but their effects are frequently less pronounced in low-income groups (König, Western, Denton, & Krukowski 2025, 6.)

Second, a person’s education is an important component of their socioeconomic status (SES), a key component of digital health literacy. The unequal growth of digital health is also impacted by disparities brought about by research. Currently, most digital health report research focuses on Western, highly educated, industrialized, wealthy, and democratic (WEIRD) countries, often overlooking low-income countries and culturally diverse populations. (König et al. 2023, 2.) In addition, the results of many studies are of limited relevance because they fail to fully consider the impact of life environment, occupation, and SES on digital health use (König et al. 2023, 3). Because recruitment for these studies is often conducted online, including people with lower education or those without reliable internet connections is difficult. In addition, low-income people may be reluctant to participate due to financial and time constraints and existing studies rarely provide incentives to increase participation rates among these groups (König et al. 2023, 3).

Digital health literacy is greatly affected by education level. Those with higher levels of education can accept digital information quickly. Conversely, those with less education struggle to comprehend complicated health information or distinguish between trustworthy and unreliable sources because they lack fundamental computing skills. For example, research indicates that people with a college degree or above are significantly more digitally literate than people without one. (Estrela et al. 2023, 5.) The digital divide, socioeconomic and demographic characteristics, and limitations in measuring

e-health literacy are some of the reasons for digital health inequalities. People with higher levels of education generally have more potent e-health literacy in terms of socioeconomic and demographics, as they can better evaluate and understand online health information. However, people have fewer financial resources and educational opportunities, and low-income individuals frequently struggle to obtain high-quality health information. (Petrič & Atanasova 2024, 9.) Addressing these gaps through inclusive research techniques and training in digital skills is necessary to reduce health disparities and increase access to digital health.

The digital divide is not just a question of "whether or not you can access the Internet" but a more complex spectrum of digital connectivity (Piers, Williams, and Sharpe 2023, 91). Low-income groups often cannot afford smart devices or stable Internet connections regarding basic network and device accessibility (Latulippe, Hamel, and Giroux 2017, 5). Many low-income families need to share a device with multiple members, making it difficult for individuals to use health technology tools. At the same time, some adolescents can only use Internet resources in public places such as schools or libraries, which restricts their usage of interventions related to digital health. In addition, during the COVID-19 pandemic, the popularity of online education and medical services has further exposed this problem, and low-income people are at a clear disadvantage in accessing telemedicine and online mental health support (Piers et al. 2023, 91). Socioeconomic and demographic factors are also important aspects that affect the fairness of eHealth. Low-income groups often lack access to stable networks and technical support due to limited resources. At the same time, people with low education levels may find it difficult to effectively use eHealth tools due to insufficient health literacy and digital skills (Latulippe et al. 2017, 5–6; Latulippe, Hamel, and Giroux 2020, 4).

6.2 Insufficient accessibility of the network and devices

Lack of digital technology capabilities and network infrastructure are also factors. Due to lacking digital skills, some patients find it challenging to understand digital health technologies (DHTs) or cannot determine which technologies are most effective for managing diabetes (Turnbull et al. 2021,5). In addition, insufficient support for digital technology in the medical system is also a significant obstacle. (Turnbull et al. 2021, 6) Studies have shown that many diabetic patients do not receive recommendations about DHTs from medical staff, doctors have limited knowledge of such technologies, and patients rely more on the Internet, social circles, or online communities to obtain information (Turnbull et al. 2021, 6-7). Complex interfaces and laborious login processes may be complicated for specific eHealth consumers. As stated in Lattitippe et al. (2017,6-7), application software development prioritizes users with higher digital proficiency over those with lesser levels. Furthermore, many eHealth resources do not have audio or video content appropriate for users with poor literacy, making it harder for those with less education to obtain helpful health information. Design flaws in eHealth could also contribute to the escalation of health disparities.

Health disparities are caused mainly by the digital divide, which is the gap in how different social groups use and have access to digital technologies. The idea that digital literacy and technology abilities are interchangeable is an exception. Digital health literacy, which includes using health applications, making appointments, searching the internet for health information, and participating in telehealth consultations, is the ability to find, understand, and apply digital health information. (Estrela & colleagues 2023, 2.) Individuals with a high degree of digital health literacy make superior healthcare management judgments. Conversely, those lacking technological abilities cannot use

digital health technologies appropriately, which exacerbates health disparities. Social media is being utilized in different ways around the world.

