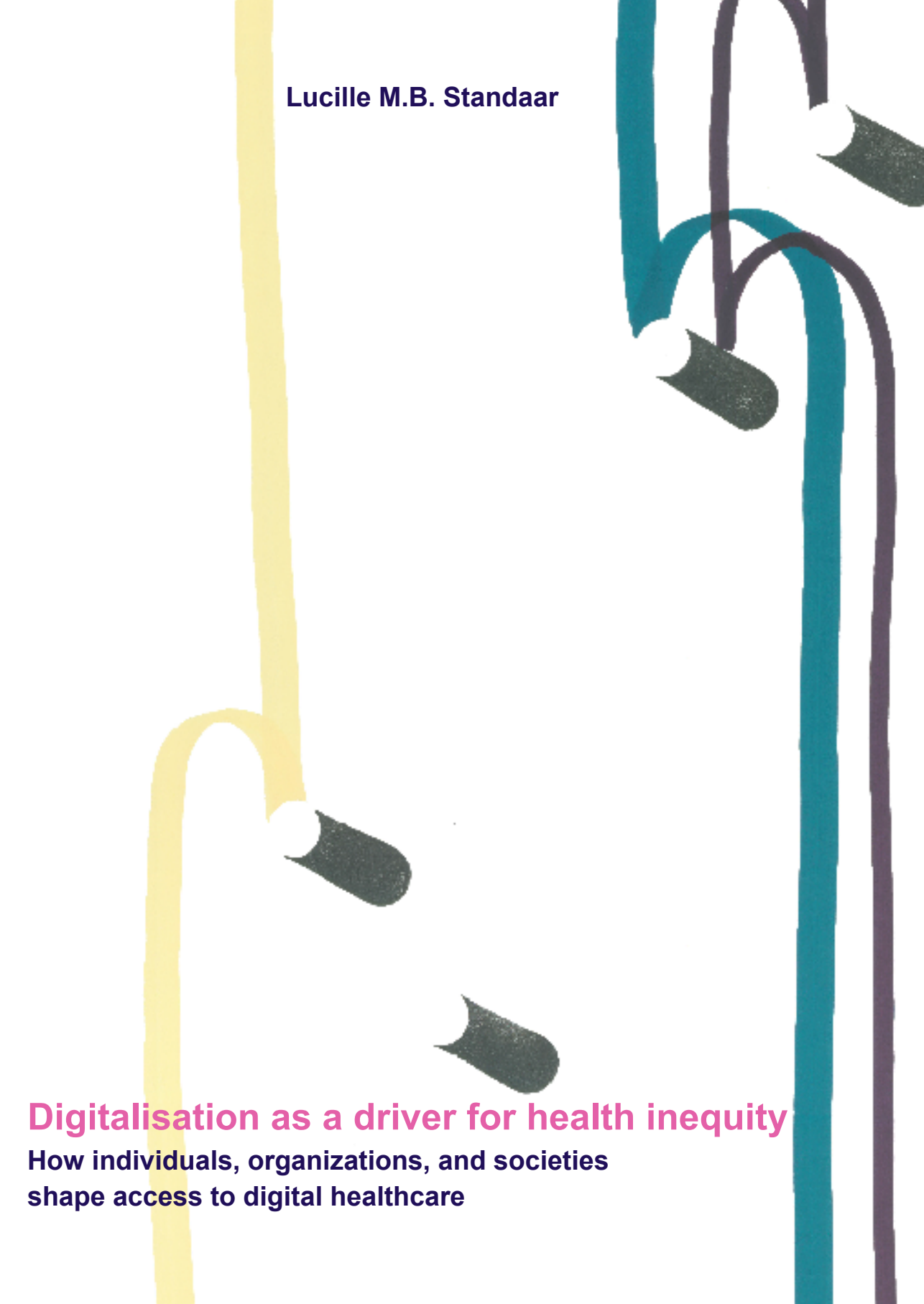


Digitalisation as a driver for health inequity: How individuals, organizations, and societies shape access to digital healthcare

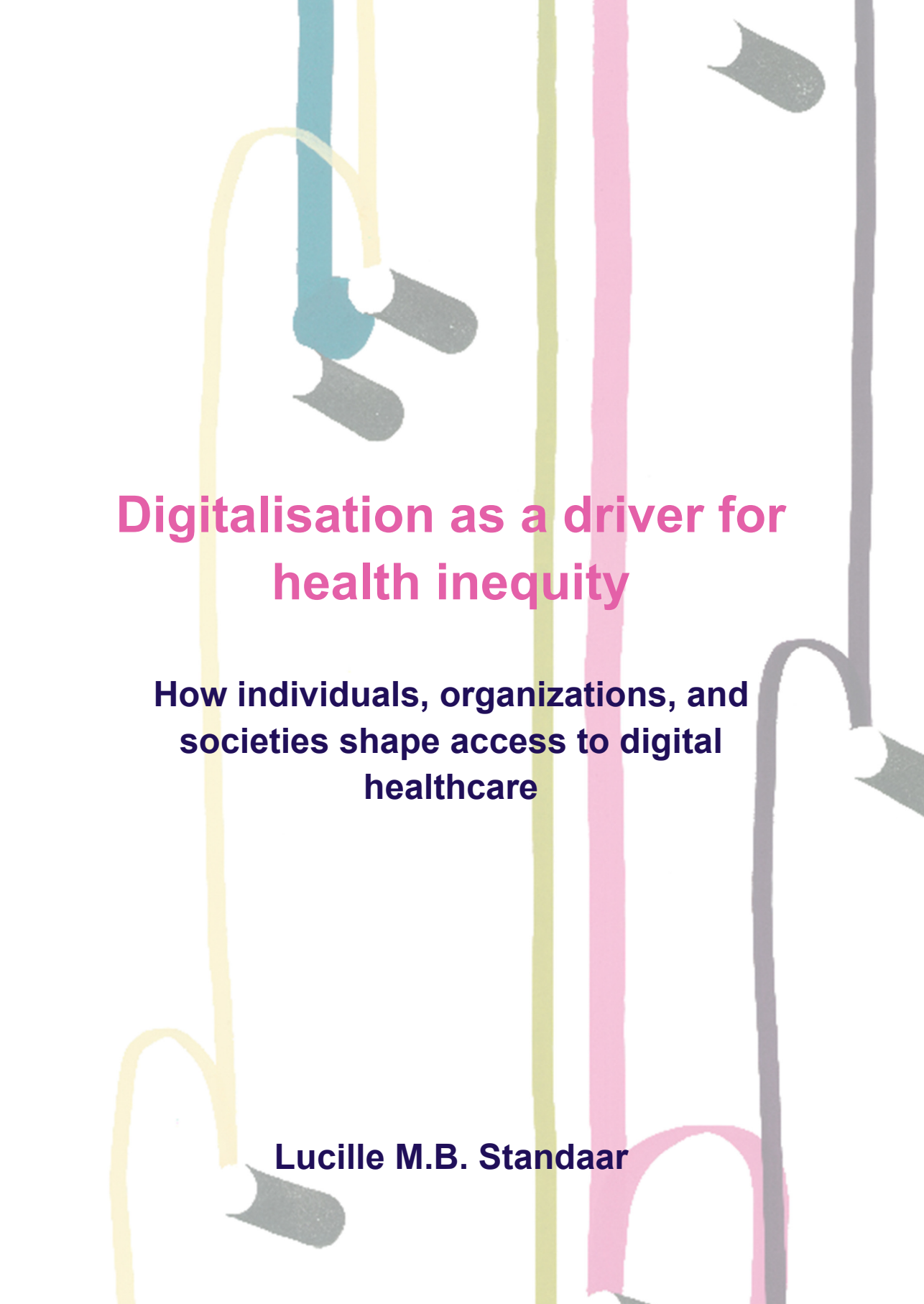
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Lucille M.B. Standaar

Digitalisation as a driver for health inequity

How individuals, organizations, and societies
shape access to digital healthcare

The background features several vertical lines in teal, yellow, olive green, pink, and grey. Interspersed among these lines are various grey, rounded, and elongated shapes, some of which appear to be connected to the lines by small white circles, resembling a network or a stylized anatomical structure.

Digitalisation as a driver for health inequity

**How individuals, organizations, and
societies shape access to digital
healthcare**

Lucille M.B. Standaar

The research for this dissertation was conducted at the Dutch National Institute for Public Health and the Environment (RIVM), department of Population Health and Health services research, and Nivel, department Organisation and Quality of Healthcare. The studies presented in this dissertation were conducted as part of the E-healthmonitor program, now known as the Digital Care Monitor [Monitor Digitale Zorg]. The Ministry of Health, Welfare and Sport commissioned the RIVM for this Monitor program.

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Digitalisation as a driver for health inequity

How individuals, organizations, and societies shape access to digital healthcare

Proefschrift ter verkrijging van de graad van doctor aan Tilburg University

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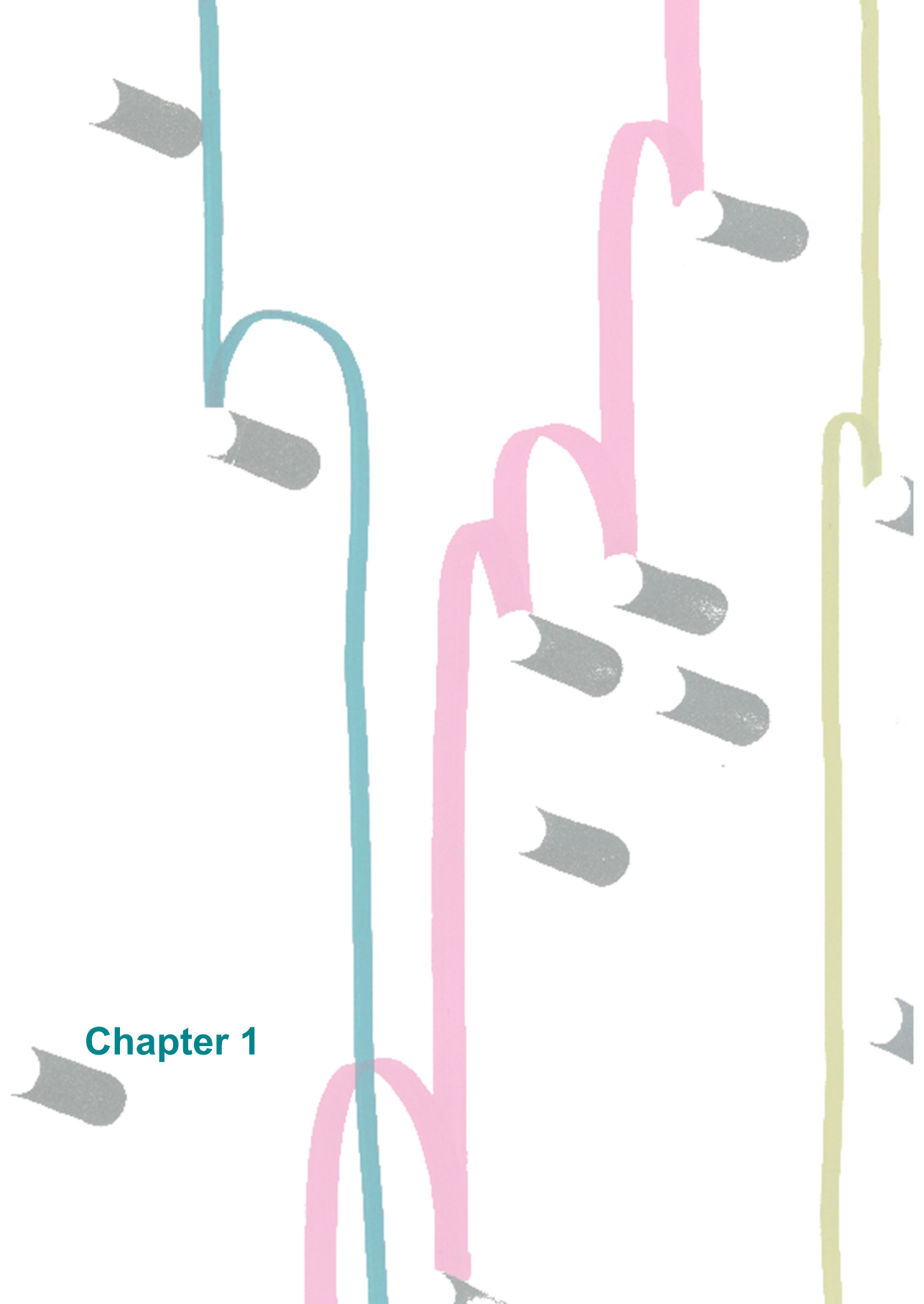
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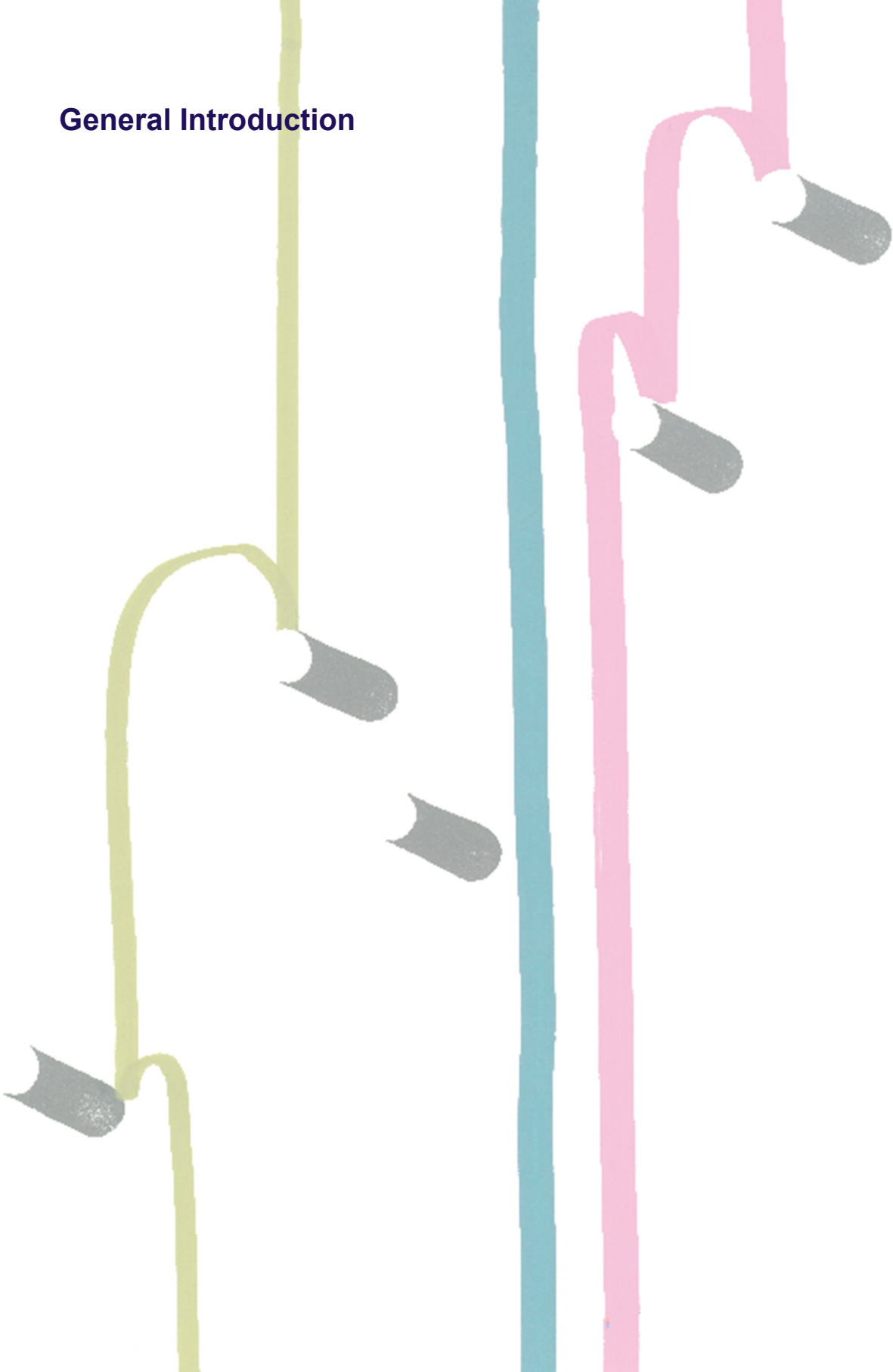
Table of contents

Chapter 1	General Introduction	10
Chapter 2	Differences in eHealth Access, Use, and Perceived Benefit Between Different Socioeconomic Groups in the Dutch Context: Secondary Cross-Sectional Study	46
Chapter 3	Digital Health Use Across Socioeconomic Groups in Patients with a Chronic Disease	76
Chapter 4	The Motivations of Citizens to Attend an e-Health Course in the Public Library: A Qualitative Interview Study	106
Chapter 5	Support in Digital Health Skill Development for Vulnerable Groups in a Public Library Setting: Perspectives of Trainers	150
Chapter 6	A Systematic Literature Review to Identify Delivery Strategies of Digital Health for Low SEP Populations	182
Chapter 7	General Discussion	270
Appendix	Summary	304
	Nederlandse Samenvatting [Dutch Summary]	312
	Acknowledgements	320
	About the Author	324
	List of Publications	326

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Chapter 1

General Introduction



Introduction

In Western societies, healthcare systems are pushed beyond their capacities. Challenges such as the rise of chronic and non-communicable diseases (CNDs) prevalence, workforce shortages, and health inequity are putting serious pressure upon health outcomes and quality of healthcare services. To address these, national and supranational governmental bodies, organizations and businesses are driving ambitious digital healthcare transitions (1-7). The WHO defines digital health, or electronic health (e-health) as: “the use of information and communication technology (ICT) in support of health and health-related fields” (8).

Although digital health is promising, several researchers have raised concerns about the effect of digital health upon health inequity (9-14). People with a low socio-economic position (SEP) use e-health less and have less improvement of health outcomes than people with a high SEP (15-18). The understanding of what challenges people with a low SEP experience in digital health access and use is vital for a fair and equitable digital health transition.

The healthcare system under pressure

Health inequity

In many societies, persistent and unnecessary differences in health outcomes exist between people with and without social and economic advantages (19-22). Health inequities are observed across the lines of SEP, race, gender, sexual orientation, sexual expression and geographic location (23). Health inequity is defined as follows: *“Health disparities/inequalities are potentially avoidable differences in health (or in health risks that policy can influence) between groups of people who are more and less advantaged socially; these differences systematically place socially disadvantaged groups at further disadvantage on health”* (Braveman 2006, p.180) (19). Health inequity affects individual lives, the economy and the demand on healthcare systems (24-31).

In Europe, people with a high SEP are predicted to live up to eleven years longer compared to people with a low SEP (27). Additionally, health inequity causes 33 million preventable cases of ill-health per year (30). Furthermore, people who are affected by health inequity are less able to manage health crises. The COVID-19 pandemic showed how vulnerable populations suffered most during and after the pandemic (32-36). Lasting effects were found in terms of health, financial stability and access to education affecting future lives of individuals and their families (37, 38).

The effects of demographic and epidemiological shifts on healthcare systems

Demographic and epidemiological shifts in Western societies are overburdening healthcare systems. Ageing populations and the rise of CNDs have increased healthcare demands. Improved living conditions and healthcare services shifted disease patterns from acute to chronic conditions, leading to longer lives often spent in poorer health (39-45). CNDs such as cardiovascular disease, cancer, and type II diabetes are now major causes of premature death and disability (39, 40, 43). Over 35% of Europeans over the age of 16 and 76% of American adults live with at least one CND (46, 47). Older adults and people with CNDs often require multiple and long-term healthcare services (45, 48). Meanwhile, ageing populations attribute to the shrinking active healthcare workforce, as more professionals retire (45, 48-51). The WHO projects a shortage of 4.1 million healthcare professionals in Europe by 2030 (50, 52). To accommodate to these societal shifts, healthcare systems must adapt and focus on prevention, treatment, and sustainable long-term care (53-55).

The potential of digital health

In the context of the technological developments of the last decades, the digitalisation of healthcare did not stay behind. The digitalisation of the healthcare system is seen as one of the solutions for the aforementioned healthcare systems' challenges (12, 14). Through digital health websites, mobile applications, wearables and domestic sensors patients and consumers can receive and organize their healthcare (56). Shaw et al. (2017) conceptualizes three overlapping functionality domains of digital health: 1) "health in our hands" which describes the use of digital technologies to monitor, track, and inform; 2) "interacting for health", which describes the use of digital technologies to facilitate communicative encounters between patients and HCPs, and; 3) "data enabling health", which describes the use of health data to improve health and health services (17). Patients' and healthy individuals' interactions with digital health fall within the first two categories.

The promise of digital health for patients, the medical care sector and public health

Through digitalisation, healthcare systems expect to improve health outcomes, healthcare services' efficiency and healthcare services' availability (14, 57-59). Yeung et al. (2023) and Abernethy (2022) describe the promises of digital health for patients (58), healthcare and public health (57). Digital

health can improve patients' and healthy individuals' opportunities for access to health information, communication with healthcare professionals, personalized care, remote monitoring, and self-management (58). In the healthcare sector, digital health can advance diagnosis and treatment, ensure care continuity, facilitate off-site patient management through telemedicine, facilitate partnership with individuals to support self-management, and reduce error and waste in the delivery system (57). From a public health perspective, digital health can support the adherence to healthy behaviour and spread health information on a large, population wide scale (57). Furthermore, gathering of medical and non-medical data, such as individual social determinants of health, through digital health interventions could provide insights on population health and effectivity of public health and medical interventions (57). Through these actions digital health could improve health outcomes, improve the availability of healthcare services, reduce logistics, time and travel burden for patients and HCPs, and empower patients through patient-centred care and improvement of opportunities for self-management of disease (10, 60, 61).

However, certain requirements need to be met to realize the potential of digital health (13, 57, 58, 62). According to Abernethy, digital health infrastructures need to address the following topics to fully realize its' potential: individual access and engagement, equity and ethics, privacy and identifier protocols, cybersecurity, data quality and reliability, data storage, sharing, and stewardship, interoperability, AI/ML, and workforce (57).

Approaches to health and health inequity

Three perspectives on health

Our political and societal understanding of health and what causes health is determinative for how healthcare is organized. Over the last hundred years, three main models of health were formulated: the biomedical model, the biopsychosocial model, and the ecological model. These models delineate different understandings of what health is and what causes health. These models shape public sentiments, research, policies, and interventions for health and healthcare systems (63). How society and healthcare systems are organized translates to the status of health inequity. When policies and healthcare services fail to reach those who need it most, health inequity persists (20, 23).

Biomedical model

The biomedical model defines health as the absence of disease and disability (64). This model adheres a dualist and reductionist approach to health, in

which the body, the mind and the context are separated (65). Until the late 20th century, prevalent diseases were often infectious or acute diseases, leading to such somatic views on health (65). The biomedical model led to a focus on curative care and individual responsibility for health. Additionally, the discovery of antibiotics in the early 20th century ignited the start of the biomedical and pharmaceutical research which led to many important discoveries in curative care (65). To this day, the evolvement around curative care has a substantial influence on the design of health care services, health research and healthcare systems (65). However, over time, the biomedical model received criticism due to its lack of acknowledgement of the complexity of disease, the existence of mental health, and the individual experience of ill-health (64-66).

Biopsychosocial model

The psychiatrist Engel (1977) proposed the biopsychosocial model as a holistic response to the reductionistic biomedical model (66). His main critique of the biomedical model was that this model reduces the complexity of health problems to biological factors (66). Engel argued that the experience of health lies in how we feel emotionally and physically, how health and sickness are viewed culturally, and the availability of social support (66). This theory underlined the importance of peoples' experience and interpretation of health (66). According to Engel, disease and wellbeing are influenced by dynamic interactions between biological, psychological, and social factors (66). Engels' theory broadened the scientific and medical view upon health and the causes of health (68).

Ecological model

While the biopsychosocial model predominantly focuses on the individuals' circle of biological, social and psychological factors, the ecological model considers these factors to be interconnected to the broader societal environment (69). Bronfenbrenner's ecological systems theory (1979) was the first to delineate the influence and the interconnectedness of individual, community- and societal factors on human and child development (70). This theory was used to interpret the factors that are relevant for health promotion and public health by McLeroy (1988). McLeroy's socio-ecological model theorizes that health outcomes are a result of health behaviour patterns that are influenced by the individual, interpersonal relations, organizations and institutions, community, and structures, policies and systems (71). McLeroy argued that the factors that are outside of individuals' control can have the greatest health impact, as the design of society and healthcare is determinative for if and how people can achieve health (69, 71). Building on

these theoretical foundations, Dalgren and Whitehead (1991) developed the Social Determinants of Health (SDOH) model. This model would become one of the most established ecological models describing the causes of health (31, 72-74). The ecological model, in contrary to the biomedical model, proposes that health is largely dependent on contextual factors that are outside of the individuals' control.

The drivers of health inequity

In the 1990s, health outcomes showed little improvement, and health inequities persisted despite substantial investments in clinical care and personal preventive measures (75-77). During this period, ecological models emphasized that the organization of society and healthcare systems plays a decisive role in determining health outcomes (69-71). These insights prompted population-level evaluations that considered a broader range of determinants of health (69, 71, 78). Research supported the ecological theoretical frameworks, arguing that societies should prioritize improving living conditions to generate health, rather than merely expanding healthcare services (24, 71, 75-77, 79, 80). Consequently, these studies deepened the recognition of how economic, social, and health policies shape health inequities.