Jafar, Quick, Rimányi, and Musuka (2024, 1) provide data showing that the penetration rate of social media in Northern Europe is 80.2%, while that in Central Africa is only 9.8%, a difference of nearly 8 times. The research shows that personal access to digital health services relies on digital health literacy. Furthermore, it is reflected that It is reflected that those who lack digital health literacy may be more prone to making poor judgments about their health. In addition, the absence of digital ability may lead to reduced autonomy, which can affect people in the medical system and is not conducive to their health management. Therefore, studying the key factors affecting digital health literacy will help formulate targeted policies and reduce health inequalities. (Estrela et al. 2023, 2; Jafar et al.2024, 4.)

Even if they have devices, some people still lack sufficient technical skills to use eHealth tools (Latulippe et al. 2017, 5). An Italian study analyzed 108 patients in a dementia clinic to assess the success rate of their neurological assessments via telemedicine during the pandemic. The study discovered that despite the patients' age, gender, and educational attainment had little bearing on the success rate of telemedicine, the age and technological adaptability of the caregivers became key factors in the success of telemedicine. (Arighi, Fumagalli, Carandini, Pietroboni, De Riz, Galimberti, and Scarpini 2020, 2–3.) The study showed that among the 108 patients who received telemedicine contact, 74 (68.5%) successfully underwent a video consultation. In contrast, 34 (31.5%) failed to complete the consultation, of which 8 (23.5%) were unable to perform telemedicine due to a lack of network equipment (computer, tablet, or smartphone), and 26 (76.4%) failed to complete the consultation due to connection problems. This result shows that although device accessibility is one of the influencing factors, technological adaptability and social support networks are the decisive factors for the success rate of telemedicine. (Arighi et.all. 2020, 2-3.)

The digital divide is reflected in multiple aspects, including insufficient essential equipment and Internet access (Latulippe, Hamel, and Giroux 2020, 2). The digital divide further exacerbates health inequality. The Internet is the foundation of digital health, especially for residents in rural and poor areas who may not have access to stable network connections, which makes it difficult for them to access online health resources. In the study of König et al. (2025, 8), Geographic location is also one of the key factors affecting digital health inequality. Urban residents generally have easier access to health resources, including online health services and digital tools, than rural residents. In addition, due to the low broadband coverage in rural areas, many residents have difficulty accessing the Internet stably, which makes them less involved in digital health interventions. According to Jafar et al. 2024, 4, the digital divide is also affected by gender, age, socioeconomic status, and urban-rural gaps. In the least developed countries, the Internet usage rate of women is only 30%, far lower than the 43% of men. At the same time, the Internet access rate of young people (15-24 years old) is 48%, while the Internet access rate of people aged 25 and above is only 26%. Regarding urban-rural gaps, low-income families in developed countries face a significant digital divide. For example, in the United States, 41% of low-income families do not have laptops, and 43% do not have home broadband, while the Internet penetration rate of high-income families is close to 100%. This digital divide directly affects the general population's access to health information and puts low-income

people at a disadvantage in managing their health and preventing illness. (Jafar and colleagues 2024, 4.)

6.3 Digital divide and vulnerable groups

The digital technology is not equitable. In a study examining the use of telemedicine for people with dementia in Italy, marginalized groups (including racial and ethnic minorities) may not be able to access culturally relevant eHealth resources, possibly due to language barriers (Piers, Williams, and Sharpe 2023, 93). language barriers affect the access and use of eHealth resources by certain groups, and many eHealth tools lack multilingual support, making them difficult for non-native speakers to understand. In addition, people with low education levels not only have disadvantages in digital skills but may also be unable to fully understand and apply health information due to insufficient health literacy, further limiting their ability to manage health. (Latulippe, Hamel, and Giroux 2020, 13.)

Older people are another vulnerable group often called the “forgotten population” in developing digital health despite their significant healthcare needs due to their lack of familiarity with new technologies (Latulippe, Hamel, and Giroux 2017, 5-6). This digital marginalization also affects youth’s access to mental health services. For example, homeless youth may lack stable devices and internet access, while rural youth may face inadequate internet infrastructure, which is not necessarily accompanied by socioeconomic disadvantage. (Piers, Williams, and Sharpe 2023, 1.) Age is an important factor affecting the efficiency of interventions in digital health. Young people are generally more comfortable using digital tools and are likelier to use health-related smartphone apps, online courses, or wearable devices. However, young people from low-income families often face complex challenges. Piers et al. (2023 99-100), discovered that this group is less likely to seek or get digital mental health care because of a lack of parental support and a lack of information surrounding mental health. In many disadvantaged families, mental health problems are seen as personal weaknesses rather than medical conditions that require professional help. This cultural belief prevents adolescents from taking advantage of existing digital mental health interventions, even if they are technically feasible. (Piers et al. 2023, 99-100.)