In the 2000's, the WHO published an important report that acknowledged the SDOH model (31, 72, 79). The WHO (2008) defines the SDOH as: *"the conditions in which people are born, grow, live, work and age, and the presence of inequities in terms of money, power and resources"* (31, 72, 79). The WHO (2025) describes individual and structural SDOH (79). Individual determinants of health are individual-bound factors such as education, employment and housing (79). Structural determinants are factors that are applicable to a population or sub-population as a whole (79). Currently, according to the WHO (2025), there are five main structural determinants: economic systems, social infrastructure, structural discrimination, conflicts & forced displacement and migration, and mega-trends, such as climate change and digitalisation (79). Structural determinants are referred to as upstream factors as these factors shape the status of individual determinants of health (31, 79). Consequently, the structural determinants of health are considered more impactful to health outcomes as they are closer to the root of the causes of health, and thus, health inequity (79). Scholars have estimated that SDOH account for 50-90% of the modifiable health outcomes (81-83). Through the SDOH, societies can modify health outcomes and reduce health inequity.

The current actions to reduce health inequity

Despite the evidence on the effect of the SDOH (20, 24, 75, 79, 81, 84-88), the biomedical model is still dominant in politics, healthcare systems and medical industries (20, 75, 81, 84-86). In Western countries health systems underperform in general health outcomes and health inequity regardless of these countries' ever increasing and high health expenditure (20, 21, 57, 75, 89-96). Health policy and interventions often focus on individual health behaviour and curative care, which are less effective in diminishing health inequity (86, 97-103).

Regardless of these observations and research findings, there is little practice of policies that address the social determinants of health, creating a cycle of inaction. Such policies often involve changes that interfere with the daily life on a large or population-wide scale (104, 105). In Western societies, individualism and freedom of choice are central values (101). Additionally, the biomedical model's focus on the individual partly elicited the public and political sentiment that health is the responsibility of the individual (69, 97-101, 106, 107). Therefore, social determinants of health policies that restrict personal freedoms, such as tobacco and alcohol regulations, often face public resistance (69, 88, 105), despite being more effective than less intrusive approaches such as health education (108). Other policies that demand a different allocation of resources, such as the improvement of housing for people living in poverty or refugees, are conflicting with individualistic values (99, 101, 106). Implementing such policies requires significant political courage and commitment (104, 106, 108). Consequently, few policies target the structural determinants of health, limiting the opportunities to generate evidence of effectiveness through policy evaluation (88, 97). Yet such evidence is vital for policy acceptance (88).

Political and public acknowledgement of the importance of social determinants on health is essential to create political willingness for change (69, 79, 107-110). Researchers in the field of health inequity policy argue for new approaches and evaluation in health, social and economic policies to realize improvement of the social determinants of health (87, 97, 111-115). Careful design of policies, policy evaluation and foremost, political action are crucial to establish a systemic change across politics, society, the medical industry, and health research (86).

Current status of digital health equity research

For the last two decades there have been signals that digital health leads to greater health inequity (11, 16, 116, 117). During the writing of this dissertation, the necessary transition to digital healthcare during the COVID-19 pandemic was illustrative of the effects of digital health upon health inequity (79, 118-124). People with a low SEP are likely to experience barriers in accessing digital health, leading to digital health inequity (15-18, 125-130). Most research and policies address digital health inequity through individual and intervention factors: physical access, motivational attitude, e-health literacy, and intervention design (14, 131-134).

Digital health inequity through the lens of the digital divide model

The development of new digital media has led to extensive research to digital inequity (135, 136). The disparities in digital media access are also referred to as the digital divide. The digital divide model by Van Dijk (2020) describes a causal and sequential model of digital media access (Figure 1) (137). This theory discusses digital inequity from an individual perspective. The digital divide model is also used to study digital health inequity (138, 139).

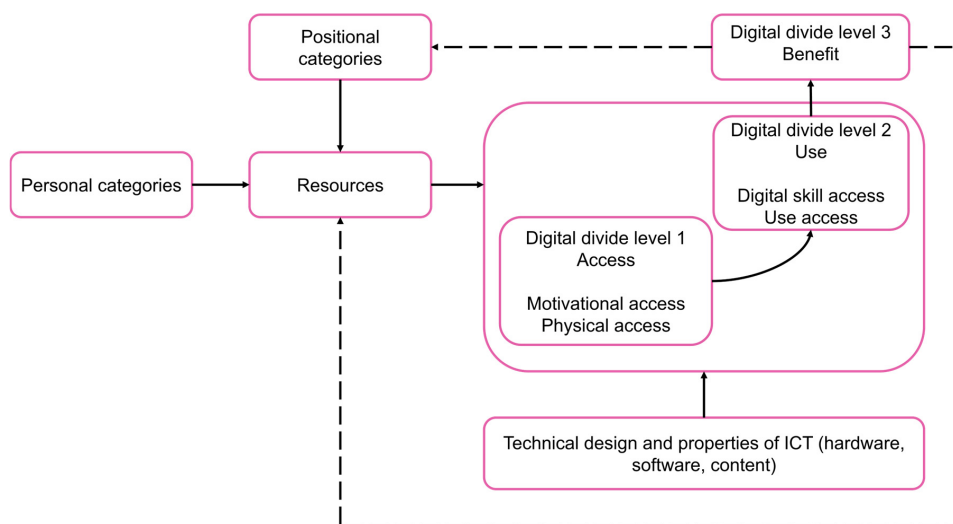


Figure 1. The Digital Divide Model by van Dijk (2020). Figure is derived from Figure 2.3 in *The Digital Divide* by van Dijk (2020), p.91. Solid lines indicate causal or sequential relations; dashed lines indicate secondary causal or sequential relations.

Van Dijk poses that people with less advantaged personal or positional characteristics have less resources and, therefore, have less opportunities to access and use digital media to their benefit. Personal characteristics are biological and personal characteristics such as intelligence, personality, sex and ethnicity. Positional characteristics are social and economic characteristics such as employment, education, and the household of the individual. Furthermore, contextual factors such as social networks and the level of digitization of the country of residence are also positional categories. According to van Dijk, these categories influence the availability of resources which are necessary to access digital media. The model distinguishes five types of resources: temporal (time to use digital media), material (income and property), mental (cognitive capacities and technical abilities), social (support) and cultural (habits in digital media use, lifestyle and status). (137)

Van Dijk describes three causal digital divide levels: 1) access, 2) use and 3) benefit. The first two levels of digital divide encompass four sequential types of access: motivational access, physical access, digital skill access, and use access (137, 140). Next to individuals' personal and positional characteristics, the technical design and properties of information and communication technology (ICT) itself also have influence on the access of digital media. (137)

The first level of the digital divide describes motivational access and physical access to digital media. Motivation, awareness, and having a positive attitude to digital media is the first step to wanting to learn digital skills and wanting to use digital media. Physical access, such as access to internet, up-to-date electronic devices, and software are technical requirements for use. (137)

The second level of the digital divide discusses digital skill access and use access of digital media. Digital skill access refers to the operational and content-related skills that are required to use digital media. The level of digital skills determines to what extent someone can benefit from digital media (141). Use access refers to a diverse and frequent use of digital media. Digital media tools can help people achieve work-, health-, personal-, financial- and leisure-related goals. Frequent use of a broad variety of useful digital media increases the likelihood to beneficial use. (137)

The third level of the digital divide describes the benefits that people can gain from participation in digital media. Successful access and use of digital media should lead to improvement of offline outcomes, resulting in improved positional categories and resources. (137)

Van Dijk and other scholars' findings show that inequity in digital media access (142-146), use (147-149) and benefit (147, 150, 151) cannot be separated from social, economic, demographic and cultural inequity (137, 152-155). Van Dijk theorizes that disparities in digital media use will exacerbate inequities, as people who have more access, use and benefit from digital media will increasingly have more opportunities to use digital media to their benefit (137).

Motivation for digital health use

The individual motivation for e-health adoption is often studied through behavioural psychology models, such as the technology acceptance model (TAM) and the unified theory of acceptance and use of technology (UTUAT) (156, 157). In essence, these theories attempt to explain and predict the intention to perform behaviour by assessing the individuals perceived value and effort, perceived self-efficacy, and social influence towards the behaviour (156). Studies show that people with a low SEP have less intention to use e-health. The following factors are associated with low SEP: less awareness of e-health, low perceived value of e-health, preference to face-to-face healthcare, negative previous experiences with e-health, a lack of trust towards e-health, and low self-efficacy due to lack of skills, technology and support (121, 145, 146, 158-165).

E-health literacy

E-health literacy is widely recognized as a key barrier to digital health access and an important driver of digital health inequities (18, 128, 145, 166). Lower e-health literacy is consistently associated with lower socioeconomic position (SEP) (128, 145, 166). A common assumption is that inequities in digital health access and use will diminish over time as digitalisation becomes fully normalized within society (12, 139, 167). This perspective aligns with Rogers' Diffusion of Innovation Theory (12, 139, 167). However, e-health literacy scholars argue that this is an overly passive and simplified view of persistent inequities in digital health access and use (12, 139). Evidence of unequal general digital media access and use in highly digitized countries further challenges this assumption (144, 153). Moreover, the rapid pace of technological development, most recently illustrated by the surge of AI integration into digital health, progresses too quickly for such normalization to occur, particularly among individuals with limited digital skills (168).

E-health literacy is defined according to the definition from Norman (2006): *"the ability to seek, find, understand, and appraise health information from electronic sources and apply the knowledge gained to addressing or solving a health problem"* (169). Lupton (2013) argues that the effort, the

capacities and the skills that the digitally engaged patient needs to possess to access and use digital health are underestimated (9, 13). There is a great variety of digital health tools that require more or less digital skills. Van Dijk & Van Deursen (2014) define two categories of digital health skills: medium-related skills and content-related skills (141). Medium-related skills are operational and formal skills and can be viewed as the basic skills in handling digital media. Content-related skills are more complicated skills in which the individual is capable to use the digital media for retrieving information, communication, content creation or achieving strategic goals (141). Van der Vaart (2017) finds that socio-economic disparities in e-health literacy are most profound in content-related skills, such as the ability to clearly formulate health questions (170). To access these more complex types of digital health, people with limited e-health literacy need resources to either learn the necessary skills or to rely on others to perform digital tasks on their behalf (171-175). When people fail to overcome barriers in e-health literacy, they will be excluded from e-health use or use e-health suboptimally (129, 174, 176).

The compatibility of digital health interventions

There is a lack of prioritization of people with low SEP in digital health intervention design. Digital health interventions need to work well and fit the needs, skills and resources of the end-user (177). Unfortunately, researchers find that digital health interventions are often not suitable for people with a low SEP (178-181). A literature review by Cheng et al (2020) shows that almost none of the e-health interventions targeted at vulnerable groups evaluated end-users e-health literacy needs and intervention literacy characteristics (180). Additionally, digital health interventions lack compatibility with older devices and smartphones, resulting in less access and use of digital health by people with a low SEP (144, 182-186).

Too often people with low SEP or other vulnerabilities are not involved in the design of digital health interventions (187-189). The lack of social, economic, cultural and gender diversity among digital health developers potentially lead to a limit understanding and consideration of the needs of other consumer groups (190). Additionally, there are signs that evaluation studies predominantly recruit people with a high SEP (181). Yet recent studies show that researchers and developers involve people with a low SEP more often in the design phase to improve the interventions' accessibility (134, 191-193). However, the effects of these involvements remain uncertain (191, 194). Researchers argue that end-users should be involved not only in the design phase but also during the problem statement and the implementation phases of intervention development (134, 191, 195, 196).

Finally, the rapid integration of Artificial Intelligence (AI) in digital health poses challenges in achieving digital health equity (197). There are signs that the data that is used by AI models is biased towards homogenous white, high SEP and Western populations (168, 198, 199). This poses a potential great risk for biased data-driven predictions, generalizations and decisions in health that disadvantage vulnerable groups in society (199).

Dissertation objective

Research into the causes of health inequity has shown that population-level and ecological perspectives are essential for understanding both the current state of inequities and the mechanisms that drive them. Research on the role of digital health in shaping health inequity has evolved in parallel. Once it became evident that digital health could exacerbate existing disparities, much of the initial focus in health sciences and health policy shifted toward individual behaviours and interventions (131, 133). Yet achieving an equitable digital health transition is a broad societal challenge that extends far beyond individual users or technological design (9, 14, 132, 152, 162, 164, 190, 200, 201). Social science scholars emphasize that implementation strategies, as well as the organizational structures and cultures in which digital health interventions operate, are crucial for enabling equitable access and use (9, 134, 195, 202). Others highlight that digital health inequity arises from the practices, policies, and cultures of actors across all levels of society (132, 190, 200, 201, 203).

Although digital health inequity is both observed and acknowledged, limited insight exists into the mechanisms that shape inequitable access and use. Current research findings are predominantly derived from descriptive or clinical trial studies, that focus on single digital health interventions and specific populations (125, 126, 204-206). This lack of population-level evidence restricts our understanding of how digital health inequity manifests across diverse groups and outside controlled research environments. Moreover, many evaluations of digital health interventions do not examine outcomes related to social determinants of health or inequity (190, 194, 196, 204). Digital health research also frequently follows a positivistic approach that aims to isolate variables to establish cause-and-effect relationships (134). In contrast, health equity research has demonstrated that the interactions among individual, community, and societal factors are central to producing inequities (22, 71, 115, 117).

Consequently, there is a clear need to assess how digital health inequity unfolds under real-world conditions and on a broader population scale.

Furthermore, it is necessary to broaden the evidence base of digital health inequities (207). Current descriptive studies reveal the associations between inequity and digital health access but fail to provide understanding to why and how these associations come to exist (207). Such insights are essential for achieving a digital health transition in which healthcare is accessible to all.

This dissertation addresses these gaps by examining digital health inequity from a population-level perspective. It further explores how individual, organizational, and societal factors shape access to and use of digital health through the lens of peoples lived experiences in their everyday encounters with digital health.

The central research question guiding this dissertation is:

What are the challenges in access to digital health for low socioeconomic positioned groups?

To answer this question, two sub-questions were formulated:

1. *How does digital health inequity manifest at a population level?*
2. *What factors influence engagement with and support for digital health use among people with a low socioeconomic position?*

Dissertation outline

To answer the first research question, two cross-sectional studies are conducted to provide a population level insight into the socio-economic disparities in digital health access in the Netherlands. To generate a population wide overview, the disparities in e-health access, use and benefit were studied in a representative sample of the adult Dutch general population (**Chapter 2**). In this chapter, socio-economic differences in e-health access were studied through three SEP variables: education, standardized income and socio-economic status of the neighbourhood. This was done to get a broader understanding of how different types of socio-economic capital are associated with digital health inequity. **Chapter 3** evaluates the disparities in digital health access and use in a population of Dutch people with a chronic disease. People with a chronic disease have more frequent interactions with a digital healthcare system and experience a burden of disease, which can be motivations to want to use digital health. This study provides insight to whether disparities still exist in a population that is more likely to be introduced to e-health and have a need for use.

The findings of Chapter 2 and 3 provided direction for our exploration of relevant factors in engagement with and support for digital health use among people with a low SEP. The following three chapters aim to answer the second research question. In **Chapter 4** the motivations to e-health use and seeking support in e-health use were studied among participants in a digital health skills development course provided in the public library. By interviewing this specific population, we had the opportunity to study the motivations of people who experience significant barriers in digital health use, a population we assumed normally to be less inclined to use e-health. The aim of this study was to identify what factors had sparked these peoples' motivation for e-health use and for seeking support in e-health use. **Chapter 5** discusses an interview study with trainers who provide the digital health skill course in the public library. The study examines the trainers' grassroot level experience in providing support in digital health skill development. Here, the individual and organizational factors are explored. The study's aim is to gain understanding in the diversity of low SEP target populations that need support, what groups are receiving support in the public library and how trainers reach people with a low SEP. In **Chapter 6** a systematic review provides an overview of digital health delivery strategies that aim to reach people with a low SEP. Furthermore, the study provides insight into the evidence for effective reach of the strategies and whether theoretical or empirical underpinnings were used in the design of these strategies. This study aims to identify what strategies are used to introduce people with a low SEP to e-health and the evidence for the effectiveness of these methods in reaching people with a low SEP.

The final chapter (**Chapter 7**) provides a summary and reflections upon the findings and the methodology of this dissertation. Furthermore, the implications for policy and practice, and future research recommendations are discussed.

Concepts

Digital health

This dissertation focuses on the access and use of digital health and its role in health inequity. This was studied through individuals' daily life experiences with accessing and using digital health (190). In this dissertation, digital health is viewed as a societal phenomenon that interacts with people's lives rather than studying the access and use of specific interventions. Digital health end-users and digital health interventions might be diverse, but the conditions for access and use stay the same. For every digital health intervention, the end-

user needs to be aware and be able to access and use the intervention. Although there was no focus on specific interventions, the digital health interventions that were used as vehicle to study access and use were interventions that are relevant for patients and individuals. Examples of devices that are used for digital health are smartphones, computers, sensors such as blood glucose sensors, and wearables such as smartwatches. Examples of digital health interventions are health information websites, mobile health interventions for lifestyle or disease management, physical movement trackers, patient portals, and digital communication with healthcare professionals.

Socio-economic position

In this dissertation, the populations who most likely need help in gaining access and use of digital health were interpreted as low SEP populations. In Chapter 2, 3 and 6 one or more of the classic variables to approximate SEP were used: education, standardized income and the socio-economic status of the living area (208). The data used for Chapter 2 and Chapter 6 provided the opportunity to study SEP through all three variables. In Chapter 3, SEP was studied through the level of education. In Chapter 4, a population that needed support in gaining access and use of digital health was interviewed.

Digital health inequity

Health inequity is interpreted according to the aforementioned definition of Braveman (2006) (19). Digital health inequity is interpreted according to the same definition but limited to the topic of digital health. In the past, inequity in digital media access was predominantly interpreted as a material issue, in which digital media access was reduced to having or not having access to devices and the Internet (153). Research into digital inequity and the digital divide model show that beneficial digital media access is a process in which the three levels of the digital divide need to be overcome: access, use and benefit (137). Furthermore, the model distinguishes four types of access: motivational access, physical access, digital skill access and use access (137). Additionally, the digital divide model provides:

- 1) A causal interpretation of the relation between socio-economic, socio-demographic, personal and biological factors, individuals' resources and digital media access, and;
- 2) A casual and sequential interpretation of the three digital divide levels and the four types of access.

The digital divide model is used in this dissertation to structure and interpret research findings. First, it theorizes the causal relationship between individual

characteristics, resources and digital media access, which is in line with current research findings on digital health inequity (16, 18, 128, 138, 151). Second, the models' description of the three levels of digital divide and the four sequential types of access allows us to identify where in the process of digital health access digital health inequity manifests itself.

The dissertations' context: the Netherlands

In the Netherlands, digital health plays a significant role in health practice, policy and law (209-215). Since 2020, healthcare professionals are obligated by law to provide online medical dossiers to their patients (209). Policies such as the *European Health Data Space* (EHDS) and the Dutch *Wegiz*, promote interoperability and secure, accessible health data across the EU and within the Netherlands (210-212). The Dutch policy *Integraal Zorg Akkoord* (IZA) outline ambitions for digital transformation and interoperability (213). The IZA (2022) targets 70% hybrid healthcare services and 50% patient participation by 2026 (213).

Regardless of policy efforts, health inequity in the Netherlands remains (216-218). In Dutch policy and national population research, educational attainment¹ is often chosen as proxy for SEP. In 2024, the general Dutch population's distribution of educational attainment was 27.9% (low), 36% (medium), 35.6% (high), and 0.5% (unknown) (219). In 2024, the difference in life expectancy between people with a low and a high educational attainment was 13.7 years (216). Predictions show that disparities in the experience of good health will worsen in the future (216, 220). It is estimated that, now and in the future, around 85% of people with high educational attainment will experience good health (220). For people with low educational attainment a decline is predicted from 60% to 52% in 2040 (220).

Embedding of the dissertation

This dissertation was part of the Dutch national E-healthmonitor. In 2013, the E-healthmonitor, now the Monitor Digitale Zorg [Monitor Digital Health], was commissioned by the Dutch Ministry of Health, Welfare and Sport (221). Since 2020, the programme has been conducted by the Dutch National Institute for Public Health and the Environment (RIVM), the Netherlands

¹ Educational attainment levels are defined as follows: low (none, primary school, or prevocational education); medium (secondary or vocational education level 1, 2, 3, or 4); and high (professional higher education or university) Retrieved from: Bevolking; hoogstbehaald onderwijsniveau en onderwijsrichting: Statline; 2025 <https://opendata.cbs.nl/#/CBS/nl/dataset/85313NED/table?dl=A2271>

Institute for Health Services Research (Nivel), and the National eHealth Living Lab (NeLL) of the Leiden University Medical Center (LUMC). The programme aims to monitor the national implementation of e-health and provide insight in the role of the digital health in societal and organizational challenges (215, 221, 222). Through annual panel questionnaire research, the programme monitors the use and availability of e-health for citizens, patients and healthcare professionals in the Netherlands. Panel questionnaire research and qualitative research are conducted for insight into the societal and organizational themes. To ensure the relevance of research questions concerning societal and organizational themes, researchers are advised by an advisory committee that consists of stakeholders that represent the healthcare field, the government, and patients.

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Chapter 2



Differences in eHealth Access, Use, and Perceived Benefit Between Different Socioeconomic Groups in the Dutch Context: Secondary Cross-Sectional Study

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Abstract

Background: There is a growing concern that digital health care may exacerbate existing health disparities. Digital health care or eHealth encompasses the digital apps that are used in health care. Differences in access, use, and perceived benefits of digital technology among socioeconomic groups are commonly referred to as the digital divide. Current research shows that people in lower socioeconomic positions (SEPs) use eHealth less frequently.

Objective: This study aims to (1) investigate the association between SEP and eHealth access to, use of, and perceived benefit within the adult Dutch population and (2) evaluate disparities in eHealth access, use, and perceived benefit through three socioeconomic variables—education, standardized income, and the socioeconomic status of the neighbourhood.

Methods: A secondary analysis was conducted on data from the Nivel Dutch Health Care Consumer Panel (response rate 57%, 849/1500, to assess access to, use of, and perceived benefits from eHealth. These data were collected to monitor eHealth developments in the Netherlands. eHealth was examined through two concepts (1) eHealth in general and (2) websites, apps, and wearables. Results were stratified into 9 SEP populations based on 3 indicators—education, standardized income, and socioeconomic status level of the neighbourhood. Logistic regression analyses were performed to evaluate whether the outcomes varied significantly across different SEP groups. Age was included as a covariate to control for confounding.

Results: This study confirms the association between eHealth and SEP and shows that low SEP respondents have less access (odds ratio [OR] 5.72, 95% CI 3.06-10.72) and use (OR 4.96, 95% CI 2.66-9.24) of eHealth compared to medium or high SEP respondents. Differences were most profound when stratifying for levels of education.

Conclusions: The access to and use of eHealth has a socioeconomic gradient and emphasizes that SEP indicators cannot be used interchangeably to assess eHealth access and use. The results underline the importance of activities and policies aimed at improving eHealth accessibility and usage among low SEP groups to mitigate disparities in health between different socioeconomic groups.

Introduction

Digital health care is expected to provide benefits for health care systems, providers, and patients and is considered a solution to address workforce shortages and rising health care costs (1-4). Moreover, digital health care is anticipated to enhance the quality of care, stimulate patient self-management, and improve health accessibility and equity (1-4). Digital health care or eHealth is defined as the digital apps that are used in health care. Health care policies focus on increased use of and dependency on the eHealth apps (4-6). Concerns have been raised that digital health care may not be equally accessible for all (7-13). Populations with lower socioeconomic positions (SEPs) are more likely to encounter financial, skill, or cognitive barriers to accessing and using eHealth, such as limited access to devices, limited digital health skills, or limited ability to take the initiative in using eHealth (7,11-16). Additionally, these populations experience challenges in comprehending and implementing health information and healthy behaviors in daily life (17-21).

The demand for health care services is often higher in low SEP populations, as people with a low SEP endure more often from chronic illnesses (18,19,22,23). Research shows that low SEP populations often have different views on health and the possible benefits of healthy behaviors compared to high SEP populations (24-27). Studies find that low SEP populations have less time, more stress, and limited financial capacities to implement healthy behaviors (26). Next to this, it is theorized that health beliefs often find origin in the health beliefs of previous generations (24-27). In the context of low SEP, the expectation of a shorter life and the belief that their own behavior has limited influence on their longevity pose barriers to adhering to healthy behaviors (20). Therefore, the digitalisation of health care could seriously impact the access and use of health care for those who need it most (5,6,13,28-31).

National digital connectivity and policies that stimulate the transition toward a digital health care system could improve the implementation and accessibility of eHealth. The European Union and its member states deploy policies to realize the digital transition of health care systems (5,6). Some states, such as the Netherlands, have been experimenting with digital health care for over a decade (4,6). Most Dutch households (98%) have fast broadband coverage (2020) and 88% of the Dutch population uses mobile broadband (2019), which indicates the use of a mobile phone or other device with mobile internet access (5). The level of connectivity in the Netherlands could facilitate the implementation of digital health care (5).

Several countries have developed national eHealth monitoring programs to monitor the uptake and effects of eHealth among health care professionals and citizens (32-34). From a citizen's perspective, the monitoring programs focus on the use and evaluation of eHealth that involve citizen interaction (32-34). This includes applications such as websites, apps, and wearables that citizens can use independently or involve eHealth tools that facilitate digital communication with a health care professional, such as video calls or messaging via patient portals (32-34). This study is based on secondary data analysis of the Dutch eHealth monitoring program (2021) (29), which collects data about access, use, and perceived benefits from eHealth among Dutch citizens through questionnaires.

There is still limited understanding of the relationship between SEP and eHealth access, use, and perceived benefit and that understanding is generally limited to either access, use, or perceived benefit from eHealth, specific eHealth apps or specific subpopulations. Research showed the relation between SEP and the use of personal health records (35) and mobile apps (36). Other research focuses on either the benefit from (37) or the use of eHealth (38,39) or specific patient groups such as cancer survivors (40,41), or citizens bound to specific locations (42). To our knowledge, insight into differences in eHealth access, use, and perceived benefits and how different indicators for SEP display these differences within the Dutch general population aged 18 years and older are largely unknown. This study aims to assess differences in eHealth-related access, usage, and perceived benefits for different socioeconomic populations, based on education, standardized income, and socioeconomic status (SES) level of the neighbourhood in the Netherlands. The findings of this study give insight into the disparities in access to, use of, and perceived benefit from eHealth in a highly connected country with an increasingly digitalized health care system. The results are insightful for other contexts that aim for or experience the same ambitions to transition to a digital health care system.

Methods

Panel

Data from the Dutch Health Care Consumer Panel (DHCCP) were used (43). The DHCCP is a panel managed by Nivel (the Netherlands Institute for Health Services Research) and currently (as of September 2023) consists of approximately 11,500 panel members aged 18 years and older (43). For this study, a study sample of 1,500 panel members was drawn by researchers from DHCCP. The study sample was representative of the Dutch population

aged 18 years and older regarding age and sex (43). Background characteristics of panel members, including their sex, age, level of education, net monthly income per household, and 4-digit postal codes were known. The panel was periodically renewed to ensure representative samples of the adult population in the Netherlands can be drawn. New panel members were recruited by buying an address file from an address supplier (43). As a result, possible new members were sampled at random from the general population in the Netherlands (43). The panel could only be joined through invitation. It was not possible for people to sign up on their own initiative (43). Upon membership, panel members were informed of the purpose, scope, method, and use of the panel (43). Based on this information, participants could give permission to participate in the panel (43).

Ethical Considerations

According to the Dutch legislation, neither obtaining informed consent nor approval by a medical ethics committee was obligatory for doing research within the DHCCP (43,44). Data analysis was conducted with pseudonymized data, according to the privacy regulations of the DHCCP, in compliance with the General Data Protection Regulation (44). The privacy of the panel members was protected. All data were carefully stored by Nivel (43). Personal information such as addresses was stored separately from the data of the questionnaires (43). The privacy of the panel members in the study sample was guaranteed by DHCCP (43). The researcher (LS) who analyzed the data had no access to the personal information of the panel members (43). A written or digital informed consent was obtained at the time of registration of a new member to the panel (43). Panel members were asked to participate approximately 4 or 5 times per year (43). Participation was voluntary.

Data Collection

Data on the population's perspective on eHealth were collected via the DHCCP as part of a larger monitoring study into the perceptions, experiences, and usage of eHealth in the Netherlands (43). A questionnaire was developed and reviewed by a team of representatives from the health care field in the Netherlands. The questionnaire was based on earlier distributed questionnaires of the monitoring study and was adjusted to reflect market developments (34). The questionnaire was distributed via email and post (according to the preferences of the panel members) in May 2021. A digital reminder was sent after 1, 2, and 3 weeks after the start of the questionnaire and 1 written reminder was sent after 2 weeks. Panel members had 4 weeks to respond.

Socioeconomic Position Indicators

Overview

The concept of SEP is complex, as it results from the interaction between individual, social, economic, cultural, and societal factors (45,46). In this study, 3 different operationalizations of SEP were used to study the digital divide in the context of eHealth—education as a historic starting point, standardized household income as a measure of current wealth, and SES level of the neighbourhood to include environmental influence (46-49).

Education

The education levels were defined as low (none, primary school, or prevocational education); medium (secondary or vocational education level 1, 2, 3, or 4); and high (professional higher education or university) (50).

Standardized Income

Standardized income was defined as the net monthly income of the household adjusted for number of household members. The net income was converted to the equivalent of the net income of a single adult household by using equivalence factors from Statistics Netherlands (the Dutch Institute for Population Statistics) (51). Some respondents acknowledged having children or other adults living in their household apart from their partner or children older than 18 years of age but did not specify the number. In the case of an unknown amount of children, 1.57 children were assumed. In case of an unknown amount of extra adults 1 extra adult was assumed. Assumptions were derived from the averages in Dutch households (50,52,53). Information gathered from the panel members about their monthly net income was in ranges, and the mean of the range was taken as the monthly net income. Standardized income was divided into three categories (1) low (between 0 and 1659 € per month (€1.00=US \$1.20. The used conversion rate was applicable on May 1, 2021)), (2) medium (between 1660 and 2332 € per month), and (3) high (more than 2332 € per month). The categories were derived from the quartile distribution of the net income of the Dutch households (2020) (54).

Socioeconomic Status Level of the Neighbourhood

The SES level of the neighbourhood of all respondents was determined using the Social Economic Status-Wealth Education Employment (SES-WOA) score (2019) from the Statistics Netherlands. The SES-WOA score was based on the wealth, educational status, and recent employment history of households in the neighbourhood (55,56). The SES-WOA score was matched to the respondent by the 4-digit postal code. The neighbourhoods of the

respondents were categorized as (1) low (first tertile of SES score: -0.89 to 0.042), (2) medium (second tertile of SES score: 0.043 - 0.21), and (3) high (third tertile of SES score: 0.21 - 0.71). The average score of Dutch neighbourhoods was 0.092 (SD 0.23 ; range -0.89 to 0.71) (55,56).

eHealth and the Digital Divide

For the interpretation of the data, the digital divide model was used. The digital divide model published by van Dijk et al (57) conceptualized that individuals' SEPs influence the available resources to access, use, and benefit from new digital media. In this study, the digital media in focus was eHealth.

Two concepts of eHealth were examined (1) eHealth in general and (2) websites, apps, and wearables. Items in the questionnaire that informed these 2 concepts were matched to the 3 levels of the digital divide model (57), namely level 1—access, level 2—use, and level 3—perceived benefit. Operationalization of the variables measuring access, use, and perceived benefit for eHealth in general and websites, apps, and wearables can be found in Multimedia Appendix 1.

First, eHealth in general was studied to gain insight into an overall interest toward digital apps in health care. The levels of digital divide that were studied are access and the perceived benefit. Access was measured by motivation. Here respondents were asked what their general thoughts are about digital apps used in health care. The perceived benefit was operationalized by measuring to what extent the respondents perceived themselves as making more conscious decisions about their health as a result of eHealth use.

Second, eHealth in terms of websites, apps, and wearables was studied to gain insight into the use of these specific eHealth tools to improve health or provide support in coping with a disease. The digital divide levels that were taken into account are access and use. Access was measured by motivation and physical access. Motivation was measured by asking the respondents if they have used or would like to use websites, apps, and wearables for their health. For physical access, the respondents were asked if they have access to an electronic device with internet.

The digital divide concept use was measured by barriers in use, diversity of use, and frequency of use. For the concept barriers in use, the respondents were asked if they experienced barriers in the use of websites, apps, and wearables. The use of websites, apps, and wearables was further operationalized in 2 variables—diversity of use and frequency of use. For these variables, the respondents were asked about 16 different websites, apps, or wearables if they used the app (once or more than once). Diversity

entails the variety of websites, apps, and wearables used, while the frequency of use operationalizes the number of times (more than once) the apps were used.

Statistical Analysis

Descriptive analyses were used to describe the demographics and the outcome of the variables measuring the access, use, and perceived benefit for eHealth in general and websites, apps, and wearables. The variables measuring access, use, and perceived benefit were constructed by combining items from the original questionnaire. The operationalization of these variables can be found in Multimedia Appendix 1.

The outcomes were stratified by the 3 variables of SEP—educational level, standardized income, and SES level of the neighbourhood. The differences in eHealth access and usage between SEP populations were investigated using logistic regression analysis. Ordered logistic regression was used for testing the differences in perceived benefit between SEP populations. Age was included in the analysis to test for confounding, as age is associated with both health and familiarity and use of digital media (10,58,59). The correlation between the independent variables was determined via the Spearman rank order correlation coefficient. Data analysis was conducted using the Stata Statistical Software release (version 16.1; StataCorp) (60). A $P < .05$ was considered statistically significant. Variables of physical access and diversity of use were not included in the logistic regression analysis because there were too few cases in outcome categories to meet the assumptions of the logistic regression analysis. The univariate outcomes are presented in Multimedia Appendix 2.

Results

Sample Characteristics

In total, 849 panel members responded to the questionnaire, resulting in a response rate of 56.6% (849/1500). Among the panel population of 1500, 8.9% (133/1500), 40% (600/1500), and 48.7% (731/1500) had a low, medium, and high level of education, respectively. Of these groups, 55.6% (74/133), 59.3% (356/600), and 54.3% (397/731) responded to the questionnaire. Regarding standardized income 35.8% (537/1500), 31.8% (477/1500), and 27.9 (419/1500) had low, medium, and high levels of standardized income, respectively. Of these groups, 57.2% (307/537), 56.4% (269/477), and 54.9% (230/269) had responded to the questionnaire. Finally, for SES-level of the neighbourhood, 42.8% (642/1500), 32.6% (489/1500), and 23.1% (346/1500) had low, medium, and high levels of SES-level of the neighbourhood in the

panel population, respectively. Of these groups, 56.1% (360/642), 58.1% (284/489), and 55.2% (191/346) responded to the questionnaire.

The demographics of the study population can be found in Table 1. An overview of the study population stratified by education, standardized income, and SES level of the neighbourhood can be found in Multimedia Appendix 3. Overall, the sample contained the same distribution of males or females as in the general population. When stratified for age category, our sample contained slightly more respondents aged 40 years and older and fewer respondents aged 18-39 years as compared to the general population. A frequency table of males and females in 3 age categories from the study population and the general Dutch population can be found in Multimedia Appendix 4 (74). Compared to the Dutch general population, the study population had more males (11.3% general population, 14.9% study population) and females (13.1% general population, 15.4% study population) in the age category of 65 years and older. In terms of sex, the distribution was equal between both populations (Dutch general population of 49.3% male and 50.7% female, study population male 48.7% and female 51.3%). The mean age was 54 (SD 16.96) years. The lowest number of respondents was in the low educational level subpopulation (74/849, 8.72%) and the highest in the high educational level subpopulation (397/849, 46.76%). A high educational level was significantly and positively associated with a high standardized income level, as indicated by the correlations of educational level and standardized income level: $p=0.37$ ($P<.001$), educational level and SES level of the neighbourhood: $p=0.021$ ($P=.55$), and standardized income level and SES level of the neighbourhood: $p=0.035$ ($P=.33$) (61).

Table 1. Demographic description of the study population (n=849). Study population was sampled (2021) from a representative population (N=1500) of general Dutch population aged 18 years and older.

		Total (n=849)
Sex, n (%)		
	Male	413 (48.6)
	Female	435 (51.2)
	Missing	1 (0)
Age (years)		
	Mean (SD)	54 (16.96)
	Range	19-92
Average household size		
	Mean (SD)	2.29 (1.11)
	Range	1-7
Number of households with children younger than 18 years, n (%)		
	No	604 (71.1)
	Yes	235 (27.7)
	Missing	10 (1.2)
Number of households with children older than 18 years, n (%)		
	No	763 (89.9)
	Yes	76 (9)
	Missing	10 (1.2)
Education		
	Mean (SD)	2.39 (0.65)
	Range	1-3
	Low, n (%)	74 (8.7)
	Medium, n (%)	356 (41.9)
	High, n (%)	397 (46.8)
	Missing, n (%)	22 (2.6)
Standardized income		
	Mean (SD)	1.90 (0.81)
	Range	1-3
	Low, n (%)	307 (36.2)
	Medium, n (%)	269 (31.7)
	High, n (%)	230 (27.1)
	Missing, n (%)	43 (5.1)

		Total (n=849)
SES ^b level of the neighbourhood		
	Mean (SD)	1.80 (0.79)
	Range	1-3
	Low, n (%)	360 (42.4)
	Medium, n (%)	284 (33.5)
	High, n (%)	191 (22.5)
	Missing, n (%)	14 (1.7)

^aEducation level—low (none, primary school or prevocational education); medium (secondary or vocational education level 1, 2, 3, or 4); and high (professional higher education or university). Standardized income was divided into 3 categories—low (between 0 and 1659 € per month); medium (between 1660 and 2332 € per month); and high (more than 2332 € per month). The SES level of the neighbourhood was determined using the Social Economic Status-Wealth Education Employment (SES-WOA) score (2019) from Statistics Netherlands. The SES-WOA score was based on the wealth, educational status, and recent employment history of households in the neighbourhood (55,56). Categories: low (first tertile of SES score: -0.89 to 0.042); medium (second tertile of SES score: 0.043-0.21); and high (third tertile of SES score: 0.21-0.71). Not all values add up to 100% due to missing values.

^bSES: socioeconomic status

Results of the Relation Between the Digital Divide Levels and the Socioeconomic Position Indicators

Overview

An overview of the measured and analysed variables can be found in Figure 1. The frequencies of these outcomes can be found in Multimedia Appendix 2.. Figure 2 presents the associations between access; use; perceived benefit; low, medium, and high education; standardized income; and SES level of the neighbourhood populations. The underlying data used for Figure 2 is presented in Multimedia Appendix 5. Table 2 presents a descriptive overview of access, use, and perceived benefit, stratified by SEP indicators. The results showed that the outcome differed the most when the population was stratified by education.

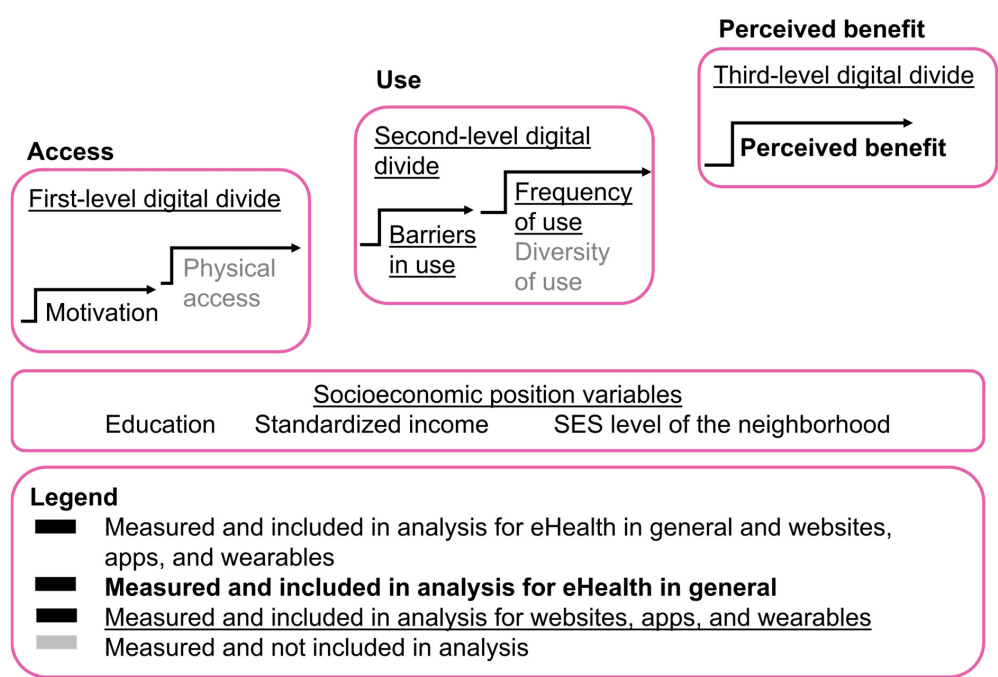


Figure 1. Overview of the concepts access, use and perceived benefit, the variables matched to these concepts and the socio-economic position indicators used in this study. Legend indicates whether the variables were matched for e-health in general (bold), websites apps and wearables (underlined) or both. Secondly, the legend indicates whether the variables were viable, either included (black) or not included (grey), for logistic (ordered) regression analysis. Adapted from Jan van Dijk (2020), *The Digital Divide* p.64 (57).

Access and Motivation

For eHealth in general, as well as for websites, apps and wearables, differences in motivation were found between different levels of education. Differences in motivation were most profound between low or medium versus highly educated respondents in both eHealth in general (odds ratio [OR] 2.18, 95% CI 1.22-3.88) and websites, apps, and wearables (OR 5.72, 95% CI 3.06-10.72). Regarding standardized income, a difference in motivation for eHealth in general was found between high and low standardized incomes (OR 1.52, 95% CI 1.05-2.21). A significant difference in motivation between low (OR 1.74, 95% CI 1.19-2.55) and medium (OR 1.63, 95% CI 1.1-2.43) versus high SES level of the neighbourhood was found for eHealth in general.

Use, Barriers in Use, and Experienced Barriers

High standardized income was associated with no experience of barriers in use in comparison to low and medium levels of standardized income. This implies that fewer respondents with a high standardized income experienced barriers while using eHealth websites, apps, and wearables (OR 1.60, 95% CI 1.11-2.31). The frequency of eHealth use also differed between respondents with a low, medium, or high level of education, with the most significant difference between high and low educational levels (OR 4.96, 95% CI 2.66-9.24). In terms of standardized income, there were significant differences between low and high (OR 1.76, 95% CI 1.06-2.91) and low and medium (OR 1.74, 95% CI 1.09-2.79) standardized income levels. High SEP respondents were more likely to frequently use an eHealth app, website, or wearable compared to medium or low SEP respondents.

Perceived Benefit

There were no significant differences found regarding the perceived benefits between low, medium, or high SEP populations.

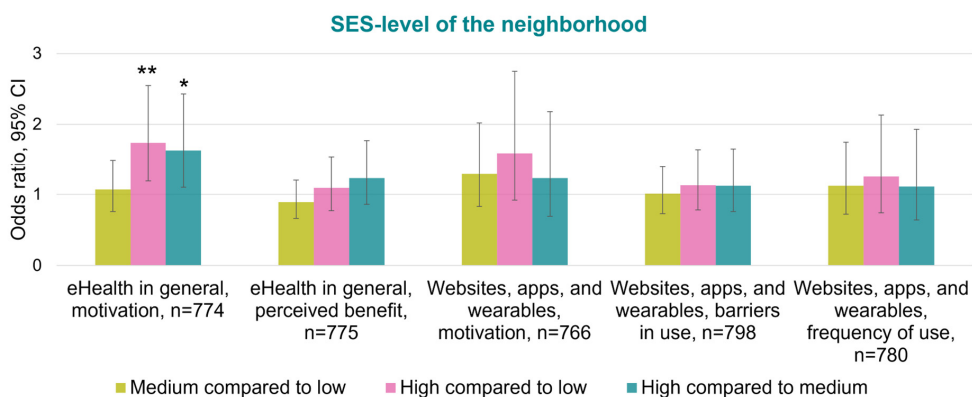
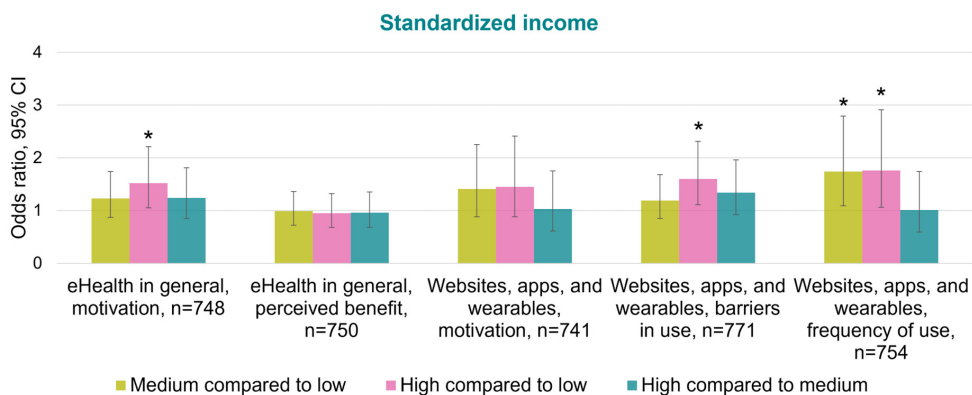
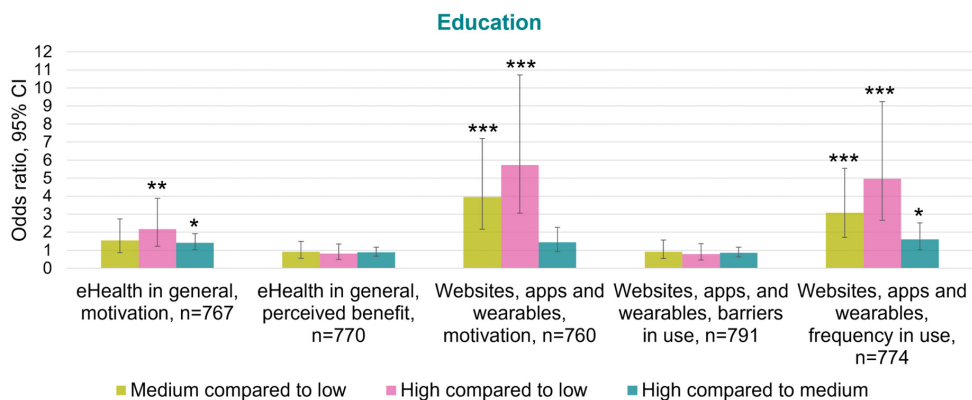


Figure 2. The relation between access, use and benefit of e-health and low, medium and high levels of three SEP indicators: education, standardized income and SES-level of the neighbourhood. Results from a questionnaire (2021) answered by a representative study population (n=849) for the general Dutch population aged 18 and above. Access: motivation, use: barriers in use and frequency of use, and perceived benefit: perceived benefit. For each SEP indicator, a bar graph of the results of logistic (ordered) regression analysis was presented. Each bar shows the odds ratio and the 95% CI for the difference between SEP levels for each digital divide concept. For each SEP indicator, the following comparisons were made: medium compared to low (dark green), high compared to low (medium green) and high compared to medium (medium green). The number of respondents (n=) included in the analysis for each digital divide concept was indicated. The variable barriers in use was recoded to ensure that positive score (1) reflected the outcome: no experienced barriers. Positive odds ratios (OR>1) should be interpreted that the primary group in the comparison, in the case of this study either medium or high SEP, had more likelihood to not experience barriers in use. *p>0.05, **p>0.01, ***p>0.001. SEP: socio-economic position; SES: socio-economic status; CI: confidence interval.

Table 2. Frequency distribution of access, use, and perceived benefit for (1) eHealth in general and (2) websites, apps, and wearables, stratified by education, standardized income, and SES^a level of the neighbourhood. Frequencies are derived from results of a questionnaire (2021) conducted among a sample of the general Dutch population (N=1500), final study population (n=849)^{b,c}.

	Total	Education			Standardized income			SES level of the neighbourhood		
		Low	Med ^d	High	Low	Med	High	Low	Med	High
Population, n	849	74	356	397	307	269	230	360	284	191
eHealth in general										
Access—motivation, n (%)										
No motivation	386 (45.5)	46 (62.2)	177 (49.7)	152 (38.3)	153 (49.8)	124 (46.1)	90 (39.1)	174 (48.3)	141 (49.6)	68 (35.6)
Motivation	401 (47.2)	21 (28.4)	153 (43.0)	218 (54.9)	131 (42.7)	127 (47.2)	123 (53.5)	157 (43.6)	127 (44.7)	107 (56)
Perceived benefit—perceived benefit, n (%)										
Totally disagree—disagree	211 (24.9)	17 (23.0)	80 (22.4)	108 (27.2)	70 (22.8)	68 (25.3)	65 (28.3)	85 (23.6)	76 (26.7)	46 (24.1)
Not agree nor disagree	370 (43.6)	33 (44.5)	171 (48.0)	159 (40.1)	144 (46.9)	119 (44.2)	89 (38.7)	158 (43.9)	134 (47.2)	75 (39.3)
Agree—totally agree	205 (24.1)	17 (23.0)	81 (22.8)	104 (26.2)	69 (22.5)	65 (24.2)	61 (26.5)	87 (24.2)	61 (21.5)	53 (27.7)

	Total	Education			Standardized income			SES level of the neighbourhood		
		Low	Med ^d	High	Low	Med	High	Low	Med	High
Population, n	849	74	356	397	307	269	230	360	284	191
Websites, apps, and wearables										
Access—motivation, n (%)										
No motivation	143 (16.8)	35 (47.3)	62 (17.4)	41 (10.3)	59 (19.2)	43 (16.0)	34 (14.8)	65 (18.1)	50 (17.6)	23 (12.0)
Motivation	636 (75.0)	29 (39.2)	265 (74.4)	328 (82.6)	221 (72.0)	206 (76.6)	178 (77.4)	263 (73.1)	215 (75.7)	150 (78.5)
Use—barriers in use, n (%)										
Experienced barriers	339 (40.0)	29 (39.2)	140 (39.3)	159 (40.1)	135 (44.0)	109 (40.5)	76 (33.0)	145 (40.3)	119 (41.9)	71 (37.2)
No experienced barriers	472 (55.6)	39 (52.7)	201 (56.5)	223 (56.2)	157 (51.1)	149 (55.4)	145 (63.0)	197 (54.7)	156 (54.9)	110 (57.6)
Use—frequency of use, n (%)										
No frequent use	131 (15.4)	29 (39.2)	60 (16.9)	38 (9.6)	59 (19.2)	36 (13.4)	29 (12.6)	57 (15.8)	47 (16.5)	24 (12.6)
Frequent use	662 (78.0)	34 (45.9)	274 (77.0)	339 (85.4)	222 (72.3)	219 (81.4)	189 (82.2)	277 (76.9)	226 (79.6)	149 (78.0)

^aSES: socioeconomic status

^bThe variables physical access and diversity of use for websites, apps, and wearables were not presented in Table 2 because these variables could not meet the assumptions for logistic regression analysis. The frequencies of these outcomes can be found in Multimedia Appendix 2.