Interestingly, König et al. 2025, 7 research shows that older adults can successfully use digital health tools and perform just as well as younger participants in some interventions. Older adults from better socioeconomic backgrounds (higher income, education, and social status) tend to adapt more quickly to digital health environments. (Merkel & Hess 2020, 3; Estrela et al. 2023, 5; König et al. 2025, 8.) In some cases, older adults have higher adherence to wearable devices, which leads to higher levels of physical activity. According to studies, those who have completed a significant amount of formal education and are at least 20 years old are nearly twice as likely to use digital health services as those who have not (Merkel & Hess 2020, 3). Better navigation, assessment, and use of health information are made possible by increased digital literacy levels, which correlate with education level. However, due to financial limitations like being unable to buy smart gadgets or pay for the internet, older persons with lower incomes are less to use digital health solutions.

People aged 75 years and older are most affected, often with poor attention spans and less frequent use of digital tools. Age-related barriers, such as cognitive decline and sensory impairments (vision or hearing loss), complicate the adoption of digital health technologies (Estrela et al. 2023, 5; König

et al. 2025, 8.) However, particularly elderly patients or those without access to technology, Health disparities were made worse during the pandemic by the digital divide between various social groups and the advantages of information and communication technologies (ICT). Due to severe digital health inequities, some people cannot receive essential health care. (Arighi, Fumagalli, Carandini, Pietroboni, De Riz, Galimberti and Scarpini 2020, 2.) These findings highlight the need to design and support digital health interventions that are age- and income-appropriate.

6.4 Disparities in policy and geography

Governments have yet to establish intense digital health training and promotion systems, marginalized groups have difficulty accessing services or acquiring the digital skills they need. (Watson, Green, Giebel, Darlington-Pollock, and Akpan 2022, 1482.) For example, Elderly Europeans' use of internet health and care resources varies widely across countries. Countries like Malta, Cyprus, and Germany have far lower rates of e-health use among their elderly population, whereas Scandinavia and Estonia report rates. Differences may influence these differences in internet infrastructure, national policies, and technological adaptability among older populations. (Merkel & Hess 2020, 2.) Survey data further highlights this issue, showing that more than 83% of older people have never used digital health services, highlighting the enormous challenges of widespread adoption of digital health technologies (Merkel & Hess 2020,2).

Watson et al. (2022, 1476–1477), highlight how shortcomings in government support have led to the availability and quality of healthcare for people with dementia (PLWD). Governments have pledged to increase funding for support services, but these commitments have yet to be delivered. Continued government underfunding and neglect of social care systems have resulted in poor differences in diagnosis, support, treatment, and outcomes. People who live in underprivileged areas or have lower socioeconomic levels are prone to experience unmet care outcomes and worse health. For PLWD and their careers, access to dependable, high-quality care in the community or institutions is severely limited, which exacerbates detrimental disparities in social and health outcomes.

Internet connection worldwide, particularly in rural areas and the global South, where inadequate infrastructure makes it difficult for people to continue using digital health services. Healthcare providers might be reluctant to support or utilize digital technology because they lack the necessary skills or have concerns about its efficacy. (König and others, 2023, 4.) Cultural and religious factors also influence digital health technology proficiency. Telemedicine and digital health tools may be impacted by the differences in concerns over data privacy and the sharing of personal health information between nations with collectivist values and those with more individualistic values. (König and others, 2023, 4.)

Research-related limitations contribute to digital health inequalities due to geography. Geographic barriers also remain, as clinical research and digital health trials are often conducted in urban areas, with rural populations underrepresented due to transportation and access constraints (König et al. 2023, 5). Even if eHealth resources are accessible, factors such as cultural inadequacy, lack of multilingual support, and the complexity of health information may prevent certain groups from fully benefiting from digital health interventions (Latulippe, Hamel, & Giroux 2017, 5).

7 SUMMARY

7.1 Enhancing digital literacy and adaptive digital design

This study focuses on the impact of individual characteristics (including age, gender, socioeconomic status, digital literacy, technology accessibility, and health service delivery model) on digital health services. It aims to reveal the mechanisms that may exacerbate health disparities in digital health popularization. By identifying and analyzing the above factors, theoretical and practical suggestions are provided for building a more equitable and inclusive digital health system.

According to Petrič et al.2024,9, improving e-health literacy and digital skills is key to reducing inequality for vulnerable populations like the elderly and those with limited incomes. They pointed out that digital skills training should be carried out to help vulnerable groups use online health resources more effectively while using easy-to-understand language in health communication and providing multilingual avoid challenges from different cultural and educational backgrounds. Estrela et al. (2023, 6) mentioned that due to language barriers, immigrant groups may find it difficult to understand digital health resources in their host country, and groups whose native language is not the mainstream language may be at a disadvantage in obtaining health information. Schools and communities should carry out digital health education to help adolescents and families improve their mental health awareness and master the ability to use digital intervention tools effectively. Future interventions should adopt a multimodal approach, combining online interventions with offline support, such as providing psychological counseling hotlines and community psychological support networks to make up for the limitations brought by the digital divide. (Piers et all. 2023.)

Therefore, providing multilingual health resources and translation services may help improve the digital health literacy of immigrants and ethnic minority groups. In addition, governments and social organizations can support fair access to digital health resources for all by developing affordable and easy-to-use health applications, improving digital infrastructure construction, and ensuring safe access to the Internet for all. Petrič et al. 2024, noted that enhancing the e-health literacy assessment instruments is essential to creating more specialized training and intervention strategies. The eHEALS-E scale, for instance, can be used to more thoroughly evaluate the level of e-health literacy across various social groups. It ensures that measurement tools are applicable across groups, prevents policy errors due to measurement bias, and provides more accurate data support for policy-making.

The e-health design also exacerbates digital inequality (Latulippe et al.2017). To address this issue, Latulippe et al. 2021, 2–3 further proposed a “co-design” approach to encourage users to directly enhance the accessibility and inclusivity of e-health products by contributing to its design. During co-creation, target users can provide practical suggestions, such as simplifying the steps to obtain information to “within two clicks” to improve the user experience. Although some older people find it challenging to participate in the technical design directly, they can point out difficult-to-understand terms in the interface, thereby helping the development team optimize the content expression.

Families with lower socioeconomic status often lack digital education resources, making it difficult for adolescents to use digital health applications. In addition, some adolescents may be more inclined to rely on social media rather than formal digital health intervention platforms to obtain mental health

information, which may lead to their exposure to false or misleading health information. Digital literacy levels may also affect whether they can effectively use digital mental health interventions. Digital literacy includes basic technical operation skills and the capability to interpret, screen, and use digital health correctly. (Piers, et all. 2023, 99–101.) This co-creation approach can add multilingual options, enhance social functions, or design health management models that align with specific cultural backgrounds. In addition, the co-creation process can also potentially improve digital skills and health literacy. People with lower skill levels can receive training and guidance during participation to better adapt to electronic health tools and improve their health management capabilities. (Latulippe et al. 2021, 2–3.)

7.2 Promoting funding and infrastructure development

Emphasize that the construction of digital health equity should be promoted from the policy level. The government can provide free or low-cost networks to financial limitation groups, expand the coverage of digital infrastructure, and provide policy support. (König et al. 2023, 3-5.) Internet access and social media use have become important social determinants of health status (Jafar et al. 2024, 2-3). Studies have found that the degree of digital health literacy increases with the frequency of Internet use. Some studies have shown that people who use the Internet to obtain health information have significantly greater digital health literacy scores than those who occasionally or never use the Internet. (Jafar et al.2024, 5; Estrela et al. 2023, 6.) Researchers must consider the user's socioeconomic status, cultural background, and individual differences when designing and evaluating digital health tools. Improving research methods (such as using culturally sensitive and easy-to-understand questionnaires) can help lower the participation threshold for people with low education levels.

Turnbull et al.2021,2 found significant inequalities in diabetes care, including access, affordability, technology proficiency, and social support. While social capital, such as help from family, friends, or diabetes support groups can help mitigate some of these disparities, it is insufficient to handle the root causes of digital inequalities. The study highlights that without strengthening social support networks and advancing digital technologies, digital health tools may exacerbate rather than reduce existing health disparities. (Turnbull et al. 2021, 9–10.)