^cNot all values add up to 100% due to missing values

^dMed: medium level

Discussion

Principal Findings

This study shows that low SEP respondents have less access to and use of eHealth compared to medium or high SEP respondents. The most significant digital divide observed in this study is related to educational background. The results of this paper contribute on a population level to previous findings that the access and use of eHealth has a socioeconomic gradient. Additionally, the results emphasize that SEP indicators cannot be used interchangeably to assess eHealth access and use.

The results of this study highlight that, across all 3 SEP indicators, the most substantial differences are found in access through motivation. Respondents from higher socioeconomic categories expressed greater motivation to use eHealth, including websites, apps, and wearables, in comparison to those from lower SEPs. Health equity researchers emphasize that comprehending how people perceive health and health care is a complex issue influenced by several societal, contextual, social, and biological individual factors. Therefore, a multidimensional and multicausal approach is necessary to comprehend these disparities (24,62,63). Weiss et al (28) discuss existing literature and multiple theories as to why differences in eHealth access and use exist between socioeconomic groups. The literature described that the social position of individuals and the influence of the context and organizations surrounding the individual play a role in whether individuals choose to consume digital health care or not (28). Other literature emphasized that the diffusion of digital health care in society will decrease the digital divide gap as the low SEP population is assumed to be the latest to adopt (28). However, the role of health care organizations, social policies, and political decisions that impact individuals' motivations toward eHealth has not been adequately studied. Current national Dutch policies concerning eHealth are focused on the development and interoperability of eHealth apps, the digital skills of health care professionals and the use of eHealth by older people at home, resulting in eHealth becoming an essential part of the health care system (64). In countries where health care digitalisation is progressing, it would be valuable to examine the potential influence of the government, health care organizations, and businesses on the motivation of low socioeconomic populations toward eHealth. Such research could offer valuable insights into the societal and policy changes required to make eHealth more appealing to low SEP populations.

In this study, use was examined by studying the barriers in use and frequency of use of eHealth websites, apps, and wearables. The results demonstrated that

respondents with a high standardized income level infrequently experienced barriers to using eHealth websites, apps, and wearables compared to lower standardized income levels. Previous studies show that highly educated people often have higher health literacy levels and digital skills and are more in contact with the digital world via their education or profession (10,31,59,65-69). Other studies show that in the development of eHealth new apps are often pilot-tested by highly educated respondents and, therefore, might be more tailored to the needs of highly educated individuals (9,70,71). In contrast, other studies point out the variety of health behaviors and health care use within SEP groups. De Boer et al (72) show that low SEP groups have more health care costs but that healthy lifestyle behavior such as smoking or being member of a sports club are attributed greatly to the variety in health care use in each socioeconomic group. In the light of eHealth, Agachi et al (73) showed that the user interface and the type of eHealth offered attributes to the use of eHealth between socioeconomic groups. Results revealed that for the same eHealth program, people living in a low socioeconomic neighbourhood use the app-based tool more than people living high in a socioeconomic neighbourhood. For the web-based version, results show the opposite emphasizing the importance of the user interface and the accessibility to digital devices, as is also theorized in the digital divide model (49,73). Both De Boer (72) and Agachi (73) show that behavior-related and technical-related factors play a role in the use of health care and eHealth. The results of this study and other studies showed that understanding and creating insight into the existence of and possible solutions for health disparities is dependent on multiple dimensions. Future research into how the socioeconomic gradient in eHealth access and use are associated with other behavioral and technical factors is important to create an in-depth understanding of disparities in eHealth access and use that can inspire research, policy, and practice.

Results pointed out that high education and high standardized income levels were associated with frequent use of websites, apps, and wearables. This is in accordance with previous research, which shows that a high level of education and income is found to be associated with more access to and use of eHealth (12,13,31). Surprisingly, no difference was found in the perceived benefits (making more conscious decisions in health because of eHealth use) in any of the SEP indicators, although the frequency of use of websites, apps, and wearables was high (78%) and did show significant differences. This implies that respondents with more frequent use of websites, apps, and wearables had the same perceived benefit, namely, making more conscious decisions due to eHealth use, compared to respondents who have not used websites, apps, and wearables once. Evaluation studies show that high SEP respondents have

better outcomes from eHealth use than low SEP respondents (10,30,31,59). The results of this study might indicate that in the real-life context, even though current eHealth apps might be more suitable for highly educated individuals, eHealth is not used appropriately or with similar discipline as in the clinical trial context.

Strengths and Limitations

The strengths of this study were the use of a large and representative sample of the Dutch population and the use of 3 SEP operationalizations to provide a broad insight into the effects of SEP on the digital divide. This study also has some limitations. Despite a large number of respondents, the skewed distribution of outcomes across SEP levels hampered the performance of multivariable logistic regression analysis (61). Next to this, the SEP indicators used are focused on social demographic and economic aspects of SEP. Cultural and other social aspects, such as social networks and cultural background, have not been taken into account.

The questionnaire used in the study was not designed to measure all the different aspects of the digital divide model and is a secondary analysis of the data gathered. Although the majority of digital divide levels could be well matched with questionnaire items, data on the second level digital divide for eHealth in general and the third digital divide level for websites, apps, and wearables was lacking. In some cases, with emphasis on the concept barriers in use for websites, apps, and wearables more in-depth insights into the digital divide levels would have been desirable to improve the validation of the findings. Van Dijk (57) provides concepts to further define the digital divide levels. Access, the first level of digital divide, is described to entail the concepts of motivational access and physical access. Use, the second level of digital divide entails the concepts of digital skills and usage. Usage here encompasses both frequency and diversity of digital media use. Perceived benefit, the third level digital divide, is conceptualized by personal outcomes that are a result of the use of digital media (57). In this study, the concept barriers in use were used instead of digital skills, as experienced barriers are not limited to barriers formed by a lack of digital skills.

Additionally, for the first and the second level digital divide, the technical design and the Information and Communication Technology (ICT) of eHealth are of importance (57). The technical design and the ICT imply factors such as accessibility, usability, mobility, quality, and accessibility of internet access and automation (self-learning devices or software tailored to serve the consumer better and automatically) of devices and apps. These factors are important to

facilitate adherence and appropriate use of eHealth apps (57). The questionnaire provided no insight into these factors.

Conclusion

The results of this study revealed that differences in motivation for eHealth use are most profound between different socioeconomic populations in the Dutch society, in which low-educated people are likely to be disadvantaged. A successful transition toward digital health care is a social issue that is dependent on the motivation to use eHealth and specific apps. It is imperative that future studies within academia and within the health care field focus on the motivations and needs associated with digital health care, specifically for low SEP populations. Research on the societal changes stemming from the digital health care transition and the technical and design studies of digital care apps in single-intervention studies are both vital for the realization of an inclusive and comprehensive digital health care system. If eHealth takes a predominant role in the Dutch health care system, it might affect access and use of health care for the citizens who need it the most. The results of this study underscore the importance of policies aimed at facilitating and supporting low SEP populations in the use of eHealth to reduce differences in health.

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Data Availability

The datasets generated and analyzed during this study are available upon reasonable request from Prof Judith D de Jong (j.dejong@nivel.nl), project leader of the Dutch Health Care Consumer Panel, or the panel's secretary (conusmentenpanel@nivel.nl).

Conflicts of Interest

None to declare.

Abbreviations

DHCCP: Dutch Health Care Consumer Panel

ICT: Information and Communication Technology

OR: odds ratio

SEP: socioeconomic position

SES-WOA: Social Economic Status-Wealth Education Employment

SES: socioeconomic status

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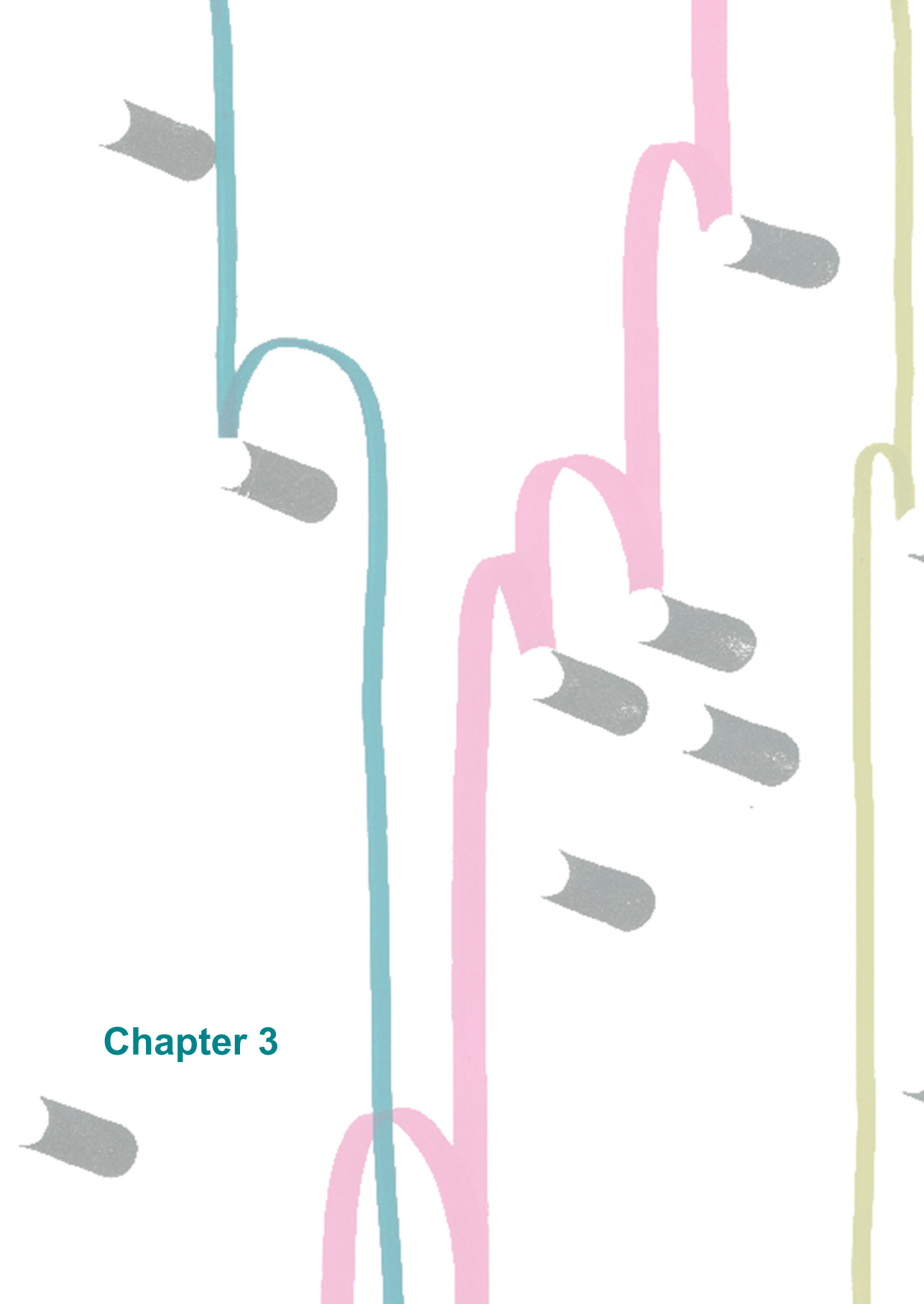
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Chapter 3

Digital Health Use Across Socioeconomic Groups in Patients with a Chronic Disease

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Abstract

People with a low socioeconomic position (SEP) are disproportionally affected by digital health inequities and chronic diseases. Being a patient with a chronic disease in a highly digitized healthcare system context may lead to greater awareness and use of e-health, regardless of SEP. This study assesses whether socio-economic differences in e-health use exist in a Dutch population of people with a chronic disease. A questionnaire (2023) was sent out to a panel consisting of Dutch adults with a chronic disease. The response rate was 1.543/2.113, 73%. Participants were asked about the use of five e-health applications and their inclination to use e-health. Educational attainment was used as a proxy for SEP. Results show that participants with a lower educational attainment used significantly less websites, apps, wearables and patient portals compared to higher educational attainment groups. Participants with a low educational attainment were less likely to be inclined and more likely to be uncertain about e-health use. Differences in e-health use and positive inclination towards e-health use exist between socio-economic groups among Dutch adults with a chronic disease. Current e-health implementation practices do not serve all patients equally, demanding more attention towards inclusive organization of e-health.

Keywords: health inequities, telemedicine, social determinants of health, patients, socioeconomic factors

Introduction

E-health is increasingly implemented in healthcare systems around the world. E-health entails use of digital technology within health care. From a patient perspective, e-health often involves the use of websites, apps or wearables for the purposes of personal health data access, health monitoring and communication with healthcare professionals. E-health could improve access to and quality of healthcare (1, 2). However, the potential increase in health inequalities between socio-economic groups due to increased reliance on e-health is a major concern (3-5). Research shows that populations with a lower socio-economic position (SEP) have less access and use of e-health (6-8). Consequently, these populations experience less benefits from e-health (4, 6, 8). As low SEP also is associated with higher occurrence of chronic disease, the disparity in e-health access affects those who need it most (9, 10).

At the same time, the presence of a chronic disease is associated with e-health use (11-14). The sense of an urgency for management of disease, and frequent interaction with the healthcare system, potentially causes more exposure to e-health and reasons for e-health use (15-17). A literature review by Taylor et al. (2022) identified that patients with chronic diseases generally experienced feelings of reassurance and abilities for self-management through e-health use (15). However, ambivalence was also experienced related to privacy, data management, burden of self-management, independence and digital skills (15). Patients might experience both positive and negative side effects from e-health use. E-health can improve the opportunities for patients' self-management; however, concurrently, also increase the individuals' burden of disease (15).

Previous research shows that socioeconomic differences in access and use of e-health are present in the general Dutch population (7). Other previous qualitative research revealed that being a patient or caregiver was one of the key motivations for people to seek support in e-health use (16). People with chronic disease might be more aware and have a cause for e-health use. Therefore, it is hypothesized socioeconomic differences in e-health use and inclination to use e-health are not present in a population of Dutch people with chronic illnesses. This study provides insights in whether socio-economic differences in e-health use still exist in a population that frequently uses health care services.

Methods

Study design

A secondary cross-sectional analysis was performed to assess the differences in e-health use and inclination to use e-health within a population of Dutch adults with a chronic disease. The STROBE guidelines were used to ensure a robust report of this study, the checklist can be found in Appendix 1(18).

Context

The Netherlands is one of the most connected and digitalized countries in the European Union (19). As of 2025, most households (93.8%) are connected with wired internet, all households are covered by 5G networks and most citizens use public digital services (91%) (19). In the Dutch healthcare system, patients with chronic diseases are stimulated to adhere to self-management and self-monitoring practices and are regularly invited for follow-up visits (20). The use of e-health in these practices is stimulated and has increased over the years (21-27). From 2021 – 2024, general practitioners, medical specialists and nurses report an increase in telemonitoring, digital communication and patient portal use (27). Financial access to health care is high as Dutch citizens are obliged to participate in a collective healthcare insurance system that covers most health care services (28, 29). The minimum yearly health insurance premium was €2112 (2025) (30). Citizens with a low income can request additional financial support with a maximum of €1572 (2025) (31, 32). Thus, in general, people with a chronic disease have the financial means to access health care services (28, 29).

Monitor Digital Care & National Panel of the Chronically ill and Disabled

The results of this study are derived from a secondary analysis from data gathered via the Monitor Digital Care (MDC) project (24). The MDC project yearly monitors e-health use and experiences from citizens, patients and health care professionals in the Netherlands [18]. The MDC included a questionnaire via the Dutch nationwide panel National Panel of the Chronically ill and Disabled (NPCD), a panel managed by the Netherlands Institute of Health Services Research (Nivel) (24, 33). The questionnaire measured e-health use. Panel members with one or more chronic somatic conditions were included in the study sample, participants that only suffered from a physical disability were excluded (24). The questionnaire was sent out in April 2023 to 2.113 panel participants, 1.543 (1.543/2.113, 73%) participants responded (24).

Panel recruitment & procedures

The aim of the panel is to gain insight in the experiences with and consequences of living with a chronic condition or long-term physical disability

from the patients' perspective. The NPCD panel committee assesses whether requests for panel use are in line with the aim of the panel. Twice a year, panel participants receive a questionnaire on various topics including health-related outcomes, use of and experiences with healthcare and experiences with participation in society. Participants receive the questionnaire online or via post. The NPCD panel consists of approximately 3500 people aged ≥ 18 years (33). Panel participants with a chronic disease are recruited from a random sample of general practices in the Netherlands (33). Within the selected practices, general practitioners (GPs) are invited to participate in the selection of patients with a chronic disease. With help from trained research staff, participating GPs draw a random sample constituting one third of their patients. All patients who are diagnosed with one or more somatic chronic diseases according to the International Classification of Primary Care (ICPC) are eligible for inclusion (34). Exclusion criteria are: < 15 years old, being institutionalized, unaware of diagnosis, being terminally ill (a life expectancy of < 6 months) and insufficient mastery of the Dutch language. Included patients receive a letter from their GP with information about the panel, an invitation to participate and an informed consent form. After subscribing for the NPCD, patients receive a short questionnaire to provide some background information, such as gender, age and education. After returning this questionnaire, a patient becomes member of the NPCD. New panel members are selected annually to replace participants who withdrew or have participated for the maximum term of four years.

Ethics approval and consent to participate

For the NPCD, a privacy regulation applies. In this privacy regulation it is described how data are managed and which measures have been taken to protect the privacy of panel members (33). All data are processed anonymously. According to Dutch legislation, neither obtaining informed consent nor approval by a medical ethics committee, is not mandatory for carrying out research in this panel.

Measurements

Difference in e-health use was studied for five types of e-health applications. Three types of them are patient-initiated e-health applications: websites, apps and wearables. Wearables are devices that are carried by patients and measure health data, for example: smartwatches that measure physical activity or sensors that measure blood glucose levels. The other two types of e-health are facilitated by healthcare providers: a patient portal and the use of digital communication. A patient portal is an online platform that is accessible via websites or apps. Patient portals often have multiple functionalities, but generally patient portals provide online access to patients' history and dossier.

Other functionalities are: medication ordering service and digital communication with healthcare providers. The use of digital communication was measured by whether the respondent had communicated with a healthcare professional via either video consultation, e-consultation or chat consultation. For data analyses of this study, the use of e-health applications was operationalized in two possible outcomes: no use (0) or use (1). For each application participants were asked if they had used the application in the past 12 months. Respondents could respond: 'Yes' (use), 'No, but I would want to' (no use) and; 'No, and I do not have need for use' (no use). In case of patient portal use, respondents were provided with additional answer options: 'I do not know' (no use), 'No, but I would want to use this' (no use), 'No, and I do not have need for use' (no use), 'Yes, I have used this once' (use), 'Yes, I have used this more often than once' (use).

Furthermore, the study assessed participants' inclination towards e-health use by asking how participants generally felt about using e-health. Inclination towards e-health use was operationalized via three outcome possibilities: not inclined (0), inclined (1) and uncertain (2). The variable 'not inclined' was constructed from the following answer options: 'I am somewhat reluctant', 'I do not see the value', 'I do not want that the care I receive to be (partially) replaced by e-health interventions' and, 'I am very negative'. For the variable 'inclined', the following options were selected: 'I am very enthusiastic', 'I would like to try', 'I have to get on with it, because this is best for my health' and, 'I have to get on with it, because that is how things are nowadays'. The variable 'uncertain' was constructed from two answer options: 'I don't know' and, 'I'm not sure yet what will work for me'.

In this study, education is used as a proxy for SEP (35). SEP was derived from different levels of educational attainment. Educational attainments were defined as following: low (none, primary school, or prevocational secondary education); medium (secondary or vocational educational attainment 1, 2, 3, or 4); and high (professional higher education or university) (36).

The following demographic variables were derived from the panels' dataset: age, sex, type of chronic disease, number of chronic diseases. The following variables were derived from the questionnaire: use of a computer, use of a smartphone or tablet, and use of apps on a smartphone or tablet. Participants were asked whether they had independent use, use with help from others, or no use of these devices or apps.

Statistical analyses

Logistic regression analysis was used to study the differences in use and inclination to use e-health between educational attainments. To study inclination to e-health use, the outcomes were converted to dummy variables to allow for a one versus rest logistic regression analysis: “inclined” (inclined (1)/ not inclined or uncertain(0)), “not inclined” (not inclined (1)/ inclined or uncertain (0)), and “uncertain” (uncertain (1)/ inclined or not inclined (0)). Participants were excluded if there was no information available about their educational attainment (n=26).

Confounding was investigated for the following factors: age and sex. Research shows that young age and being female is associated with e-health use (37-39). Factors were considered a relevant confounding factor when the factor led to a change of 10% in outcome compared to the initial model. Age was a confirmed confounder, therefore only age was included. Data can be found in Appendix 2.

Results

Demographics

The final study sample consisted of n=1.517 (98.3%) participants after exclusion of participants with missing information on educational attainment. Demographics of the study sample can be found in Table 1. The study sample had an average age of 66 years (SD: 12.8), 61.5% of the population belonged in the age categories 65-74, and 75+ years of age. In terms of educational attainment, most participants belonged in the medium educational attainment group (45.1%), followed by high (31.2%) and low (23.7%). All types of disease were equally present among the educational attainment groups. Cardiovascular disease (30%) was the most prevalent in all groups (min: 28.9%, max: 32.8%). The majority of the population had one (38.8%) or two (32.9%) diagnoses. Around 70% of the study population independently used a computer, a smartphone or tablet, and apps on a tablet or smartphone. Participants with a high or medium educational attainment showed higher use compared to participants with a low educational attainment. Participants with a lower educational attainment independently used smartphones or tablets (54.4%) more often than computers (46.1%).

Table 1. Demographics of the study sample both presented for the total study sample (n=1,517) and stratified by educational attainment^a.

	Educational attainment			
	Total	Low	Medium	High
N	1,517 (100.0%)	360 (23.7%)	684 (45.1%)	473 (31.2%)
Age (Mean (SD))	66 (12.8)	69.4 (10.9%)	65.5 (13.2)	64.2 (13.1)
Age 15 - 39 (n (%))	70 (4.6%)	6 (1.7%)	32 (4.7%)	32 (6.8%)
Age 40 - 64 (n (%))	514 (33.9%)	103 (28.6%)	239 (34.9%)	172 (36.4%)
Age 65 - 74 (n (%))	546 (36.0%)	129 (35.8%)	243 (35.5%)	174 (36.8%)
Age 75+ (n (%))	387 (25.5%)	122 (33.9%)	170 (24.9%)	95 (20.1%)
Sex (n, (%))				
Male	723 (47.7%)	160 (44.4%)	299 (43.7%)	264 (55.8%)
Female	794 (52.3%)	200 (55.5%)	385 (56.3%)	209 (44.2%)
Type of chronic disease (n (%))				
Cardiovascular disease	455 (30.0%)	118 (32.8%)	198 (28.9%)	139 (29.4%)
Asthma, COPD ^b	213 (14.0%)	44 (12.2%)	98 (14.3%)	71 (15.0%)
Musculoskeletal disorders	151 (10.0%)	44 (12.2%)	74 (10.8%)	33 (7.0%)
Cancer	95 (6.3%)	22 (6.1%)	38 (5.6%)	35 (7.4%)
Diabetes	209 (13.8%)	60 (16.7%)	94 (13.7%)	55 (11.6%)
Neurological conditions	103 (6.8%)	15 (4.2%)	52 (7.6%)	36 (7.6%)
Gastrointestinal diseases	57 (3.8%)	13 (3.6%)	22 (3.2%)	22 (4.7%)
Other	234 (15.4%)	44 (12.2%)	108 (15.8%)	82 (17.3%)
Number of diagnoses (n, (%))				
One	590 (38.8%)	122 (33.9%)	271 (39.6%)	197 (41.6%)
Two	499 (32.9%)	128 (35.6%)	211 (30.8%)	160 (33.8%)
Three	265 (17.5%)	60 (16.7%)	121 (17.7%)	84 (17.6%)
Four or more	163 (10.7%)	50 (13.9%)	81 (11.8%)	32 (6.8%)
Use of a computer (n, (%))				
Independent in use	1075 (71.0%)	166 (46.1%)	502 (73.4%)	407 (86%)
Use with support	127 (8.4%)	55 (15.3%)	55 (8.0%)	17 (3.6%)
No use	194 (12.8%)	102 (28.3%)	65 (9.5%)	27 (5.7%)
Missing	121 (8.0%)	37 (10.3%)	62 (9.1%)	22 (4.7%)

		Educational attainment		
	Total	Low	Medium	High
Use of a smartphone or tablet (n, (%))				
Independent in use	1109 (73.1%)	196 (54.4%)	511 (74.7%)	402 (85%)
Use with support	115 (7.6%)	44 (12.2%)	56 (8.2%)	15 (3.2%)
No use	179 (11.8%)	84 (23.3%)	60 (8.8%)	35 (7.4%)
Missing	114 (7.5%)	36 (10.0%)	57 (8.3%)	21 (4.4%)
Use of apps on a smartphone or tablet (n, (%))				
Independent in use	1057 (69.7%)	192 (53.3%)	477 (69.7%)	388 (82%)
Use with support	108 (7.1%)	36 (10.0%)	57 (8.3%)	15 (3.2%)
No use	235 (15.5%)	97 (26.9%)	92 (13.5%)	46 (9.7%)
Missing	117 (7.7%)	35 (9.7%)	58 (8.5%)	24 (5.1%)

- a. Educational attainment: low (none, primary school, or prevocational secondary education); medium (secondary or vocational educational attainment 1, 2, 3, or 4); and high (professional higher education or university).
- b. COPD: Chronic Obstructive Pulmonary Disease

Measurement outcomes

An overview of the frequencies of all the outcomes are presented in Table 2. Websites (50.4%) and patient portals (50.1%) are used by over 50% of all the participants. Other applications were used less frequent (16% - 32.1%). Digital communication with health care providers was used the least (16%) and had most missing values (24.8%). The frequency of each outcome of the inclination to use e-health were equally distributed: not inclined (29.2%), inclined (27.9%) and uncertain (28.8%). The outcome of the regression analyses are presented in Figure 1 and Figure 2. The figures are derived from the data presented in Appendix 3.