Socioeconomic and demographic factors are at the heart of digital health inequalities. The high cost of digital health technologies (DHTs), such as fitness trackers, and the lack of digital skills remain significant barriers (Piers et al. 2023; Latulippe et al. 2020,5). Many patients struggle to understand or use these tools. Social networks—including the “tech buddy” model, where a tech-savvy friend or family member assists using a device—can help bridge this gap. Sometimes, patients can also receive free samples or discounted devices through connections in diabetes support groups. These forms of social capital are particularly valuable for people with low incomes and education levels. (Turnbull et al. 2021,9-10.)

Governments and healthcare organizations should increase funding for digital health centers in underserved communities. To assist people in using technologies effectively by training healthcare professionals and providing the needed technology. “Technology Buddy” programs and other community-level initiatives can improve digital inclusion. Without these initiatives, disparities in digital health across socioeconomic groups are expected to widen. Volunteer-led training programs can improve

basic digital competencies, and e-health designs should integrate multimedia content (e.g., videos, animations, and multilingual audio) to improve usability. (Latulippe et al.2017, 7.)

Supporting global equity in digital health requires encouraging free access to data and research. Open access facilitates the sharing and utilization of the most recent knowledge by researchers and practitioners worldwide (König et al. 2023, 6). Digital health technologies can become more accessible and egalitarian, helping people worldwide through greater open access, enhanced infrastructure, better study design, international collaboration, and legislative interventions.

7.3 Ethics and reliability

The literature review concept is to collect, read, summarize, understand, and analyze a large amount of relevant literature to fully understand the relevant research results achieved in different disciplines and specific periods, the problems existing in related research, and new development trends. Chetwynd et al.2022, 392 pointed out that narrative literature reviews follow research ethics and methodological norms, mainly focusing on the reliability and validity of the cited literature. Review studies should critically evaluate the consistency and accuracy of the measurement tools used in the included studies. Therefore, when screening and analyzing literature, this article focuses on recording the tools used to measure socioeconomic status and digital health variables in various studies and examines the reliability and validity of supporting information reported in different studies.

The literature review adopts a detailed, rigorous, and precise method. Literature reviews can be divided into comprehensive and thematic reviews according to their content and scope. Comprehensive reviews focus on specific disciplines or professions, while thematic reviews focus on specific topics. (Green et al. 2006,104.) Literature research is based on a particular problem or purpose. This article explores the specific research object of digital health inequality. The literature review mainly reflects the historical status, latest progress, and feedback on important topics in a specific discipline or field, as well as new developments, trends, levels, principles, and related research techniques. It enables researchers to develop criteria to determine whether research publications should be included or excluded from the final comprehensive analysis of research results. This article will introduce the methods used in the study step by step. In order to gather all original (first-hand) research on the subject, the authors of the systematic review will search several databases, perform manual searches, and get in touch with the authors of previously published studies.

In a systematic literature review, ethics is a core consideration in developing literature retrieval and sample inclusion strategies (Suri, 2020). Empirical evidence shows that studies with specific methodological tendencies or statistically significant "positive" results are more likely to be funded, published, recognized, or included in academic databases. When decision-makers rely on these review opinions and believe they accurately represent the complexity of the public or the real world, standard forms of bias include funding, method, result, and confirmation. These biases can distort the evidence base by marginalizing studies with nonsignificant findings or challenging common assumptions. From an ethical perspective, this reflects more profound inequalities and structural imbalances in knowledge production and dissemination—issues that systematic reviewers must consciously address. It is unethical. Therefore, reviewers need to think critically about the types of studies included and excluded and the reasons behind these decisions. This narrative literature review article is from

the Information Service Center of the Library of Savonia University of Applied Sciences. The articles are reliable and authentic. Most articles are from CINAHL and MEDLINE. The analysis is based on strict adherence to the writing ethics guidelines, and the references are written in full compliance with Savonia University of Applied Sciences regulations—the authenticity of the publication year and source.

In the field of social sciences, everyone may have a different understanding of the same topic. A successful literature review should be able to systematically analyze, evaluate, and predict research trends. It will provide strong support and argument for establishing a new topic. Reviewers must reflect critically on what studies are included or excluded and why. The process of selective inclusion should follow clear, transparent, and ethical standards. It respects the context of original knowledge construction and enhances the review process's ethical integrity, transparency, and fairness, thereby supporting more equitable policy and practice outcomes. Throughout the research process, it makes a reliable and valuable contribution to the development of digital health by studying and exploring the factors that cause digital health inequality.

8 DISCUSSION

This study explores digital health services and their inequality risks. Digital health has gradually penetrated multiple medical services such as hospitals, primary care, home care, health monitoring, disease diagnosis, and prediction. This widespread technological penetration has improved the efficiency and coverage of medical services, but it has also exposed potential digital health inequality issues. Four aspects were explored through the analysis of 12 articles: digital health gaps caused by socioeconomic status, insufficient network and device accessibility, digital divide and vulnerable groups, and policy and regional differences.

The digital health gap caused by socioeconomic status is closely related to insufficient network and device accessibility. The unbalanced development of digital health has exacerbated the health insecurity of vulnerable groups and made medical equity more vulnerable. Those with double low incomes and education levels are among the important statistical categories and are also frequently disproportionately affected by digital health inequity. One of the main reasons is that they generally lack sufficient digital devices and network services. Economic ability limits the ability of these groups to obtain digital terminal devices. Even if they have devices, they find it challenging to handle modern digital health platforms smoothly due to old devices and limited functions. It requires firm policy and financial support to improve the construction of a strong and widespread network infrastructure and provide strong support for purchasing smartphones and digital devices, including preferential pricing policies.

The limitations of education level further amplify this digital fault. Groups with lower educational attainment frequently lack health information literacy and basic computer literacy. Many have trouble understanding how digital health management systems, online platforms for diagnosis and treatment, or health monitoring gadgets operate, and many even question the accuracy of the information they are given. This "technophobia" and "knowledge threshold" jointly inhibit their willingness and ability to obtain and use digital health services actively. Their inability to operate complex tablet interfaces, coupled with low income, low education, and insufficient access to networks and devices, constitutes a “multiple disadvantage” in digital health services, which not only limits the group's right to access fair medical information and services but may also lead to further deterioration of health conditions and exacerbate existing social health gaps. With growing of digital health with digital networks as the core, if this structural barrier is not taken seriously and intervened, the dividends of digital health will be concentrated in the hands of specific groups. On the contrary, vulnerable groups will be excluded from the digital health system, resulting in new health inequalities. The level of education is mainly reflected in digital literacy, and community building needs to meet this demand through education and training.

The digital divide has differences in technology accessibility and concentrated reflection of various inequalities in social structure. Elderly, ethnic minorities, and people in remote areas face double marginalization in digital health services. Vulnerable groups face the challenges of language support, complex technologies operating interfaces, and lack of accessibility. Even if they have specific devices and network resources, it is difficult for them to truly enjoy the benefits of digital health. Therefore, appropriate policy support is necessary. For example, simplifying the development of digital health software, providing community training to encourage vulnerable groups to use digital health, and training medical staff to enable them to provide correct guidance to vulnerable groups.

Policy and regional differences exacerbate this situation and existing infrastructure construction, policy investment, and education resource allocation gaps. In economically underdeveloped areas, access to digital health services that rely on Internet connection may be challenging due to the lack of network infrastructure. For example, when network coverage is insufficient, Wi-Fi may not be available or disconnected, and the network speed may also be slow. Rural areas are often neglected due to a lack of government support or delayed budget allocation. In contrast, urban areas have better network connections, faster technology updates, and more digital health pilot projects. In addition, the digital health policies of some countries tend to be market-oriented rather than universal, resulting in technology solutions led by the private sector ignoring the real situation of vulnerable groups. When marginal factors such as policy orientation, geographical location, and social identity are intertwined, a structural digital divide will be formed. This divide is reflected not only in the physical access level (device access and network connection) but also in the inequality of digital literacy and service accessibility (culturally and socially appropriate services) at a deeper level. It may widen the health gap between different social groups. Therefore, expanding network infrastructure construction and increasing policy support is crucial.

To sum up, the research attempts to thoroughly examine the primary obstacles encountered in attaining fair healthcare throughout the evolution of digital health and investigate ways to lessen the disparity between health outcomes and health access through efficient treatments. Studies have shown that although digital health holds enormous promise for increasing the effectiveness of healthcare services and expand telemedicine and personalized treatment, its development process has exposed many structural problems that hinder equity. These interrelated variables restrict people's access to and utilization of digital health services, further exacerbated by the digital divide. Solving low-income levels, insufficient education, and poor accessibility to the network and digital devices is the primary task of building digital health. To narrow the digital divide, only by organically combining technical, social, and policy factors can digital health interventions truly serve all people, especially those most likely to be marginalized, to achieve a more equitable and sustainable health system.