Use of e-health applications

Participants with a low educational attainment were the least likely to use websites, patient portals, apps, wearables and digital communication. Significant differences in e-health use between educational attainment groups were found for all e-health applications, with the exception for digital communication. Use of websites and patient portals significantly increase for each higher level of educational attainment. Results show significant differences between: low and medium (websites: OR 2.58, 95% CI 1.94-3.44; patient portal: OR 2.21, 95% CI 1.66-2.94), low and high (websites: OR 4.78, 95% CI 3.50-6.53; patient portal: OR 3.24, 95% CI 2.38-4.41) and, medium and high (websites: OR 1.85, 95% CI 1.42-2.40; patient portal: OR 1.47, 95% CI:

1.14-1.89) educational attainment groups. Participants with a low educational attainment used apps and wearables less often compared to medium and high educational attainment groups. Results show that the low educational attainment group was significantly less likely to use these e-health tools compared to medium (apps: OR 2.39, 95% CI 1.68-3.40; wearables: OR 2.01, 95% CI 1.47-2.76) and high (apps: OR 2.88, 95% CI 2.00-4.16; wearables: OR 2.12, 95% CI 1.52-2.95) educational attainment groups. There were no significant differences found for apps and wearable use between medium and high educational attainment groups.

Table 2. Descriptive results of e-health use and inclination to use e-health in a study sample (n=1517) of people suffering from a chronic disease. Study sample was drawn from the National Panel of the Chronically ill and Disabled (2023). Results are presented for the total population and stratified per educational attainment^a group.

	Total	Educational attainment		
		Low	Medium	High
N	1,517 (100.0%)	360 (23.7%)	684 (45.1%)	473 (31.2%)
Websites (n, (%))				
Not used	664 (43.8%)	240 (66.7%)	287 (42.0%)	137 (29.0%)
Used	765 (50.4%)	103 (28.6%)	348 (50.9%)	314 (66.4%)
Missing	88 (5.8%)	17 (4.7%)	49 (7.2%)	22 (4.7%)
Mobile apps (n, (%))				
Not used	1,005 (66.2%)	285 (79.2%)	434 (63.5%)	286 (60.5%)
Used	410 (27.0%)	49 (13.6%)	197 (28.8%)	164 (34.7%)
Missing	102 (6.7%)	26 (7.2%)	53 (7.7%)	23 (4.9%)
Wearables (n, (%))				
Not used	936 (61.7%)	267 (74.2%)	396 (57.9%)	273 (57.7%)
Used	487 (32.1%)	71 (19.7%)	236 (34.5%)	180 (38.1%)
Missing	94 (6.2%)	22 (6.1%)	52 (7.6%)	20 (4.2%)
Patient portal (n, (%))				
Not used	656 (43.2%)	215 (59.7%)	284 (41.5%)	157 (33.2%)
Used	760 (50.1%)	111 (30.8%)	353 (51.6%)	296 (62.6%)
Missing	101 (6.7%)	34 (9.4%)	47 (6.9%)	20 (4.2%)
Digital communication with healthcare professional (n, (%))				
Not used	899 (59.3%)	186 (51.7%)	408 (59.6%)	305 (64.5%)
Used	242 (16.0%)	37 (10.3%)	105 (15.4%)	100 (21.1%)
Missing	376 (24.8%)	137 (38.1%)	171 (25.0%)	68 (14.4%)
Inclination to use e-health (n, (%))				
Inclined	423 (27.9%)	54 (15.0%)	192 (28.1%)	177 (37.4%)
Not inclined	443 (29.2%)	103 (28.6%)	204 (29.8%)	136 (28.8%)
Uncertain	437 (28.8%)	140 (38.9%)	191 (27.9%)	106 (22.4%)
Missing	214 (14.1%)	63 (17.5%)	97 (14.2%)	54 (11.4%)

a. Educational attainment: low (none, primary school, or prevocational secondary education); medium (secondary or vocational educational attainment 1, 2, 3, or 4); and high (professional higher education or university).

Differences in use of e-health applications between low, medium and high education levels

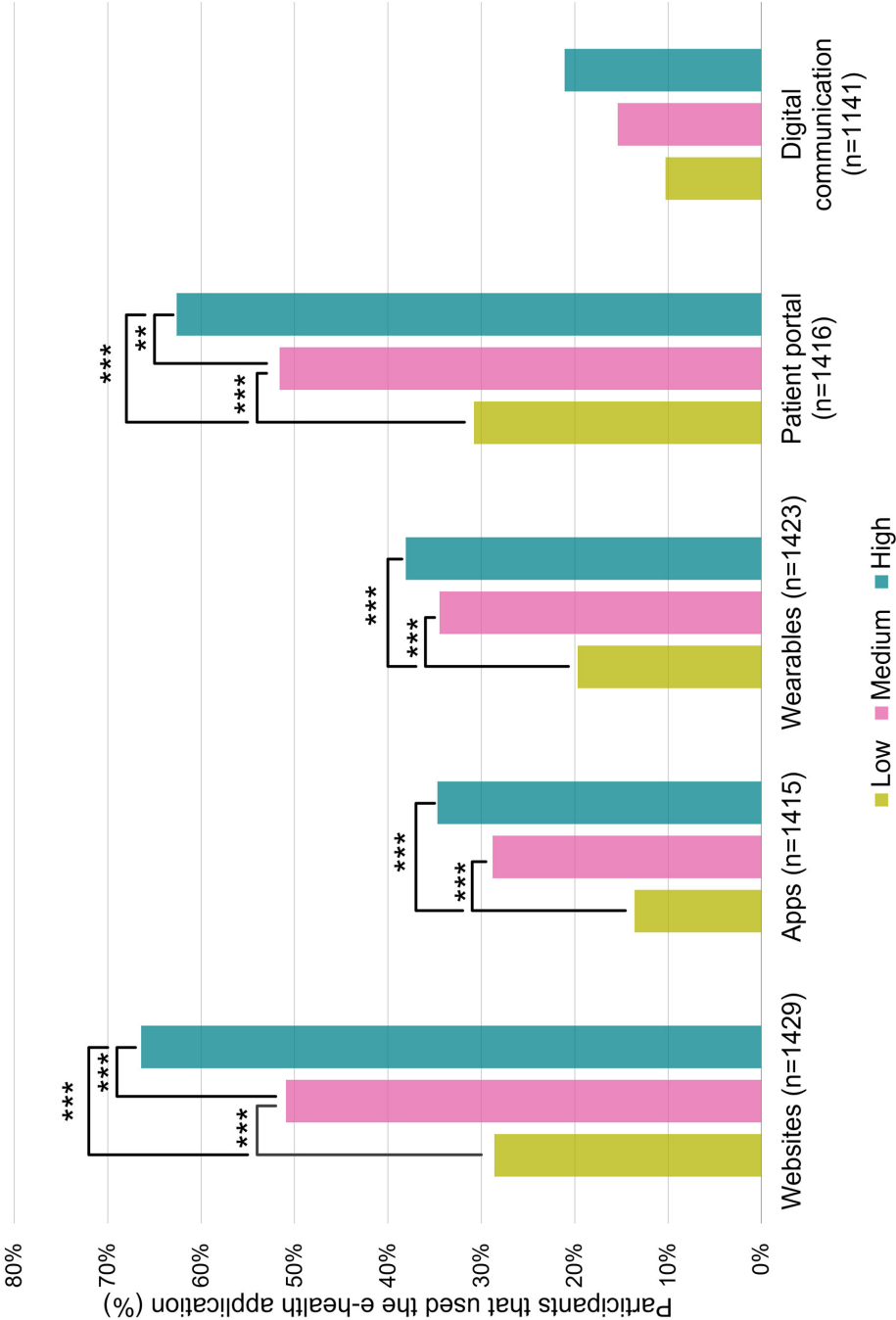


Figure 2. Results of logistic regression of use of e-health application use between low, medium and high educational attainment groups^a in a study sample (n=1,517) of people with a chronic disease. Study sample was drawn from the National Panel of the Chronically ill and Disabled (2023). Use of the following e-health applications were tested: websites, apps, wearables, patient portal and digital communication. Digital communication entailed the use of video consultation, e-consultation or chat consultation. Significant comparison between groups are indicated with a line. Asterisks represent the level of significance: ***p<0.001, **p<0.01, *p<0.05.

^a Educational attainments were defined as followed: low (none, primary school, or prevocational secondary education); medium (secondary or vocational educational attainment 1, 2, 3, or 4); and high (professional higher education or university

Inclination to use e-health

Significant differences between low, medium and high educational attainment groups were found for being inclined to use e-health and being uncertain about using e-health. The low educational attainment group was the least likely to be inclined to use e-health. Participants with a high educational attainment were more likely to be inclined to use e-health compared to participants with a medium (OR 1.47, IC95: 1,13-1,91) or low (OR 2,97 95% CI: 2,08-4,25) educational attainment. Participants with a medium educational background were also more likely to be inclined to use e-health compared to participants with a low educational attainment (OR 2,02 95% CI: 1,43-2,85). Uncertainty about e-health use was significantly more likely for participants with a low educational attainment. Participants with a high (OR 0,39 95% CI:0,29-0,54) and medium (OR 0,56 95% CI:0,42-0,74) educational attainment were less often uncertain compared to participants with a low educational attainment. Participants with a high educational attainment were also significantly less likely to be uncertain about e-health use compared to participants with a medium educational attainment (0,71 95% CI:0,54-0,94). All groups showed equal results for not being inclined to use e-health.

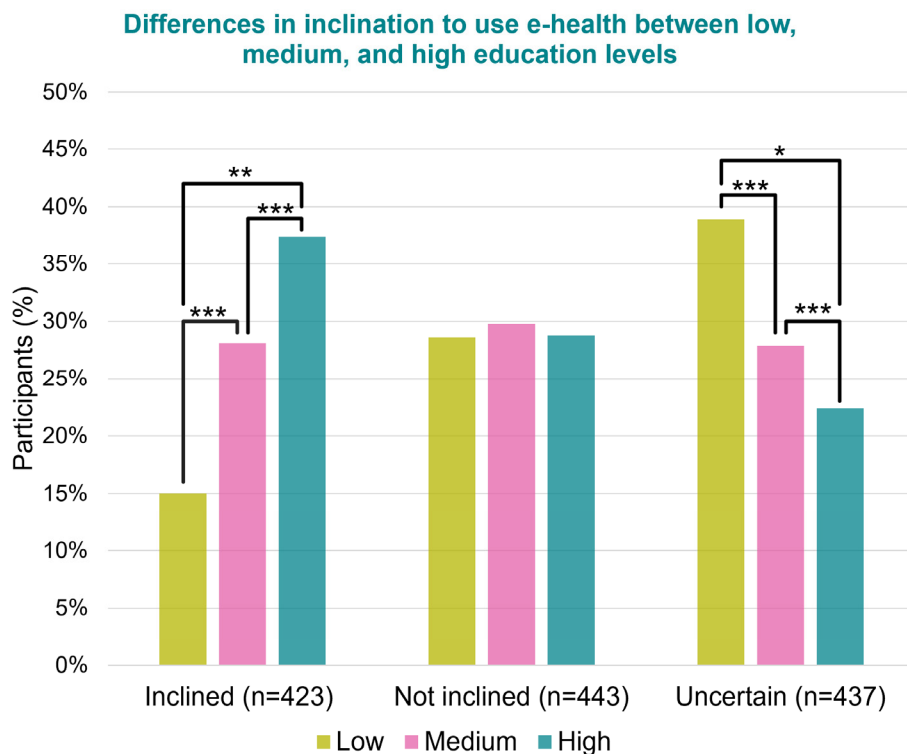


Figure 3. Results of logistic regression analyses for the inclination to use e-health between low, medium and high educational attainment groups^a in a study sample (n=1517) of people with a chronic disease. The study sample was drawn from the National Panel of the Chronically ill and Disabled (2023). A one vs rest approach was used to compare inclination to e-health use between educational attainment levels. The following comparisons were done for each educational attainment group: inclined vs not inclined and uncertain, not inclined vs inclined and uncertain, and uncertain vs inclined and not inclined. In the total population, participants were inclined (n=423), not inclined (n=443) and uncertain (n=437) to use e-health. Significant comparison between groups are indicated with a line. Asterisks represent the level of significance: ***p<0.001, **p<0.01, *p<0.05.^a Educational attainments were defined as followed: low (none, primary school, or prevocational secondary education); medium (secondary or vocational educational attainment 1, 2, 3, or 4); and high (professional higher education or university).

Discussion

Socioeconomic differences in e-health use are present in a population of Dutch people with chronic illnesses. It was expected that living with a chronic disease and frequent interactions with a highly digitized healthcare system would provide reasons and opportunities for all patients to access and use e-health. Consequently, it was assumed that this process would lead to a more equal use of e-health for different socio-economic populations. The results show that differences in e-health access and use still exist between different educational attainment levels regardless of the aforementioned conditions. Therefore, our hypothesis is rejected. There were socioeconomic differences in use for websites, apps, wearables and patient portals. The differences in use of websites and patient portals between low and high educational attainment groups were the most profound. In terms of inclination for e-health use, our results implied three findings; first, that participants in the high educational group were more often inclined to use e-health. Second, that participants in the low educational attainment group were more often uncertain about e-health use. Third, an equal substantial percentage of the participants in each education attainment level is not inclined to use e-health.

Our hypothesis assumed that the presence of a chronic disease would serve as a contributing factor to equitable access to and use of e-health. However, results from this study and a comparison with earlier research indicate otherwise (7). A similar study (2021) to access and use of e-health was conducted among a sample of the Dutch general population (7). Comparison between the studies reveals that across all levels of educational attainment, participants from the general population sample were more frequently inclined to engage with e-health services compared to their counterparts in the current study (7). Furthermore, socioeconomic differences in e-health use was found in both populations (7). The results and the aforementioned comparison indicate that people with a chronic disease and the general population both show socioeconomic differences in inclination to use e-health. These findings are concerning as it reveals that e-health is less favourable and less used by the people who need it most and are dependent on access to care.

Socioeconomic disparities in use of e-health applications is found in many other studies (3, 7, 8, 40, 41). Our results show the most profound socioeconomic differences in the use of the web-based applications: websites and patient portals. Anrijs et al. discusses media literacy through the lens of internet capabilities, and digital skills (42). Internet capacities refers to whether someone is able and has the resources to access internet services when needed (42).

Internet skills are the abilities and knowledge needed to perform concrete actions to access internet services (42). In terms of internet capabilities, several scholars argued that people with a low SEP increasingly use smartphones rather than other devices (43-45). Our demographics show that participants with a low SEP independently use smartphones or tablets more often than computers which is in line with these findings. Scholars point out that access to smartphones does not overcome digital inequalities as smartphones are less suitable for specific digital tasks (44-46). Agachi et al (2022) found that people with a low SEP adhere more to mobile-based e-health applications compared to web-based e-health applications (43). Correa, Paves and Contreras (2018) found that people who only use a smartphone perform less online information seeking, transactions and e-government activities (46). Smartphone users might have less internet capacities to access websites and patient portals due to incompatibility between smartphones and web-based e-health applications.

Next to internet capabilities, the use of e-health requires the possession of digital health skills. Limited digital health skills are one of the main barriers for e-health access and use and is associated with low SEP (47-49). Participants with a low educational attainment are less likely to use websites, patient portals, apps and wearables compared to participants with a high and medium educational attainment. Furthermore, the low educational attainment group reported that 53,3% used applications on their smartphone or tablet and 13,6% used e-health apps. Several scholars reveal that certain aspects of digital health skills are perceived more difficult than others, especially for those with a low SEP (49-51). Van der Vaart & Drossaert (2017) showed that almost all respondents reported knowing how to use a computer, mouse and websites (51). However, around 60% was unsure about self-generating content skills, including formulating health questions, or protecting their privacy (51). People with a low SEP use smartphones and mobile applications, suggesting that they may have the potential to access and engage with e-health services. However, barriers, such as incompatibility between e-health applications and smartphones, and the lack of specific digital health competencies, highlight the ongoing existence of socioeconomic disparities in e-health access and use.

Participants with lower educational attainment were more often uncertain about e-health use compared to participants with higher educational attainment. The lack of awareness is frequently mentioned as reason to why patients don't adopt or are uncertain about e-health use (52-58). The importance of the role of the healthcare professional in the introduction of e-health to patients is often reported (15, 16, 47, 52, 59). In 2024, the Monitor Digital Care (MDC) project published a report on doctors' decision-making practices regarding the delivery

of care via e-health. Doctors indicated the following practices were applicable in decision-making about e-health use: a shared decision between the doctor and the patient (64.6%), choice was made by the patient (25.1%), the decision was made by the doctor (20.8%), hybrid care delivery is the standard (32.3%), and/or care cannot be delivered digitally (24.2%) (27, 60). Healthcare users, however, reported a different experience: 19.4% of citizens and 17.4% of people with a chronic disease felt that the use of e-health was a shared decision (27, 60), which means there is room for improvement in shared decision making. Several studies show that there are differences in patient-provider communications between SEP groups (61-64). From a patient perspective, a literature review by Allen (2019) reported that half of the literature identified positive associations between SEP and patient participation behaviour (61). Tenfelde (2023) and Aelbrecht (2015) describe that patients with low SEP speak less and provide more one-word answers during consultations compared to middle and high SEP patients (62, 63). Tenfelde (2025) studied the doctors' perspectives on communicating with patients with a low SEP (64). These findings reveal that doctors also make assumptions about patients' understanding and share information accordingly, for example by using simplified language, more top-down communication, less involvement in shared-decision making, and providing more surface level information (64). The behaviour from patients with a low SEP and doctors' communication style and assumptions likely hamper the introduction of e-health to patients with a low SEP. These findings indicate that there are opportunities to raise awareness about e-health among patients with a low socioeconomic position (SEP) through medical professionals.

Strengths and limitations

Strengths of this study were the access to a large study population of people who suffer from a chronic disease. The study population allowed for evaluation of use and inclination towards e-health use among a population that is most likely to need and benefit from access to e-health. The findings of this study provide real-world evidence on the access to e-health among people who suffer from a chronic disease, as data is gathered outside of e-health evaluation studies, reflecting participants' e-health use in daily life. The data was gathered via both online and paper-based questionnaires, enlarging the likelihood of participation from participants who are less digitally skilled. Furthermore, the panel participants cannot sign up themselves and are recruited via a broad selection of GP's in the Netherlands. The panel population is recruited as randomly as possible, ensuring a low risk of participant selection bias.

The study had some limitations. First, the study sample was on average from an older age, therefore the results do not represent a younger population. Secondly, despite the sample size, logistic analyses for specific chronic disease types or incorporation of multiple confounders were unfeasible as the number of cases were too low to meet the assumptions for logistic regression analyses. It is to be expected that different types of chronic diseases have more or less use of e-health applications. The variable digital communication had most missing values (24.8%) in comparison to all other items. Relatively, the group with a low educational attainment had most missing values (38.1%), followed by medium (25%) and high educational attainment (14.4%). These outcomes suggest that the results on use of digital communication is biased due to skewed non-response. This may imply that the question was either not clear for all the participants or that the theme of the question was unknown for a subset of participants. Finally, a single variable was used as a proxy for SEP. Education is a classic variable to indicate SEP (35, 65), but the use of education attainment as direct translation of SEP is critiqued upon (65, 66). Scholars find that it is desirable to use multiple variables to represent SEP (35, 65, 66), although use of composite variables should be done with caution as these variables are hard to produce and interpret (35).

Implications and future research

In a population of Dutch people with chronic diseases, results show that regardless of burden of disease and frequent interaction with a highly digitized healthcare system, people with lower educational attainment make less use of e-health applications and more often are not sure whether they are inclined to use e-health applications. Our findings show that not being inclined to use e-health is substantially present in each educational attainment group. This suggests that e-health access is also not a given for people with a medium and high SEP. These findings imply that the current implementation of e-health does not serve all patients and potentially drives health inequity. Ill health and failure to adhere to healthy behaviours is often related to individual factors, however, the role of systemic factors is often overlooked (67-70). Scholars argue that contextual factors such as social context, health organization contexts and (health) policy are highly important for health outcomes in general and reduction of health inequities (67, 68, 70-74).

Furthermore, e-health relies upon the premise that patients share responsibility, take initiative and show autonomy in their disease and health management. Therefore, inclusive organization of e-health systems and all-user-friendly e-health application designs are essential in enabling patients' access and use. Currently, the lack of user friendliness, cultural and language adjustments and

compatibility of e-health with digital devices, especially smartphones, reduces the accessibility of e-health applications, increasing digital health inequity (75-77). A previous literature review from Standaar (2025 – preprint), shows that there is some evidence that the location, the person who introduces e-health and offline promotion strategies are positively associated with successful e-health delivery for people with a low SEP. Standaar also reported that researchers scarcely describe, evaluate and reflect upon their delivery practices, which is a missed chance in accumulating knowledge and practical insights to inclusive e-health delivery practices. Future research and practice should focus on how to improve inclusivity of digital health systems and e-health by focussing on e-health delivery and design.

Moreover, this study reveals the importance of e-health solutions and delivery strategies that are sensitive to the specific needs and constraints of people with a chronic disease and low SEP. Current research identifies specific factors in e-health access and use that are important for people with a chronic disease (15, 16, 52-54, 78). Factors such as patients' perceptions of the significance of e-health, negative experiences with e-health, the burden of e-health use for people with a chronic disease, and insufficient support are important for patients (15, 16, 52-54, 78). Several studies have demonstrated that patients' perceptions of the significance of e-health serve as a motivator for transitioning from traditional disease management approaches to e-health practices (16, 52-54). Turnbull and Cabral (2024) emphasized that negative experiences and a lack of support during the COVID-19 pandemic reduced patients' willingness to engage with e-health in the long term, specifically for patients with a low SEP (78). Taylor et al. (2024) highlighted the ambivalence experienced by patients with chronic conditions towards e-health (15). While e-health offers increased access to care and opportunities for self-management, its successful use requires patients to take on additional responsibilities, which can be burdensome (15). These factors and previously discussed factors associated with a low SEP are both relevant in e-health access and use for people with a low SEP and a chronic disease. Future research and practice should prioritize inclusive, and supportive e-health approaches that address these intersecting challenges.

Conclusion

Socioeconomic disparities in e-health access exist in a Dutch population of people who suffer from chronic diseases. There are significant differences in use of websites, apps, wearables and patient portals between participants from low, medium and high educational attainments. The differences between low

and high educational groups were the largest in use of websites and patient portals. Furthermore, people who attained less education were significantly less inclined and more often uncertain about e-health use. Differences in e-health use and inclination to use e-health exist, even though the participants are subjected to the urgency to manage disease and are exposed to chronic disease care in the context of a highly digitized healthcare system. The current implementation of e-health care does not serve people who suffer from chronic diseases equally, potentially driving health inequity between socioeconomic groups. Research and practice should focus on how e-health implementation and design can serve all and how societal, political and (health) organizational factors can contribute to a more equitable e-health system.

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Conflict of Interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Data Availability

The datasets used and/or analysed during the current study are available on reasonable request from dr. Juliane Menting (j.menting@nivel.nl), project leader of the National Panel of the Chronically ill and Disabled.

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Ethics approval and consent to participate

All data are processed anonymously. According to Dutch legislation, neither obtaining informed consent nor approval by a medical ethics committee, is not mandatory for carrying out research in this panel.

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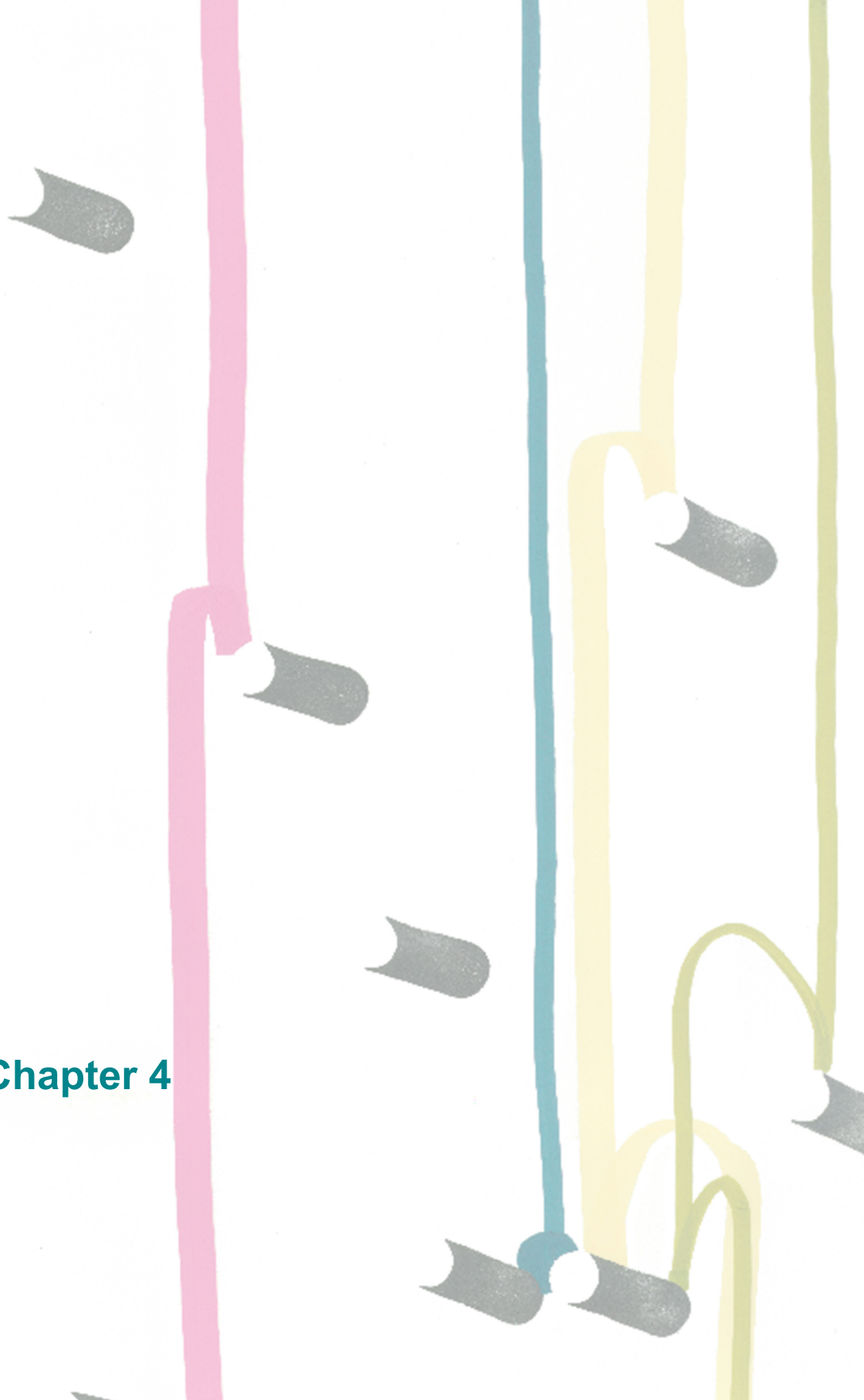
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Chapter 4



The Motivations of Citizens to Attend an e-Health Course in the Public Library: A Qualitative Interview Study

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Abstract

Background: There is world-wide recognition of the potential increase of digital health inequity due to increased digitalisation of healthcare systems. Digital health skill development may prevent disparities in e-health access and use. In the Dutch context, the public library has started to facilitate support in digital health skill development by offering public e-health courses. Understanding motivations of people to seek support may help to further develop this type of public services.