8.1 Research implications and future directions

Based on the literature review, this study systematically combed the connection between digital health and social equity. However, the current analysis lacks original data support and real-case verification. Future research can consider introducing research forms such as field surveys, structured interviews, or small sample surveys while evaluating the effectiveness of existing practice cases. By comparing the changes in health service utilization or resident satisfaction before and after policy implementation, the actual effect of digital health in specific populations can be evaluated. Small sample interviews or questionnaires can be used to understand the usage habits, acceptance, and barrier perception of health tools (such as remote consultations, EHRs, and wearable devices) among low-income or elderly groups. Especially the elderly and chronic disease patients with high technical barriers, co-creation design is expected to become an important strategy to improve usability and acceptability and truly realize the transformation from designing for users to co-building with users. Moreover, it provides more operational suggestions for digital health policy optimization, tool adaptation, and educational intervention.

In order to enhance future research, one can introduce empirical data or provide case study support, such as the experience and problems in the Finnish digital health project, to enhance the practicality and translation potential of the research so that it can positively impact work and living standards. Secondly, the research materials provided by the library of the Savonia University of Applied Sciences are limited, lacking original data and real case verification, which limits the application of research results in actual policy making and service design. It is recommended that the scope of data acquisition be provided.

Expanding on the international perspective, the research objectives of this paper mainly focus on developed countries. In order to enhance global applicability and academic breadth, future research should include cases and data from developing countries and, through cross-national comparison, show how different political environments affect how digital health equality policies are implemented—economic and cultural backgrounds, which will help to build a more inclusive global digital health governance pattern.

Pay attention to the ethical risks and data governance of artificial intelligence. Although artificial intelligence has been widely applied in digital health, its related ethical risks have not been fully explored. Research in the future should look at the dynamic equilibrium between technology and governance and ethical norms in conjunction with the EU General Data Protection Regulation (GDPR), which will not only improve the critical depth of research but also help guide the direction of digital health. It should also thoroughly analyze privacy violations, algorithmic discrimination, insufficient right to know, and other issues that may be caused by artificial intelligence in medical scenarios. To enhance the guiding value of this study for practice and policy, it is recommended that the operational policy roadmap be further refined in subsequent research. Develop digital health equity assessment standards to narrow the digital health gap, thereby promoting the construction of a more inclusive and equitable digital health ecosystem.

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APPENDIX 1: RESEARCH ARTICLES SUMMARY

Writer(s), public year and country	Research article	Research Method	Research theme
Arighi, A., Fumagalli, G. G., Carandini, T., Pietroboni, A. M., De Riz, M. A., Galimberti, D., & Scarpini, E. Publish year:2020 Country: Italy	"Facing the digital divide into a dementia clinic during COVID-19 pandemic: caregiver age matters."	Quantitative approach	“The most impacting factors to digital divide in our population are the social support networks and the experience with the technology “.
Estrela, M., Semedo, G., Roque, F., Ferreira, P. L., & Herdeiro, M. T. Publish year: 2023 Country: Portugal	“Sociodemographic determinants of digital heath literacy	Systematic review with meta-analysis, using quantitative statistical methods	“Digital health literacy is dependent on socio-demographic, economic, and cultural factors, which may require tailored interventions that consider these nuances.”
Jafar, Z., Quick, J. D., Rimányi, E., & Musuka, G. Publish year: 2024 Country: Switzerland	“Social Media and Digital Inequality: Reducing Health Inequities by Closing the Digital Divide”	Narrative review method	“Purpose to reduce digital health inequities”.

König, L. M., Krukowski, R. A., Kuntsche, E., Busse, H., Gumbert, L., Gemesi, K., Neter, E., et al. Publish year: 2023; Researchers representing thirteen countries	"Reducing intervention-and research-induced inequalities to tackle the digital divide in health promotion"	Delphi research method	“Discuss in the field of digital health promotion and healthcare contributing to the digital divide ways”.
König, L. M., Western, M. J., Denton, A. H., & Krukowski, R. A. Publish year: 2025	“Umbrella review of social inequality in digital interventions targeting dietary and physical activity behaviors.”	Umbrella review methodology	“Age and gender/ sex differences were most frequently studied. Most reviews found digital interventions to be effective irrespective of age, while men benefitted more from digital interventions than women. Other inequality indicators (e.g., income, education) were rarely studied, despite them being potential causes of a digital divide. A more systematic and thorough exploration of inequalities in digital health is required to promote health for all.”
Latulippe, K., Hamel, C., & Giroux, D Publish year: 2020 Country: Canada	“Co-design to Support the Development of Inclusive eHealth Tools for Caregivers of Functionally Development Older Persons: Social Justice Design”	Qualitative research approach	“Aim to explore how co-design can support the development of an inclusive eHealth tool for caregivers in a real-world context”.

Latulippe, K., Hamel, C., & Giroux, D. Publish year: 2017 Country: Canada	“Social Health Inequalities and eHealth”	Qualitative, quantitative and mixed articles	“Identifying characteristics of people at risk of experiencing social inequality in health”; “Determining the possibilities of developing eHealth tools that avoid increasing SHI”; “modeling the process of using an eHealth tool by people vulnerable to SHI “.
Merkel, S., and M. Hess Publish year: 2020 Country: Germany	“The use of internet-based health and care services by elderly people in Europe and Importance of the country context.”	Quantitative research	“This study examined how elderly people are using digital services to access health and social care. Moreover, it examined what personal characteristics are associated with using these services and if there are country differences.”
Piers, R., Williams, J. M., & Sharpe, H. Publish year: 2023 Country: UK	“Can digital mental health interventions bridge the digital divide for socioeconomically and digital marginalised youth?”	Systematic review methodology	“Digitally delivered interventions can be effective in improving mental health outcomes among socioeconomically and digitally marginalised youth, more high-quality research is needed in order to determine whether DMHIs can fully bridge the so-called digital divide’.”
Petrič, G., & Atanasova, S Publish year: 2024 Country: Slovenia	“Validation of the extended e-health literacy scale: structural validity, construct validity and measurement invariance."	Quantitative research	“Ensures an unbiased eHealth literacy assessment across different social groups, which is crucial for interventions that aim to reduce health-related social inequalities.”

Turnbull, S., Lucas, P. J., Hay, A. D., & Cabral, C. Publish year: 2021 Country: England	“The role of economic, educational and social resources in supporting the use of digital health technology by people with T2D”	Qualitative study	“To gain insights into how and why people with T2D access and use DHTs and how experiences vary between individuals and social groups”.
Watson, J., Green, M. A., Giebel, C., Darlington-Pollock, F. Publish year : 2022 Country: England	“Social and spatial inequalities in healthcare use among people living with dementia in England (2002–2016)”	Quantitative research methods	“Systemic and societal measures are needed to reduce disparities in inequalities in health care use among people living with dementia (PWLD).”

APPENDIX2: ANALYSIS OF INDUCTIVE CONTENT

Original Expression	Reduced expression	Subdivision	General category	Core Theme
"Research has shown that digital inequalities exist across socioeconomic levels, with lower -income individuals "	Lower income causes digital inequalities	Income level affects digital access	Economic level in access to digital health	SES effect digital health inequalities
"The results showed that individuals with higher levels of education tended to have higher digital health literacy than those with lower levels of education, thus reinforcing its role in digital health literacy."	Higher level of education reduces digital divide	Education level influence's ability to handle digital technology	Education's influence on digital health literacy	SES factors related to digital divide
"Technology is becoming central to maintain active social interactions. This rapid transition has made it difficult for physicians and patients to anticipate barriers to successfully implement telemedicine visits, facing with digital divide."	Digitalization in healthcare increase barriers for physicians and patients due to digital divide	Hard to adapt in telemedicine systems	Lack of technology skills implementations due to digital divide	Digital health literacy effect digital divide
" The inability to access or use social media-a consequence of the digital divide-can be a marker for health. We can consider social media access -and	Lack of digital access affects health outcomes.	Digital connectivity as measure of disparities in health	Limited digital access relates to digital divide	Insufficient accessibility of the network and devices cause digital divide

digital access at large-to be a social determinant of health."				
"In some areas, connectivity will also rely on innovations in electric supply. Many developing countries, especially in sub-Saharan Africa, have limited access to electricity, especially in rural area."	Digital connectivity in rural locations is hampered by limited access to electricity.	Electricity supply imbalance between rural and urban areas	Digital Health Infrastructure Issues	Barriers to Digital Health Equity caused by infrastructure
"People aged over 75 years are up to four times more likely to have lower levels of digital health literacy. When conducting a meta-analysis, a statistically significant negative effect of age on eHEALS scores was observed."	The digital health literacy of older persons is much lower	The susceptibility of older persons to digital access	Ageing population face digital divide	Digital divide and vulnerable groups
"Four factors are impacting to the degree of ability to use the equipment, autonomy of use, social support networks, and experience with the technology for retaining benefits from its use ".	Social support and experience with digital technology	Social support for using digital technology	Support digital device use	Social policy support reduce digital divide