Objective: This is a qualitative study on motivations of citizens participating in an e-health course offered by public libraries. The study's aim was to explore why citizens were motivated to seek non-formal support for e-health use.

Methods: Twenty semi-structured interviews with participants who participated in an e-health course were conducted in seven public libraries across the Netherlands. The interviews were conducted between April and June 2022. Purposive sampling took place in the public library during the e-health course. The interviews covered participants' motivations, attitudes, and experiences with e-health use and their motivations to seek help with e-health use. Interviews were audio-recorded and transcribed. Themes were identified via a comprehensive thematic data analysis.

Results: The participants were aged 51 to 82 years of age (average 73.5 years of age) and 14 (70%) participants were female. Three motivational themes were identified: 1) adapting to an increasingly digital society, 2) sense of urgency facilitated by prior experience in health care, and 3) a need for self-reliance and autonomy. Additionally, participants expressed a general desire for social contact and lifelong learning. A lack of adequate informal support by friends and family for digital skills and positive experiences with formal support by public libraries stimulated the participants to seek formal support for e-health use.

Conclusion: We show that the participants had a feeling of urgency that sparked their motivation to seek non-formal support in the public library. Motivations to participate in the e-health course stemmed from the need to adapt to the digital society, being a patient or a caregiver or the need or wish to be independent from others. Participants of the study were mainly older female adults who had native language abilities, up-to-date digital devices and time. It is likely that other populations experience similar feelings of urgency but have other support needs. Future research should explore the needs and attitudes of non-users and other users of digital health towards seeking support in e-health access and use.

Keywords: digital health; help-seeking behavior; socio-economic factors; community health services; elderly

Introduction

With the growing demand for health care services, e-health is increasingly recognized as a critical tool for efficiently managing and delivering health care (1). Through the adoption of patient portals, telemonitoring tools, and smartphone applications, patients can experience improved access to health information, shared decision-making, and self-management (2,3). However, not everyone within society is able to access and use digital health care (4-12). The increased implementation of digital tools in health services is linked to the widening disparities in health (13).

The need for more emphasis on equity in access and use of digital healthcare systems is recognized worldwide. Research shows that disparities in use of digital health is common in member states of the European Union (14, 15). Causes of digital health inequities derive from unequal access to resources, language, and digital health skills required for effective e-health utilization (8-10, 16-22). WHO and OECD encourage countries to adopt digital health literacy policies on citizen and health system levels (23, 24). Yet, only 27 out of 52 European Union member states have developed policies on digital health literacy (2023) (23). Digital health literacy is defined by Norman et al. as “the ability to seek, find, understand, and appraise health information from electronic sources and apply the knowledge gained to addressing or solving a health problem” (25). Enhancement of digital health skills is one of the avenues for achieving a more equitable digital health care system (23, 24, 26)

In The Netherlands, the COVID-19 pandemic created awareness about the lack of digital health literacy which resulted in a collaborative effort between the government and the public library organization to facilitate support and education in the development of digital skills, including digital health skills (27-29). As a result of this collaboration, the public library in the Netherlands has evolved into an organization that aims to support ‘those who need help’ (30, 31). The public library offers a non-formal free-of-charge e-health course, designed to enhance digital health skills (31). In literature three categories of support are defined: formal support: institutionalized education with officially recognized awards, non-formal support: institutionalized support and education without officially recognized awards and informal support: support via social network (32). Support via the public library is a form of non-formal support. As the public library is freely accessible to the whole population, costs or resources would not deter use of this type of support. However, the first step to participate remains to be taken by the individual and depends on their motivation to improve their digital health skills (17, 19, 31).

A better understanding of the motivations of people that seek non-formal support can create useful insights into the sentiments that drive e-health adoption and support-seeking behavior. These insights can be used to improve e-health implementation and the design of e-health support strategies. This study aims to explore the motivations that drive participants in a freely accessible e-health course to seek non-formal support for e-health use. Building on our prior research and other findings, which demonstrated that education was associated with motivation to use e-health (18), this study's findings will also be explored through the lens of educational background of people that seek support.

Methods

Study design

This study aims to understand and explore the motivations of participants to seek support with digital health skill development. A qualitative study design with semi-structured interviews was deemed most appropriate as this study aims to explore and describe the motivations to seek help in e-health use of participants of an e-health course (33). Due to the explorative nature of the research question, this study follows the interpretivism approach (34). As this study has an explorative nature with the aim to create deep understanding of the motivations of the participants to seek support, the results of this study will be unique to the study setting and the study sample. This paper adhered to the Standards for Reporting Qualitative Research (SRQR), the SRQR checklist can be found in Appendix 1 (35).

Ethical considerations

The study was declared to fall outside the scope of the Dutch Medical Research Involving Human Subjects Act by the Clinical Expertise Center of the Dutch National Institute for Public Health and the Environment (VPZ-559). Transcripts of the interviews and the informed consent forms are stored and protected at the Dutch National Institute of Public Health and the Environment. All participants provided their informed consent prior to conducting the interviews. Participants received a 15 euro-voucher for their participation. Transcripts were deidentified.

Setting

Digital healthcare is widely implemented within the Dutch healthcare system and involves data-storage, interaction between (healthcare) professionals, interaction between healthcare professionals and patients and freely accessible health information websites and applications (36). Implementation of digital healthcare has been experimented with for over the last decades within the

Dutch healthcare system and is stimulated by the government (37-39). The Netherlands is one of the best connected countries in the European Union, with 98% of its citizens connected to a type of internet connection (40). The history of experimentation with e-health implementation, the governmental support and the wide availability of internet is likely to support the digitalisation of the healthcare system further.

The e-health course "DigiVitaler" is part of the online educational material from the national public library and available to all public libraries since 2021 (41). In 2022, 60 of 137 public libraries offered the e-health course (41). This course is structured into multiple classes, each covering a specific e-health topic, such as the patient portal, video consultations, and online health information. Participants are introduced to e-health by providing hands-on experience with e-health applications in simulated digital environments. The course consists of one up to eight classes, each with a duration of 2-3 hours, and accommodation of 2-12 participants. Public libraries are free to choose the number of classes they offer. Public libraries employed printed, word-of-mouth, and online advertisement strategies to announce the course, disseminated via libraries' own platforms, local newspapers, and local organizations.

Recruitment

Purposive sampling of participants who had experience with the e-health course was performed by three researchers (LS, AI and AS) in the context of seven public libraries. Researchers aimed to recruit a representative sample of all participants of the e-health course. Through contact with the developer (Stichting DigiSterker), the researchers retrieved contact information of the libraries offering the e-health course. The course developer was not involved in this study. Libraries were contacted via e-mail and received information about the study with the request to allow the researchers to be present during the e-health course for participant recruitment. Seven of the 26 contacted libraries agreed to participate. Reasons for libraries to decline were course cancellations due to a low number of course participants, no course dates in the data collection period, no response or unwilling to participate in the study. After obtaining consent from the librarians, the researchers (LS, AI and AS) attended nine classes in seven libraries located in rural and urban areas in the Netherlands. At the start of each class, potential participants were introduced to the study through a presentation and a flyer. With approval of the course trainer, researchers would play an active role during the class, providing support and answer the course participants' questions about the course material. At the end of the class, participants were invited for an interview. Participants who expressed interest were provided with detailed study information, a consent

form, and the opportunity to ask questions. Recruitment and interview procedures were designed to limit the participants' potential efforts to participate in the study. Procedures were conducted in familiar context for the participants and required limited travel time and no digital skills. All participants were interviewed at the library, either immediately following the course or at a preferred later date. Telephone interviews were an option but were not requested by the participants. Online interview formats were not considered as it was highly likely that the participants had limited digital skills, which would potentially pose a barrier for recruitment.

Participants

Participants were eligible to participate if they were aged above 18 years and participated in the e-health course. Educational background was categorized according to the International Standard Classification of Education (ISCED), where low educational background is categorized as ISCED 0-2, intermediate as ISCED 3-4 and high as ISCED 5-8 (42). Rurality of the libraries where participants participated in the e-health course was used to indicate the area of living from the participants. Rurality was determined via the rurality classification from Statistics Netherlands (43). A total of 48 participants attended the classes visited by the researchers, of which 20 (20/48, 42.0%) participants participated in the study. Reasons for non-participation were lack of time or interest, or the participant's own perception of lack of experience with e-health.

Data collection

In this study, motivations related to seeking help and use of e-health were studied. The themes of the interview guide covered: demographics of the participant; the motivations, self-efficacy, and attitudes for e-health use; motivations regarding seeking and receiving support for e-health use; social context of support and e-health use. The interview guide can be found in Appendix 2.

Multiple theories describe the transition from motivation to behavior (44-46). The three concepts attitude, social norms and self-efficacy are often described to result in motivation (44-46). In this study, these theories were used as a means to develop the interview guide that covers the main concepts of motivation. Attitude refers to positive and negative beliefs about the consequences of certain behavior (44-46). Social norms include the beliefs of others about the behavior (44-46). Self-efficacy expectations refers to the beliefs of one's personal capacities to actually change behavior (44-46). Questions that cover these concepts entailed questions such as: "What or who caused you to seek support with e-health use and why?" (attitude and/or social norm); "What was the role of family; friends; health care professionals; the

library; or the municipality to use e-health?" (social norm); "Would you be able to use e-health yourself after the course?" (self-efficacy). The interview guide was developed by LS and AI and reviewed by LT, AS, and MB.

Semi-structured interviews were conducted face-to-face by researchers LS, AS, and AI, all experienced in conducting qualitative research. None of the researchers knew the participants prior to this study. The data collection period lasted from April until June 2022. All interviews were audio-recorded with participants' permission and lasted 30-60 minutes. After each cycle of six interviews, the content of the interviews was discussed by LS and AI. After 20 interviews no new information regarding motivation to seek help with e-health use was heard. At this point, it was concluded that data saturation was reached.

Data analysis

Deidentified verbatim transcriptions of the interviews were analyzed with the 'Codebook Thematic Analysis' approach (47). This approach allows for a structured process of coding, theme development and conceptualization in a multidisciplinary team while maintaining the open, inductive approach of reflective thematic analysis to explore the motivations of the participants in depth (48). First, transcripts were read and summarized for data familiarization. A deductive codebook was derived from the interview guide. The first two interviews were double coded by LS, AS, LT, and AI who then collaboratively defined and fine-tuned the codebook. After consensus, the remaining interviews were coded and cross-checked by LS and AI, using MaxQDA for data management. This deductive analysis was performed to create an overview of the data gathered, followed by an inductive analysis to identify underlying patterns. The following topics were analyzed inductively: motivation for e-health use, motivation for seeking support in e-health use and motivation to participate in the e-health course. The first 20% of the transcript segments per topic were inductively coded by LS and AI separately. After reaching consensus, the rest of the transcripts were coded and cross-checked by LS and AI. The inductive codes were arranged into candidate themes. Candidate themes were then further defined through discussion between all researchers to determine the final themes. After analysis, all the transcript summaries were reread and the presence of the themes for every participant was evaluated through the lens of their life course with the aim of identifying possible differences according to educational background. Quotes were translated using the translation software DeepL and these were checked by a native English speaker with limited Dutch fluency.

Results

Five men and fifteen women with an average age of 73.5 years (range: 51-82) participated in this study. All participants were white and fluent in the Dutch language. Most participants (n=13) lived in an urban area. Seven participants were categorized with a low educational background (LE), six with an intermediate (IE), and seven with a high educational background (HE). All participants made use of one up to four digital devices and 14 participants had prior experience with digital health services. The study sample's (n=20) demographic overview can be found in Appendix 1. Participants mentioned three types of support to develop their digital skills: 1) family, friends and acquaintances, 2) the public library, other public or social organizations, and 3) commercial resources. Participants were either introduced to the e-health course by library staff during participation in other courses offered by the library, advertisements in the local newspaper, or via their church, social organization, or computer club.

General experience with the digitalizing society

The participants' experiences with and attitude towards the digital world varied, yet all expressed some degree of difficulty using digital devices and services due to a perceived lack of adequate digital skills. Many pointed out that it is difficult for 'their generation' to keep up with the latest developments within an ever-changing field. 'Their generation' pertains to those who did not grow up with computers/Internet and only learned this later in life, even though some had multiple years of digital experience. *"I think it's a shame that there's no choice anymore. There's obviously a generation of us that needs to have a transition that's a little bit smooth, and not like: bam, next year everything's just different. I think a lot of people my age have problems with that."* - Participant 5 (female, 72, LE). For most, this digital experience was work-related where they were trained in specific, mostly simple computer programs useful for their jobs. However, this was different from their experience in this day and age where every aspect of life has become infused with digitalisation and there often is little to no alternative left.

Themes

Three themes were identified to describe individuals' motivations to seek help for e-health use: 1) adapting to an increasingly digital society, 2) a sense of urgency facilitated by health care experience, and 3) a need for self-reliance and autonomy. Additionally, a desire for social contact and lifelong learning were general reasons to participate in courses offered by the public library. An

overview of the themes, the topics and the number of codes linked to a topic is presented in Appendix 2.

Theme 1 – Adapting to an increasingly digital society

The majority of the participants experienced that society is becoming more digital and they feel the urgency to try and keep up with the digital transition to be able to function as participating citizens. Three aspects encompass this motivation: 1) realizing the lack of one's own digital skills, 2) feeling forced by society to keep up with digitalisation, and 3) a desire to feel included in society and be prepared for the future. This theme was identified among all participants, regardless of educational level. It seems in this respect that among the participants of this course their age and the fact they have not had much experience with digital technology play a bigger role than their educational background.

A lack of digital skills

The experience and expectation of lacking digital skills created a sense of urgency for most participants to learn how to use e-health. Participants found it uneasy to navigate through the digital world in general. Many participants reported that developing and maintaining digital skills requires continuous effort. *“But it’s my experience, if you don’t do it regularly, it disappears again. Then you think, ‘Oh dear, how did I do this again?’ And just figuring that out, it’s very frustrating.”* - Participant 11 (female, 73, HE). Some participants experienced fear using the computer, since they were afraid to make (irreversible) mistakes. *“The fear of buttons for me is that I think I’m pressing such wrong buttons that everything’ll disappear.”* – Participant 15 (female, 74, HE). Some participants tried to use e-health but failed due to lack of digital skills. Others found that their lack of digital skills limited them in using e-health to its full potential or impeded their preferred option in health care services. This motivated them to start learning.

Feeling forced by society to keep up with digitalisation

As services and goods become increasingly digitalized without alternatives, participants felt compelled to adapt and commit to them. *“Then I think: something is being shoved down my throat again. I don’t want that at all. But still, I get it: you have to, whether you want to or not.”* – Participant 19 (female, 74, LE). Anxiety to fall behind and become isolated from society or losing part of their autonomy was common. Feelings of insecurity, shame, or feeling scared using new digital technology were no exception, as previous experiences with or news warnings about scamming or loss of privacy raised their concerns. *“A copy of my passport, I find that very uncomfortable when asked for it. [...] I don’t really dare to [upload]...because I’m afraid, yes it’s very farfetched but it does*

happen. I'm still afraid of being taken over by cybercriminals.” – Participant 17 (female, 51, HE).

Many participants foresaw that health care services will further digitalize. They feared diminished access to care if they are unable to use e-health, which resulted in beliefs that they need to forcefully commit. However, the barriers participants experienced for the use of e-health were numerous. Negative experiences contributed to the reluctance participants felt to use e-health: lack of uniformity between e-health applications, difficulty identifying appropriate health information and difficulty in phrasing health problems in digital form. *“Too complicated for us at this age [asking questions via e-consultation]. You have to do too many steps. You have to log in, you have to type, you have to explain what it is, and everything has to be short.” – Participant 10 (female, 78, HE).*

Desire to feel included in society and be prepared for the future

Desire to keep up with digital developments led to an intrinsic motivation to learn how to use e-health. The participants felt that by keeping up, they stay part of society and are prepared for possible (future) encounters with e-health. Some participants felt the urgency to learn how to use e-health now because they foresaw that this will become harder as they age. *“It is the future where we are headed, soon you have to do a lot by computer and by smartphone. Then it's really nice if I know how to use it, because if I'm approaching 70 and I still have to learn, well then it is too late.” – Participant 6 (female, 66, LE).* These participants noticed that they are the early adopters of e-health in their social network. Friends and relatives did not share the same interests or understand why the participant was willing to learn digital skills to use e-health. This is part of the reason why non-formal support in the form of the e-health course is a particularly attractive option, as the informal network of the participants is not as knowledgeable.

Theme 2 – Sense of urgency facilitated by prior health care experience

The second theme depicts that the participants felt motivated to seek help to use e-health through their prior health care experience. Three aspects encompass this theme: a) the responsibility as a patient or caregiver, b) experience with the benefits of e-health, and c) the attitude of health care professionals towards e-health. This theme was mentioned by all participants from the low educated group, a few participants in the intermediate education group, and half of the high educated group. Regardless of their educational background, the participants that have had experience in the health care system, feel more urgency to use e-health.

The responsibility as a patient or caregiver

Many participants had some form of experience with health care, although not all with e-health. Being a patient or caregiver to their partner or child stimulated a feeling of responsibility to take an active role in the care process. For these participants, this active role encompassed the ability to use e-health. Participants illustrated this with examples of preparing hospital appointments or looking up information in their electronic patient records. They are able to take more time to think about the medical information before a consultation to prepare questions, and also afterwards to reread the information given during a consultation. E-health allowed participants to better process the information and use this to their advantage. *“My husband was in the hospital with a heart attack [...] and I saw everything was digital there. I had already looked up his medical history once and printed it out because my husband forgets a lot. [...] And I think, now they are going to start something else [a new digital system] in the hospital again. I have to learn this from the start, and I think my husband has to go along with that.”* – Participant 13 (female, 70, LE). A few participants expressed that they feel this type of active role is expected of them by medical professionals to be able to partake in shared decision making. These experiences motivated the participants to learn more about e-health when they were presented with the opportunity.

Experience with the benefits of e-health

Prior experience with health care created perceptions that e-health can be beneficial and can be a necessity in health care. The benefits participants mentioned were less travel time, the opportunity for digital health care appointments at home, improved exchange of health information between health professionals and organizations, and an improved overview and insight into their personal health information. *“The next time I visit my doctor and I need information, then beforehand I’ll read [my file]. [...] I’d rather know what’s on the record about me first. Maybe I can ask another sensible question. Because otherwise you’re just a clueless patient.”* – Participant 14 (male, 76, IE). Some participants also believed that e-health can contribute to the efficiency of the health care system, which they deemed positive for themselves and society. Most participants were not familiar with the possibilities of e-health before their health care experience. After experiencing these benefits, participants felt eager to learn about the possibilities of digital care. As a result, they sought non-formal support.

Attitude of health care professionals towards e-health

A positive attitude towards e-health or regular use of e-health by health professionals motivated participants to use e-health and learn skills that enable

e-health use. Some participants decided to do the course after a health professional suggested or used e-health for their care. *“Yes, Thuisarts.nl [a website that provides easily readable patient information on primary health care issues, issued by the Dutch College of General Practitioners], I consult that often. [...] That’s what I agreed with the general practitioner at the time. He said, ‘Did you look on Google again?’ [...] And then, ‘If you go to Thuisarts.nl, that’s very reliable.’ And I just do that.”* – Participant 12 (female, 80, IE). Most participants indicated they never received any information about the possibilities of e-health via their general practitioner or other health care professionals. Some participants argued that better promotion of e-health is needed to spread awareness and stimulate use.

Theme 3 – Need for self-reliance and autonomy

Participants’ motivation to seek help for e-health use was also tied to their wish for independence. The need for self-reliance and autonomy was described by three aspects: 1) limited informal support, 2) discomfort with dependency on others, and 3) discomfort with loss of their own autonomy. This theme was identified equally among all participants, regardless of educational level. Thus again the social circumstances such as having children and the existence or absence of a social network seem to affect the participants more directly than their educational background.

Limited informal support

Limited or inadequate informal support resulted in participants feeling forced to become independent users of e-health. In a few cases, limited support meant that participants were childless, whereas they felt that society often wrongly assumes that their family will take care of them. This can create a sense of loneliness, but also motivation to learn these skills. *“I do feel more or less obliged [to become independent in e-health use]. [...] because I have nobody to fall back on. Everyone says: oh, you just ask your children. Well, I don’t have any.”* – Participant 1 (female, 73, HE). Other participants expressed they never felt a need to learn because their spouse would take care of all things digital. However, after their partner falls ill or has passed away, they are on their own and feel they have no other choice but to learn these skills themselves. In addition to the absence of informal support, some participants also experienced inadequate informal support, when the support they receive does not match their needs and wishes. This is especially true for the help the participants receive from their (grand)children, who are digital natives and proceed to quickly resolve any issues. This is often done in such a way that the participants are left clueless to what the solution entails and are not stimulated to learn how to tackle these problems themselves. They continue to be dependent on others,

which frustrates them. . To be able to develop these skills on their own, they feel they need more structured explanation, time to practice, and patient teachers which the course offers them. *“Otherwise, I always have to ask one of the grandchildren. [...] They’ll help me, but it’s all quick, quick, quick. Well, that doesn’t work. [...] That’s why I’m here taking this course.” – Participant 6 (female, 66, LE).*

Discomfort with dependency on others

To lean on others for help in e-health use was uncomfortable for some participants due to their desire for independence, leading to their wish for independent e-health use. Usually requesting help with small or acute matters within close ties such as family is acceptable, but depending on others outside of the family such as neighbours or friends feels uncomfortable and like they are burdening others. Some participants expressed that even asking family for help can feel like they are asking too much of their children, especially if they feel their children are busy with their own household, young children to take care of or demanding jobs . The course offers a welcome alternative, where the participants do not feel like a burden. *“Because I wanted to deal with it [e-health] more easily. I do have children who want to help, but everyone still has their own thing. I don’t want to become dependent on my kids.” - Participant 10 (female, 78, HE).* Some also reported that they are afraid or find it difficult to ask for help from formal institutions such as the municipality. This in turn also has to do with a lack of trust and safety. Participants feel discouraged to ask for support from these type of organizations because they think they will not get sufficient guidance. Participants found commercial services to be too expensive, incompatible with their own equipment, insufficiently informative or too time-consuming.

Discomfort with the loss of their own autonomy

Asking for help or being unable to use e-health meant for some participants that they cannot manage their own life and health. Their discomfort lies in their dependency on others rather than being uncomfortable burdening others with their need for help. It means the loss of autonomy which many of the participants experienced their whole lives by their employment, role in the household and management of daily life. But as they get older, they feel they lose this freedom as it becomes harder to keep up with digital innovation. Many participants feel they want to be able to solve problems on their own, without asking for help. Attending the course feels like they are in control and actively solving the problem by learning new skills and by doing something themselves. They experience this as more empowering than asking someone else to solve their problems for them. *“Of course, I always wanted to do everything myself. Now*

you have to [ask for help] every time... That's the thing. Every time you have to give up a piece of your personality. That's how it feels." – Participant 19 (female, 74, LE).

In addition to these three themes related specifically to the motivation for e-health use support, the participants expressed a general desire for social contact and life-long learning as a reason to participate in the e-health course. With regards to social contact, participants reported to find solace and support to tackle digital (health) skills together with likeminded people, where they are not the only ones experiencing difficulty with new technology and have the opportunity to learn from each other's questions and mistakes without feeling like the odd one out. This feeling of kindred spirits can contribute to alleviating feelings of shame that participants may feel due to their lack of adequate digital skills. With regards to life-long learning, some participants proposed their curious personality as a reason to participate in all kinds of different courses offered to them, by the public library. For most of these participants, they initially started on a path to improve their digital skills and this course was a natural continuation of that process to develop these further. Especially those participants who already had positive experiences with formal support at the public library were stimulated to continue with this type of support.

Discussion

In this qualitative study, including participants of older age and with varying educational backgrounds, three motivational themes were identified for seeking help with e-health use: 1) adapting to an increasingly digital society, 2) a sense of urgency facilitated by health care experience, and 3) a need for self-reliance and autonomy. A lack of adequate informal support by friends and family and positive experiences with non-formal support stimulated the participants to seek non-formal support in the public library for e-health use. In addition to the three themes, participants expressed a more general desire for social contact with peers and lifelong learning.

The first theme 'adapting to an increasingly digital society' explores the motivation to seek support driven by a wish or need for digital inclusion and societal participation in a digitalized society. It shows that the exponential development of digital technology can seem daunting and therefore insurmountable for some older adults who have little to no prior experience with this (49, 50). However, for others it acts as a stimulus to stay engaged with societal changes, fuelling the desire to adopt new technology (49, 51). In our study, this latter attitude also emerged as an important reason to seek support for e-health use. While computer anxiety and low computer self-efficacy have

been named important barriers to technology and e-health adoption in older adults (52-54), our study shows that awareness of one's own limited self-efficacy in e-health use can be an important incentive to seek support when individuals see the potential usefulness for themselves as 'preparation for the future'. Associated concepts such as healthy ageing, ageing in place (e.g. living longer at home) and older person's empowerment have all been positively linked to the use of digital (health) technology (55-58) and are reflected in the third theme.

The second theme 'a sense of urgency facilitated by health care experience' revolves around participants' prior experience with e-health, health care, and health professionals. In our study, some participants experienced this as a necessity while for others, this stimulated a positive attitude towards the potential benefits. Both acted as a facilitator for seeking support. Ware et al. (55) equally found that a desire for ownership, access, and an individual responsibility for personal medical information were motivators to use e-health. Other research also underscores the importance of perceived e-health benefits, positive prior e-health experiences, and endorsement of health care professionals to motivate individual use (53, 54). This 'window of opportunity' could be used to motivate others to seek non-formal support for their digital skills, for example when introduced by trusted health professionals. However, this type of experience as a motivator for older adults to seek non-formal support for development of digital (health) skills seems to be a novel finding.

The third theme 'a need for self-reliance and autonomy' emphasizes that participants want to be self-sufficient in their abilities. This attitude towards self-reliance and autonomy illustrated how participants want to live and manage their health independently. It can support ageing in place, encouraging older adults to live independently for as long as possible, a desire of most older adults and stimulated by policy makers (59, 60). Informal support by family and friends can both be a facilitator or barrier for adoption of new digital technology (51, 53, 54). In our study, part of the participants showed a dislike for dependency on family and friends and did not want to burden others turning informal support into a barrier, a sentiment also observed by others (51, 53). In our study, the help offered by family members did not lead to the development of more digital skills, as the participants desired. Therefore, they experienced this as limited and inadequate informal support. This particular phenomenon is seen elsewhere for informal support for Internet use among older adults (61). In addition, our findings on limited informal support are in line with others who find that intergenerational support can lack sufficient patience and understanding for the level of digital skills of older adults (51, 53). This may act as a barrier if

it creates a learning environment characterized by judgmental delivery, a fast pace, and use of unfamiliar jargon (54).

Theoretical reflection from the perspective of Maslow's Hierarchy of Needs provides an opportunity to create a deeper understanding from the origin from the identified motivations. Maslow's theory focuses on human needs, theorizing a five different types of needs (62). When these needs are not met, motivations to change behavior can emerge (62). Furthermore, the theory implies a hierarchy in the five needs (62). The basic needs are physiological needs (e.g. water and food) and safety needs (e.g., a roof over one's head and the heating on) (62). Then there are psychological needs, starting with the social need for love and belonging and moving up to the need of self-esteem (62). Lastly, there are the self-fulfilment needs, or the need for self-actualization, e.g. developing one's full potential (62). Theme 1 and 2 both reflect a safety need. The urgency to adapt to an increasingly digital society and the urgency of being a patient or caregiver show a need for security in access to (digital) healthcare now or in the future. The motivations from theme 3 can be interpreted as esteem needs, as this theme can be interpreted as a need for independence in access and use of the digital world and independence from support. The motivation stemming from the desire for lifelong learning can be interpreted as a need for self-actualization. The need for social connection can be interpreted as a social need. The perspective of Maslow's theory provides the insight that independent access to digital healthcare was perceived as a basic safety need and an esteem need by the participants.

Motivation to use e-health and to seek support in e-health use are two aspects of many when discussing digital health inequity. The digital divide model by van Dijk describes how personal and contextual factors are related to the resources one has available to have motivation, physical access, use and benefit from digital media, or in this case digital health (10). Resources to improve the likelihood of accessing digital media involve cultural, social, mental, material and time related factors (10). The study sample expressed a lack of digital skills and knowledge about digital health but also expressed access to up-to-date devices, language skills, time and feeling comfortable in public library setting. Our prior research and other research found that other populations experience barriers to seek support in the factors that were facilitative for the current study population (63-65). Standaar (2025), Choudhary & Bansal (2022) and Goedhart (2019) reported that other populations that need and potentially seek help in digital skills development experience barriers in language skills, digital skills, stigma, time, logistics and feelings of belonging in the context of institutions (63-65). A literature review by Choudhary & Bansal (2022) allowed for

categorization of the barriers to participate in training programs on the administrative level, training level, learner level and community level (63). This categorization acknowledges that barriers are not only individual-bound but also bound to the training content, training context and community in which training is provided (63). Our findings suggest that access to up-to-date devices, language skills, time and feeling comfortable in a public library setting were required to perform support seeking behavior in the public library context. These reflections suggest that access to support for digital health skill development is also dependent on personal factors, contextual factors and resources.

We explored the motivations for seeking e-health support among participants. Additionally we explored if differences in educational backgrounds led to differences in motivation. We found that other life events like losing connection with (digital) society, becoming a patient or caregiver and becoming dependent on others later in life appeared to be more important in the emergence of their motivations to participate in an e-health course. Even prior computer experience was not always an indication of well-developed digital skills that are needed in the current digital age. Furthermore, exploration of the results through the perspective of education is complex in this older, mostly female sample as it may not clearly indicate educational differences due to historical cultural norms and educational opportunities for women in the 20th century (66). Therefore the results of this study provide very limited and non-generalizable insights on if people from different educational backgrounds have different motivations to seek support in e-health use.

Strengths and limitations

Our study has several strengths. Firstly, participants come from diverse backgrounds, including rural and urban areas enabling exploration of a wide range of experiences. A large percentage of the potential participants (20/48, 42.0%) participated in the study, ensuring a broad representation of the study population. Secondly, interviews continued until data saturation was reached, ensuring robust findings. Thirdly, the e-health course was not part of a research program, which allowed us to evaluate participants' motivations in a real-world setting. The on-site visits enhanced understanding of the e-health course context and allowed the interviews to take place in familiar surroundings for the participants. Our participant selection resulted in a culturally non-diverse elderly group with access to digital devices, motivation and capability to seek non-formal support, as a result of this specific research context. Next to this, it is likely that the people attending an e-health course have some prior knowledge or experience with e-health, the majority (n=14) of our study sample had some experience with e-health. Other research in the same context confirms from

digital health skill development trainers' perspective that the population attending the e-health course is homogenous and similar to our study sample (64). Asmar et al. (67) refer to this specific group as 'community supported'. However, theirs and other research indicates that older adults are far from homogenous in their use of digital technology or support-seeking behavior (67-69). Therefore, it is likely that in other settings different typologies and characteristics of older adults might result in other motivations.

Implications and future research

Our study highlights the importance of non-formal support in using e-health, for those lacking adequate informal support. Kebede et al. (54) found that attainment of digital competence among older adults depends on awareness of existing technology and availability of support and instruction. They stated that personalized training and opportunities for need-based learning in a safe environment facilitates skill acquisition and initial digital engagement, if the learning environment is accessible and inclusive for older adults (54). Our findings indicate that public libraries can provide this type of support for digital health skill development. The results shed light on the motivations of participants, mainly older adults, to engage in non-formal support for e-health use, advancing digital health literacy. While existing literature has focused on facilitators and barriers of digital (health) technology adoption by older adults, measuring e-health/digital health literacy and the effectiveness of such interventions, often in research settings (53, 54, 70), our study reveals motivations for participation in the real world. It highlights how motivations are associated with their specific needs for support and training, a need for security in access and a desire for independent use of digital healthcare.

It would be interesting to explore the group of (non-)users that do not seek non-formal support. Earlier reflections upon our results suggested that our study population possessed certain characteristics, resources and needs that align with seeking support in the public library context. Research shows that e-health non-users are common among other age- and socioeconomic groups and that their needs for support and e-health use are diverse (4, 8, 64, 65, 73-75). Scholars find that populations rely on different types of support, it being formal, non-formal and informal support, to gain access to digital skill development and e-health (76-78). Findings from Nygren and Hayat underline the importance of informal support to overcome digital literacy barriers. However, other findings indicate that digital inequality can manifest itself in informal support, where those who experience the most difficulties online are also those who have fewer resources for high-quality informal support (65, 74). Furthermore, Deursen, Courtois and Van Dijk (2014) show that in comparison to formal support,

informal support might be insufficient to overcome all skill and content barriers for beneficial internet use (79). The barriers of limited access and poor quality of informal support were also found in our study, additionally we found that discomfort with being dependent on others was also important. Smit, Swart & Broersma (2024) showed that Dutch citizens with low literacy overcome digital and literacy barriers by support from family, friends, community, and volunteers and base decisions on who they ask for support based upon the level of privacy surrounding a topic, the affective dimension involved, and the depth of knowledge possessed by the supportive actors (78). These and our findings implicate that different populations are likely to seek support from different sources that fit their needs and personal circumstances. Further research is needed to understand the motivations, experiences, and needs in support for e-health use of both digital technology users and non-users. Findings can provide insights to what qualities e-health support should entail to ensure equitable access to support and consequently to e-health.

Conclusion

This study indicates that participants seeking non-formal support for e-health use were driven by a need to secure independent access and use of digital health care. This need derived from the necessity to adapt to a digital society, the expected or current need to use digital health and by a desire to independently engage in a digital society. In general, participants were motivated to develop digital health skills they feel are necessary for societal participation. Additionally, the e-health course met the need for social connection and lifelong learning. The study sample was a predominantly homogenous group of older female adults with language skills, access to up-to-date devices and time. It is likely that the need for support to gain independent access and use of digital health care is present in other populations. Future research should explore the needs and attitudes of users and non-users of digital health towards support in e-health access.

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Data Availability

The data sets generated during and/or analyzed during this study are available from the corresponding author on reasonable request.

Declaration of interest statement

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Appendices

Appendix 1

Standards for reporting qualitative research checklist. Checklist is derived from Standards for reporting qualitative research: a synthesis of recommendations, by O'Brien et al. (2014) (35).

Standards for Reporting Qualitative Research Checklist		
		Page/line no(s).
Title and abstract		
Title - Concise description of the nature and topic of the study Identifying the study as qualitative or indicating the approach (e.g., ethnography, grounded theory) or data collection methods (e.g., interview, focus group) is recommended		Page 1
Abstract - Summary of key elements of the study using the abstract format of the intended publication; typically includes background, purpose, methods, results, and conclusions		Page 1
Introduction		
Problem formulation - Description and significance of the problem/phenomenon studied; review of relevant theory and empirical work; problem statement		Page 3
Purpose or research question - Purpose of the study and specific objectives or questions		Page 4
Methods		
Qualitative approach and research paradigm - Qualitative approach (e.g., ethnography, grounded theory, case study, phenomenology, narrative research) and guiding theory if appropriate; identifying the research paradigm (e.g., postpositivist, constructivist/ interpretivist) is also recommended; rationale**		Page 4

Researcher characteristics and reflexivity - Researchers' characteristics that may influence the research, including personal attributes, qualifications/experience, relationship with participants, assumptions, and/or presuppositions; potential or actual interaction between researchers' characteristics and the research questions, approach, methods, results, and/or transferability	Page 7
Context - Setting/site and salient contextual factors; rationale**	Page 5
Sampling strategy - How and why research participants, documents, or events were selected; criteria for deciding when no further sampling was necessary (e.g., sampling saturation); rationale**	Page 6, page 7
Ethical issues pertaining to human subjects - Documentation of approval by an appropriate ethics review board and participant consent, or explanation for lack thereof; other confidentiality and data security issues	Page 5
Data collection methods - Types of data collected; details of data collection procedures including (as appropriate) start and stop dates of data collection and analysis, iterative process, triangulation of sources/methods, and modification of procedures in response to evolving study findings; rationale**	Page 7
Data collection instruments and technologies - Description of instruments (e.g., interview guides, questionnaires) and devices (e.g., audio recorders) used for data collection; if/how the instrument(s) changed over the course of the study	Page 7
Units of study - Number and relevant characteristics of participants, documents, or events included in the study; level of participation (could be reported in results)	Page 6, 7, 8
Data processing - Methods for processing data prior to and during analysis, including transcription, data entry, data management and security, verification of data	Page 5, 8

	integrity, data coding, and anonymization/de-identification of excerpts	
	Data analysis - Process by which inferences, themes, etc., were identified and developed, including the researchers involved in data analysis; usually references a specific paradigm or approach; rationale**	Page 8
	Techniques to enhance trustworthiness - Techniques to enhance trustworthiness and credibility of data analysis (e.g., member checking, audit trail, triangulation); rationale**	Page 8
	Results/findings	
	Synthesis and interpretation - Main findings (e.g., interpretations, inferences, and themes); might include development of a theory or model, or integration with prior research or theory	Page 8 - 15
	Links to empirical data - Evidence (e.g., quotes, field notes, text excerpts, photographs) to substantiate analytic findings	Page 8 - 15
	Discussion	
	Integration with prior work, implications, transferability, and contribution(s) to the field - Short summary of main findings; explanation of how findings and conclusions connect to, support, elaborate on, or challenge conclusions of earlier scholarship; discussion of scope of application/generalizability; identification of unique contribution(s) to scholarship in a discipline or field	Page 15 - 20
	Limitations - Trustworthiness and limitations of findings	Page 18 - 19
	Other	
	Conflicts of interest - Potential sources of influence or perceived influence on study conduct and conclusions; how these were managed	Page 21

*The authors created the SRQR by searching the literature to identify guidelines, reporting standards, and critical appraisal criteria for qualitative research; reviewing the reference lists of retrieved sources; and contacting experts to gain feedback. The SRQR aims to improve the transparency of all aspects of qualitative research by providing clear standards for reporting qualitative research.

**The rationale should briefly discuss the justification for choosing that theory, approach, method, or technique rather than other options available, the assumptions and limitations implicit in those choices, and how those choices influence study conclusions and transferability. As appropriate, the rationale for several items might be discussed together.

Appendix 2

Interview guide used to conduct semi-structured face-to-face interviews with participants of the e-health course DigiVitaler in the context of Dutch public libraries about their motivations to seek support in e-health use.

Introduction (2 minutes)

First of all, thank you for agreeing to participate in this conversation.

Introduction to Digital Care

The world is becoming increasingly online and digital. Through mobile phones, computers, and the internet, we can manage more and more things. This also applies to your health. Care delivered via a computer or mobile phone is called digital care. Digital care is used to provide services, such as assisting with diagnoses or supporting therapies.

In public health, digital care is used to share information about health and healthy lifestyles via websites or mobile applications. It is also used to help with administrative tasks, like booking appointments or requesting repeat prescriptions online.

Many people need assistance using digital care. The government wants to learn more about experiences with support for digital care—what is working well and what could be improved. The ideas of participants in this course are very important! In this conversation, we will discuss:

- Your opinions about digital care
- Support for using digital care

This conversation will take about an hour.

Consent to Recording (1 minute)

Go over the consent form and sign it.

Before we start, may I ask if I can record this conversation? The purpose of the recording is to review your ideas and opinions afterward. The recording and the results of the discussions will not be traceable to you. The recording will be stored securely on our computer, accessible only to the research team. Your name will not appear on the recording, which will be assigned a number instead. Recordings will never be made public and will be deleted after the study concludes.

Would you like to participate in the study? If so, could you please sign this form?

Do you agree to let me record the conversation?

If yes: Start the recording.

Ground Rules (1 minute)

We are interested in your experiences and ideas, so there are no right or wrong answers. If you don't wish to answer a question, feel free to let us know, and we will skip it.

Do you have any questions before we begin?

Introductions (5 minutes)

Before we start, let me introduce myself. My name is Lucille, and I live in The Hague. I am conducting research on how best to help people use digital care.

Would you like to introduce yourself? Where do you live, and what do you do during the day?

What year were you born? / Are you above or below 50 years old?

What is the highest level of education you've completed?

What kind of work do you do/did you do?

Do you have a smartphone (with internet)? Do you have a computer at home (with internet)? What do you use them for?

How is your health?

If someone else is present during the interview, please also note their presence.

The Interview (45 minutes)

General Help Questions (for interviewer only)

Can you tell us more about it?

Can you give an example?

That's interesting—what happened then?

How was that for you?

You mentioned ...; what do you mean by that?

Main Themes

Starting Question: How did you come across this course?

Experience with E-Health

Have you used digital care before taking this course? Examples include websites like thuisarts.nl, step counters, repeat prescriptions, GP websites, or online appointments.

If yes: Can you tell us more about it? (Reason, format, experience—positive/negative, usefulness)

If no: Have you ever tried using digital care?

Introduction to E-Health

Why did you start using digital care?

Was it your initiative or encouraged by family, friends, or healthcare providers?

Experience with Support (Libraries and Others)

What do you think of the course so far?

Do you feel confident using digital care at home after this course?

If yes: What about the course helped you?

If no: What is still missing?

Support from Others

Do you receive help from others with digital care? (Family, friends, caregivers)

If yes: How did they support you? Was it enough?

If no: Would you have liked support?

Closing Question

This report will be sent to the Ministry of Health. Digital care is increasingly being seen as a solution in healthcare. What would you like to share with the Ministry to improve digital care?

Closing Questions (3 minutes)

Are there any other points you'd like to share?

Do you feel like you've been able to say everything on this topic?

Conclusion (5 minutes)

This concludes our conversation. Would you like to add anything else?

What did you think of the interview?

Thank you again for your time and effort. We will process this and other interviews into a report, which will be presented to the government. Would you like to receive a copy of the report?

Once again, thank you for your time and effort!

Compensation

Provide a gift card (VVV-bon) and leave a phone number for any follow-up questions.

Appendix 3

Demographics of the study participants interviewed between April and June 2022. Participants were categorized in educational level based upon the international standard classification of education level (ISCED) (42). Rurality of the public library the participants attended the e-health course was determined based upon zipcode of the library and the indexed rurality by Netherlands Statistics (43).

Overview of participants							
No. interview	Sexe, (F/M) ²	Age (years)	Educational level (ISCED #) ³	Ethnic background	Location of public library (rural/urban)	Use of digital devices (type of device)	Prior (to the interview) experience digital health services (yes/no: what kind)
1	F	73	Short-cycle tertiary education (ISCED 5)	White	Rural-urban	Tablet, laptop	Yes: patient portal, health information websites
2	M	79	Post-secondary non-tertiary education (ISCED 4)	White	Rural-urban	Smartphone, desktop computer	Yes: refill medication prescription

² F: Female, M: Male

³ ISCED: International standard classification of education

Overview of participants

No. interview	Sexe, (F/M) ²	Age (years)	Educational level (ISCED #) ³	Ethnic background	Location of public library (rural/urban)	Use of digital devices (type of device)	Prior (to the interview) experience digital health services (yes/no: what kind)
3	F	78	Master's or equivalent level (ISCED 7)	White	Urban	Smartphone, laptop	Yes: health information websites
4	F	82	Lower secondary education (ISCED 2)	White	Urban	Smartphone, tablet, laptop	No
5	F	72	Lower secondary education (ISCED 2)	White	Urban	Smartphone, laptop	Yes: patient portal, doctor appointments
6	F	66	Lower secondary education (ISCED 2)	White	Rural-urban	Smartphone, laptop	No
7	F	72	Upper secondary	White	Urban	Smartphone, tablet, laptop	Yes: health information websites, doctor

Overview of participants							
No. interview	Sexe, (F/M) ²	Age (years)	Educational level (ISCED #) ³	Ethnic background	Location of public library (rural/urban)	Use of digital devices (type of device)	Prior (to the interview) experience digital health services (yes/no: what kind)
8	F	76	Lower secondary education (ISCED 2)	White	Urban	Smartphone, laptop	No appointments, refill medication prescription
9	M	70	Upper secondary education (ISCED 3)	White	Urban	Smartphone, desktop computer	Yes: health information websites
10	F	78	Short-cycle tertiary education (ISCED 5)	White	Urban	Smartphone, laptop, desktop computer	No
11	F	73	Bachelor's or equivalent (ISCED 6)	White	Rural	Smartphone, tablet, desktop computer	Yes: patient portal, health information websites

Overview of participants							
No. interview	Sexe, (F/M) ²	Age (years)	Educational level (ISCED #) ³	Ethnic background	Location of public library (rural/urban)	Use of digital devices (type of device)	Prior (to the interview) experience digital health services (yes/no: what kind)
12	F	80	Upper secondary education (ISCED 3)	White	Rural	Smartphone, tablet, desktop computer	Yes: health information websites, health apps
13	F	70	Primary education (ISCED 1)	White	Rural-urban	Smartphone, tablet, desktop computer, smartwatch	Yes: patient portal, health apps
14	F	76	Upper secondary education (ISCED 3)	White	Rural-urban	Smartphone, desktop computer	Yes: patient portal
15	F	74	Bachelor's or equivalent level (ISCED 6)	White	Urban	Smartphone, desktop computer	Yes: health information websites
16	M	79	Upper secondary	White	Urban	Smartphone, desktop computer	No

Overview of participants							
No. interview	Sexe, (F/M) ²	Age (years)	Educational level (ISCED #) ³	Ethnic background	Location of public library (rural/urban)	Use of digital devices (type of device)	Prior (to the interview) experience digital health services (yes/no: what kind)
			education (ISCED 3)				
17	F	51	Bachelor's or equivalent level (ISCED 6)	White	Urban	Smartphone, laptop	Yes: health apps
18	F	76	Lower secondary education (ISCED 2)	White	Urban	Smartphone, tablet, laptop, smartwatch	Yes: health information websites
19	F	74	Lower secondary education (ISCED 2)	White	Urban	Tablet, desktop computer, smartwatch	No
20	M	73	Master's or equivalent (ISCED 7)	White	Urban	Smartphone, tablet, desktop computer, smartwatch	Yes: patient portal

Appendix 4

Overview of inductive themes and inductive topics and number of codes per topic derived from twenty interviews that were conducted with participants from an e-health course in Dutch public library settings.

Theme 1 – Adapting to an increasingly digital society		Number of codes
	I have to keep up with the digitalizing world in order to stay part of society	7
	I need help with the development of my digital skills	14
	I have to prepare myself for a future where e-health is the norm	7
	I want to prepare myself for a future where e-health is the norm	6
	I see the benefits and the necessity of e-health	10
Theme 2 – Sense of urgency facilitated by experience with health care		
	I'm a patient or a caregiver and I need to know how to use e-health	5
	I was exposed to e-health	3
	I see the benefits of e-health and I am eager to use it	2
	I'm a patient or a caregiver	8
	I see the benefits and the necessity of e-health	10
Theme 3 – Need for self-reliance and autonomy		
	My social network can't provide adequate help	5
	I want to be independent from others	5
	I want to be self-sufficient in using e-health	3
	My social network can't provide adequate help	3
	I want to determine how I receive care and how I get access to health care information	4

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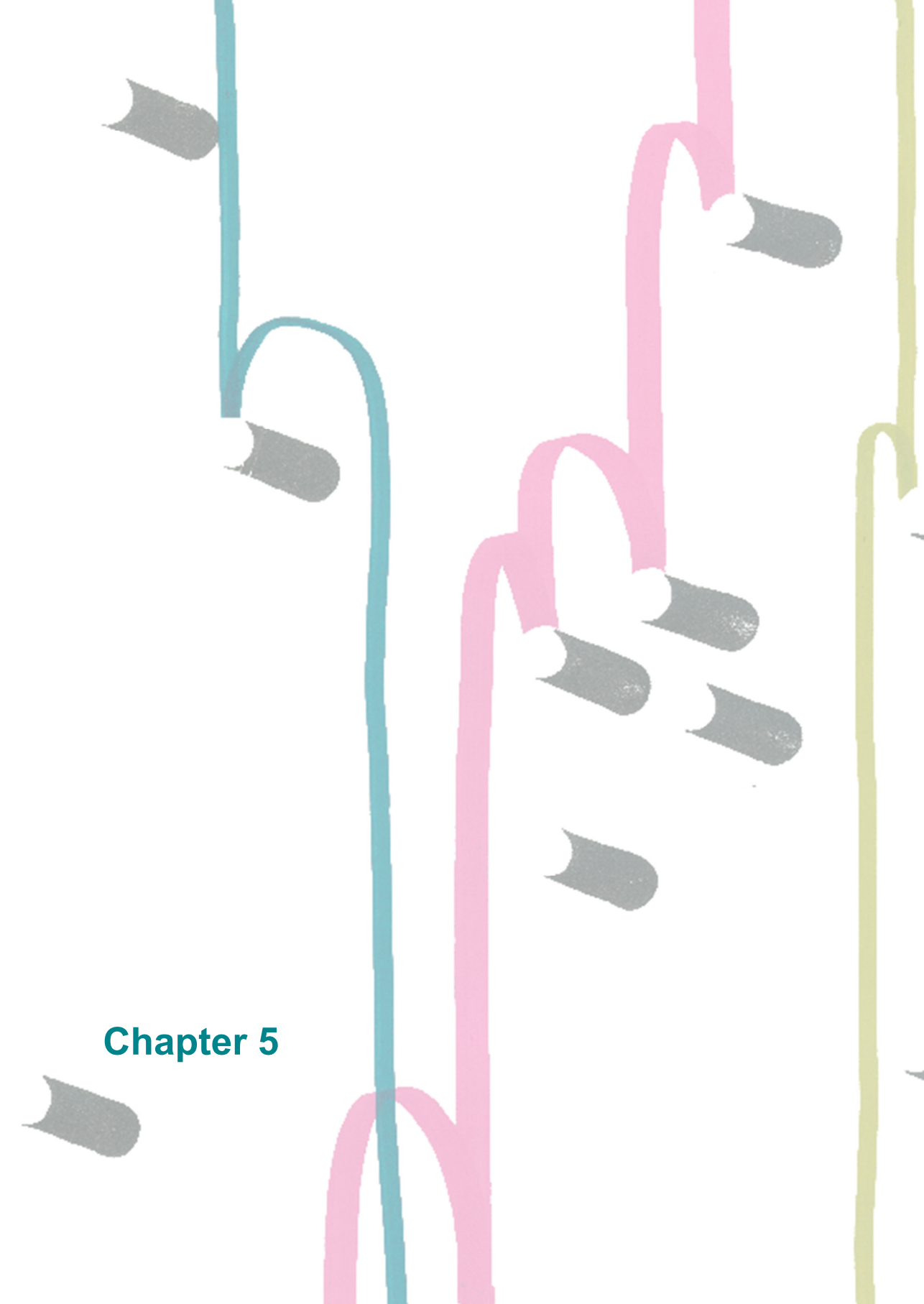
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Chapter 5



Support in Digital Health Skill Development for Vulnerable Groups in a Public Library Setting: Perspectives of Trainers

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Abstract

Introduction: The digitalisation of healthcare poses a risk of exacerbating health inequalities. Dutch public libraries offer freely accessible e-health courses given by trainers. However, there is limited knowledge on whether these libraries successfully reach and support those in need. This study aimed to explore trainers' perspectives on the challenges, successes, and potential improvements in digital health skill education in a library setting.

Materials and methods: Trainers of the e-health course were interviewed. Topics included: the role of the library in digital health skills education, the successes and challenges in reaching groups with a low socioeconomic position, the perceived impact of the digital health skills education, and strategies for future improvement in digital health skills education. A deductive analysis based upon the interview guide topics was performed. A second inductive analysis was applied to identify underlying patterns. Coding was done independently and cross-checked. Codebooks and themes were determined in discussion with authors.

Results: Three themes emerged. 1) Trainers' services, skills and expertise: Trainers identified older adults, youth, people with low (digital) literacy, the unemployed, and people from non-native cultural backgrounds as the groups most in need of support. Trainers felt equipped to address these groups' needs. 2) The libraries' reach: improving engagement, perceived accessibility, and clients' barriers: Despite trainers' efforts to adjust the course to the target groups' level of commitment, digital and literacy levels, and logistics, the digital health course predominantly engages older adults. Experienced barriers in reach: limited perceived accessibility of the public library and clients' personal barriers. 3) Collaborations with healthcare, welfare and community organizations: Trainers emphasized that collaborations could enhance the diversity and number of participants. Current partnerships provided: reach to target groups, teaching locations, and referral of clients.

Discussion: Trainers in public libraries recognize a various target groups that need support in digital health skill development. The study identified three challenges: accessibility of the digital health course, reach of the public library, and clients' personal barriers. Public libraries have potential to support their target groups but need strategies to improve their engagement and reach. Collaborations with healthcare, welfare, and community organizations are essential to improve their reach to those most in need of support.

Introduction

Rapid digitalisation of healthcare imposes barriers in access to care for people with low digital health literacy or limited access to resources (1–3). Digital health, or e-health, is the use of information and communications technologies in healthcare to manage illnesses and health risks and to promote wellbeing (4). Digital health has a broad scope and includes the use of wearable devices, mobile health, telehealth, health information technology, and telemedicine (4). Known barriers to use digital health are a lack of access to hard- and software, a lack of language literacy, digital health literacy, digital skills, and limited awareness of the existence and the benefits of e-health (5–9). Digital health literacy is defined by Norman et al. as “the ability to seek, find, understand, and appraise health information from electronic sources and apply the knowledge gained to addressing or solving a health problem” (10). This leads to a growing concern that the increasing adoption of e-health will lead to increased disparities in health (11, 12). The Digital Divide Model by Van Dijk describes the existence of a socio-economic gradient to the availability of resources that lead to access, use and derived benefit from new media, such as e-health (13). These resources are categorized in temporal, material, mental, social and cultural resources (13). According to the Digital Divide model and related research, policies and laws are countries’ instruments to redistribute public resources in an equitable manner to mitigate this divide (1, 13–20).

Scholars expect that the need for social services in a fast digitizing society and digitizing health care system will grow (21, 22). Public libraries have the opportunity to become key in facilitating education and support within a community setting increasing resilience to societal changes and improve inclusion of all citizens in modern society (23–25). International and national policies push the public library forward to facilitate support in the development of digital health literacy among citizens (26–34). Many studies underline the potential of libraries to educate citizens in digital skills and in health literacy, and increasingly in the combination of the two; digital health literacy skills (26, 28, 35–40). Libraries are viewed as accessible for anyone and well-rooted in society. Therefore, the library is considered a suitable avenue for reaching populations in need of support (18, 19).

Dutch public libraries are evolving from a source of written information towards an institute with a broad societal role, facilitating support in a variety of skills, including digital skills and accessing e-governmental services (31, 41–45). These developments show that the Dutch public library is a social services organization that is expanding their variety of services with the aim to help

citizens to overcome challenges in current society. In this role, libraries predominantly focus on supporting people with limited language literacy, limited digital skills, in particular: older adults, parents with limited language skills, refugees and immigrants, and people with a lower socio-economic position (SEP) (46). Around 4 million Dutch citizens lack the language and numeric skills to participate in the knowledge-driven economy of the Netherlands (41, 42, 45). The public library estimates the level of language and numerical skills to be indicative for the level of digital skills (41, 42, 45). The Dutch library covenant (2021–2023) states the goal to reach 10%–20% of these citizens with support for the development of digital skills by employing effective interventions (42).

The Dutch government and the public library organization developed a program for digital inclusion (43, 44). Helpdesks [Informatiepunt Digitale Overheid] were opened in most libraries with the purpose to provide direct support in digital governmental, health and tax matters or refer clients to other forms of support offered by the library, such as courses or walk-in hours (43, 44). This study focuses on the digital health education provided in the public library, which is mainly facilitated via the trainer-led e-health course “DigiVitaler”. We previously showed that participants of the e-health course valued the content of the course and felt supported in their digital health skill development (47) and, that the participants were predominantly older adults (47). The general aim of the public library is to reach and educate a variety of people who need support in digital skill development most (46). To gain more insight into how the support in digital health skill development is realized in daily practice and if, how this support could be improved, trainers of the e-health course are interviewed.

This research aimed to gain insight into trainers’ perspectives regarding the challenges, successes, and possible future improvements in digital health skills education within the context of the Dutch public library. Results from this study provide grass-root level insights into what is needed to expand the role of the public library and the trainer as a valuable resource within the welfare and healthcare infrastructure in the context of digital health literacy.

Materials and methods

Setting

The organization DigiSterker develops courses for digital health skills, DigiVitaler and digital government skills, a.o. DigiSterker. Organizations that want to facilitate the courses have to purchase a license and trainers must follow a trainer education program (48). The public library organization has purchased the license of DigiVitaler for all public libraries to use (48). The course is available for public libraries to implement in their services since 2021

(49, 50). Each library needs to have a trainer that completed the trainer education program before offering the DigiVitaler course. The course DigiVitaler aims to enhance digital health literacy and is offered in 60 of 137 public library organizations in the Netherlands (2022) (49, 50). This course is structured into multiple classes, each covering a specific e-health topic, such as the patient portal, video consultations, and searching for online health information. Trainers introduce clients to the potential of e-health by providing hands-on experience with e-health applications in simulated digital environments. Libraries are free to decide what topics they offer and how the course is structured. There is no measurement of the level of digital skills before or after the course. In public libraries, participation in the course is free of charge.

Data collection

A qualitative research design with semi-structured interviews was used. DigiVitaler trainers were interviewed regarding their daily practices in providing support for the development of digital health skills for people with a low SEP. The interviews took place in June and July 2022. The topics discussed included: (1) the role of the public library in digital health skills education, (2) the successes and challenges in reaching low SEP groups, (3) the perceived impact of the content of DigiVitaler, and (4) strategies for future improvement in digital health skills education. The interview guide was developed in collaboration with authors Lucille Standaar (LS), Adriana Israel (AI), Lilian van Tuyl (LvT), and Anita Suijkerbuijk (AS) and can be found in Supplementary File S1. In addition, the age, sex, level of education, job description and years of work experience of each participant were recorded. The level of education was determined according to the International Standard Classification of Education (ISCED): 0–2 corresponds with low, 3–4 with intermediate and 5–6 with a high level of education.

Recruitment

Trainers were eligible for participation in this study if they worked as a trainer for the course DigiVitaler within a public library. Contact information for the DigiVitaler trainers was provided to the researchers through DigiSterker, the developer of DigiVitaler. The trainers were approached via email, phone, or face-to-face as part of a previous study to inquire if they were interested in participating in this study. Prior to the interviews, the trainers received digital information about the study and were asked to sign an informed consent form. Participants were provided the opportunity to ask questions about the study and the interview procedure via phone or e-mail. Informed consent forms were collected via e-mail prior to the start of the interview. Participants received a 15 euro digital voucher for their participation. The interviews were conducted online

via Microsoft Teams by LS and AI. All the interviews were recorded and lasted between 30 and 60 min. The content of the interviews was discussed among LS and AI after each cycle of six interviews. After fourteen interviews, no new information was retrieved and after discussion between LS and AI, it was concluded that data saturation was reached.

Fourteen trainers participated in the study. The participants were predominantly female ($n = 10$), with a mean age of 54.8 years (range of 31–62 years). This is in line with the gender and age distribution of all employees within public libraries, as 83% is female (2022) and 87% of employees fall in the age range of 30–60+ years of age (2022) (51). Eleven trainers were employed by the library, two were volunteers, and one was self-employed. The trainers were recruited from twelve different libraries across the Netherlands, covering both rural and urban municipalities. Most participants ($n = 12$) were highly educated. The participants were involved in education of digital skills for 8 years on average (range 1.5–25 years). All participants completed the trainer education program from DigiSterker, the developer of the course DigiVitaler. A detailed overview of the participants' demographics is presented in Supplementary Table S2.

Data analysis

The interview audio recordings were transcribed verbatim by a professional transcription service. Data were analyzed with the Codebook Thematic Analysis approach (52). Codebook thematic analysis allows for a structured process of coding, theme development and conceptualization in a multidisciplinary team while maintaining the approach of reflective thematic analysis to explore the perspectives of the trainers in-depth (53). First, transcripts were read for data familiarization. A codebook was created based upon the topics from the interview guide. The first two interviews were double coded by LS, AS, LT, and AI who then collaboratively defined and fine-tuned the codebook. After reaching consensus, the interviews were coded and cross-checked by LS and AI, using MaxQDA for data management. This deductive analysis was performed to create an overview of the data gathered. A second, inductive, analysis was performed to identify underlying patterns. The following topics were analyzed inductively: libraries' services for digital health skills development, trainers' guidance, trainers' observations, target groups, collaborations, ideas for the future. The first 20% of the transcript segments per topic were inductively coded by LS and AI separately. After reaching consensus, the rest of the transcripts were coded and cross-checked by LS and AI. The inductive codes were arranged into candidate themes. Candidate themes were then further defined through discussion between all researchers to determine the final themes. An

overview of the final themes and the underlying codes can be found in Supplementary Table S1. Quotes were translated by using DeepL and checked by a native English speaker.

Ethical considerations

The study was declared to fall outside the scope of the Dutch Medical Research Involving Human Subjects Act by the Clinical Expertise Center of the Dutch National Institute for Public Health and the Environment (VPZ-559). Transcripts of the interviews and the informed consent forms are stored and protected at the Dutch National Institute of Public Health and the Environment.

Results

Three main themes were identified to describe the trainers' experiences in providing support in digital health skills development in a public library setting: (1) Trainers' services, skills and expertise, (2) The libraries' reach: improving engagement, perceived accessibility and clients' personal barriers, and (3) Collaborations with healthcare, welfare and community organizations. An overview of the themes and subthemes can be found in Figure 1.

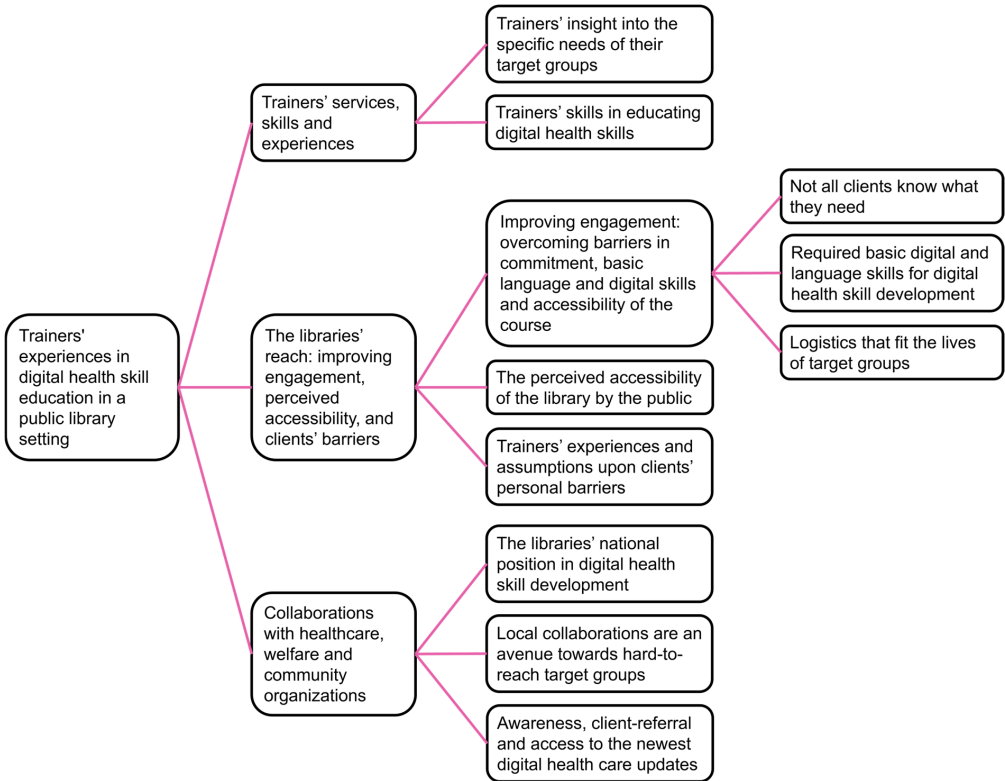


Figure 1. Overview of described themes and subthemes derived from the trainers' experiences in digital health skills education in a public library setting. Data was collected via semi-structured interviews ($n = 14$). Interviews were held with Dutch trainers in digital health skills who taught in public libraries.

Trainers' services, skills and experiences

Trainers' insight into the specific needs of their target groups

The trainers felt that specific groups might need more assistance to acquire the skills necessary to access digital health. Most of the trainers have years of experience and worked with a diverse clientele in terms of age, skills, cultural backgrounds, and language proficiencies. Trainers expected the following populations to need support: people who are unemployed or who are not used to digital work, older people, persons with a migration background or people with low literacy skills, and the youth. The need for support was not perse related to socio-economic status according to the teachers. It was often mentioned that trainers expect different target groups to have different needs in accessing digital health.

"A low-literate person may need help more often, but there are just people who have nothing to do with a smartphone or digital devices, but who are quite intelligent [...] they also need help. The immigrants who have just come to the country, who are still working on the language, but also need to know what DigiD is, [...] where they can go, what is on offer. So basically you are dealing with all layers." - Interview 13

"Yes, newcomers. [...] Yes, with them I do have to make a comment, because they are digitally proficient. Because very often they come.. They have these nice mobile phones and so on, but they also have to be able to find their way within the Dutch infrastructure. And so we have to teach them that." - Interview 04

Youth and people with migration backgrounds were often seen as digitally skilled but were perceived to have less knowledge about how the (Dutch) governmental digital systems work. Additionally, some trainers experienced that the youth had less awareness of what safe use of the internet is and how important that is regarding their intensive participation in the digital world. Trainers observe that people with a migration background and people with limited literacy would benefit from developing their (Dutch) language skills to be able to fully participate in the digital health services.

"Youth are not so aware of what an app does and what information is stored. Who is the creator? Is it reliable? They are actually a little less concerned with that than would be good for them" - Interview 14

Trainers' skills in educating digital health skills

Trainers reported to feel highly skilled and equipped to support the development of digital health skills among their clients. Most trainers explained that taking

time and asking questions about their clients' needs is important to be able to serve their clients best and adjust education efforts accordingly. Nevertheless, for each target group, different aspects of access to digital health are of importance and thus, a few trainers said to feel uncertain to best address the needs of some target groups. Their daily work includes providing courses, workshops, and directly accessible technical support to improve digital health skills of clients. Most trainers perceived the digital skills needed within digital health similar to other digital areas, as digital health often requires the use of a digital authenticator to log in, fill in forms or visit a website.

"I now also start more from the student's demand. In the beginning, of course, you have a fixed programme, and you want to run it. And then at a certain point I noticed that people had their own problems. So every course looks different and it kind of depends on what the course participants want." - Interview 09

"It's mainly people who have been on welfare for a very long time. Yes, they are quite difficult to reach. And we know, we can't put our finger on that either, how digital-savvy are they actually?" - Interview 04

Even though the trainers themselves feel well-equipped, they find that, in general, there is a lack of skilled and experienced workforce to strengthen their teams. The lack of skilled and experienced workforce poses a challenge on effectively educating their clients. Some trainers noted that they must depend on volunteers, which can occasionally result in education and support that does not fully meet the clients' needs. Others mentioned that, to improve the quality of the libraries' service, they would like to provide training in didactical skills and digital health for their volunteers and new library staff, but that they lack the stable financial funding for this type of development.

"It's also a choice for us to do that with professionals because you can also work with volunteers, you can also say, we have computers and people can just practice on their own but we do feel that we have to offer something more than that. We really have to guide people a bit in that, take them by the hand and also because of that, we spot what people are asking, what they are struggling with, and then of course we try to find an answer to that." - Interview 01

"There is still some subsidy for it now, but suppose that disappears, you have a chance that it will only have to be done by volunteers. That would be a shame, though, so I actually hope that the national management [...] will continue to pay attention to it" - Interview 07

The libraries' reach: improving engagement, perceived accessibility, and clients' barriers

Trainers experience that most clients who attended the course DigiVitaler were ethnic white female older adults of 60–80 years of age who were fluent in Dutch. Both successfully engaging diverse target groups in the digital health skill course and reaching target groups through the public library were experienced as challenging.

Improving engagement: overcoming barriers in commitment, basic language and digital skills and accessibility of the course

Not all clients know what they need

Trainers experience difficulty in balancing between the guidance needed for clients to learn new skills and the time-consuming effort that the development takes. Clients tend to overestimate their level of digital skills and rather commit to short courses. Most libraries had converted their multi-day courses into single workshops to address their clients' needs. Even though, most trainers expressed that long term courses delivered to small classes are the most effective way to learn digital skills.

“We thought of, shall we then extend our course? That we'll make it, say, six classes? But that's quite a long time span, that you're committing people and they don't want that so then you get that people aren't going to sign up again because the course is so long so it's a bit of a balancing act as well, a bit of a commercial story, but how do you get people in?” - Interview 14

Regardless, most trainers felt that the digital health skills course improves clients' confidence, skills and awareness in digital health, albeit it depends on the client how fast they progress in their skill development. Some trainers shared that people who only use the library for technical support tend to develop their digital skills less, as problems get solved for, and not by, clients.

“Of course we have the digital government information point where people are really helped with what steps to take. In that you don't really teach people to become proficient themselves, that's really more of a service and for me that's a bit of the dividing line because at the IDO [Information Point Digital Government] you help people with a question they have. But if people want to learn how to do that themselves, they can go to the digital house” - Interview 03

Required basic digital and language skills for digital health skill development

According to the trainers, the e-health course demands a certain level of digital and language skills that not everyone possesses yet. Some participants

mention that they assess the digital skill level of the client before admitting them to the digital health skills course. If the digital skill level is assessed as too low, the client is directed to a general course in digital skills. Some trainers mention that the course material would be difficult to teach to people with limited Dutch fluency and would direct these clients to language courses. Others mention that with the right tools and enough time, they would be able to teach digital health skills to non-native Dutch speakers.

"You just ask some things. [...] Are they working with tablet? Are they working with a laptop? Or only on mobile? And what do they do then? [...] We have also recently developed a very short questionnaire that we ask people to fill in before they start taking courses. And then we can check whether, gosh, are they doing well or do they perhaps need to take another level [digital skills] lower or higher"
- Interview 02

"Steffie's [a website that provides videos explaining various topics in easy language] videos. [...] To reach people in a clear way also for example low-literate people and also even non-native speakers, because with some of the videos it is also possible that to see the text in your own language Arabic or Turkish. So that's also how you reach that target group. So I also use those from time to time." - Interview 09

Logistics that fit the lives of target groups

Trainers were aware of the importance of providing classes at times and places that suit their target groups. Some trainers offer classes according to the schedule and format (live/online) of their clients. One trainer mentioned that they offered the course at different times of the day to serve more target groups. Some trainers also offer their services in settings outside the library: community centres, in nearby villages without a library or during events from local associations such as older adults associations.

"If you [as a younger adult] would then want to know something, you go and look it up in the evening [...]. And whether we have to do that in the evening physically, or whether we have to do that via Zoom or those kinds of methods, I'll leave that in the middle. But not everyone also has the need to then leave the living room in the evening and leave that hot cup of coffee because they are going to the library for a course." - Interview 08

"We had a lot of courses during the day but we also deliberately made courses on evenings but that doesn't make much difference to the age group [...] the same people arrive there and we also switched evenings on occasion, saying, you know, is it because of Monday?" - Interview 06

“We also went back into the neighbourhoods since last year, we are now in two neighbourhoods, socially disadvantaged neighbourhoods so to speak. And from September we will enter a third neighbourhood, where we will also have a drop-in point and walk-in consultations in community centres. To make it accessible to more people, because for many people the library is a complicated thing and not very accessible, whereas it should be, but it’s not in people’s minds to just walk into a library.” - Interview 03

The perceived accessibility of the library by the public

Most trainers expressed that they experienced difficulties in reaching the target groups that need support. All trainers felt that the public library is an organization that is and should be accessible for everyone. Some trainers found that the difficulties in reach originate in limited awareness of the libraries’ services or that the potential client was unable to commit to learning new skills due to limited time available or other priorities.

The perceived accessibility of the library by the public is mentioned as important for reaching the intended target groups. To improve the visibility of the course, trainers mention the use of various online and offline marketing methods, such as advertising in local newspapers, posters, flyers, word of mouth, and social media. Some libraries collaborate with older adults associations, general practitioners, pharmacies, and computer associations to use their network as an advertisement outlet. The trainers mentioned that most people that attend the course were made aware via newspaper advertisements or via local associations’ advertisement outlets.

“I think you have to set it up as broadly as possible. And people who are actually confronted with it [digital healthcare] and don’t know anything about it [digital healthcare], they will automatically come to you to start asking those questions” - Interview 08

Another perspective of the participants was that the library might be less accessible for certain target groups. Reluctance to visit the library may originate from perceived or experienced psychological, financial or logistic barriers. Trainers have mentioned that potential clients with limited literacy often avoid the library as they feel it is a place where they don’t belong as they are unable to read. Others have mentioned that people may still have an old-fashioned image of the library; the library being a place for elites and where you can only read books. Some mention that for some people the library is too far away, travel is too expensive, or they experience discomfort leaving the familiarity of their neighbourhood.

“People with a migration background [...] they don't like to come here (public library in the city centre) either. [...] they say, it has to be here in the neighbourhood because it's too far or I can't get there or they have to walk. It's a combination of not being able to and finding it scary. Or that they have no money for it, but also because they find it scary. The neighbourhood is safe and especially for people with a migration background, who often stay in their neighbourhood and take their children to school” - Interview 03

Trainers' experiences and assumptions upon clients' personal barriers

Some trainers experience that especially the youth and middle-aged adults are difficult to engage in digital skills courses, even though they do ask for information at the helpdesk and are offered the option to attend a course. Some trainers assumed that shame for being less digitally skilled, lack of time or lack of motivation to invest in digital skills could explain this.

“Yes, especially if we find that they [younger adults] could use some further training. And then we don't so much refer to that digital care, but more to the DigiD, working with DigiD and things like that. If we find that they are actually not that good with the computer at all, then it will also be the Klik & Tik [basic digital skill course]. [...]. Generally, they do take a leaflet with an offer, but I don't know whether they sign up then, you know. I think there is also a bit of shame there, I suspect. That they would rather go to one of these consulting hours just to ask for help again than to actually take a course.” - Interview 07

Additionally, a few trainers also mentioned the importance of access to devices and awareness of the existence of e-health. The older adults and people with limited financial means often have less access to up-to-date devices. Even though libraries have devices available during the course, trainers feel that the course is less effective for people with little access to digital equipment. Clients may not have access to applications or websites due to outdated hardware or software. Some trainers mentioned that older adults are less aware of the possibilities of digital health because they might not be made aware as much as younger generations.

“There are also people who don't have a laptop or a smartphone, who do have a computer at home, but it is either very slow or gathering dust because, of course, it's no fun when it doesn't work properly or you can't use it much. They are often those discarded, you know, I have one left, mum, do you want it? That's how it often goes in families, so there are also students who don't actually have all those devices and still want to know how it works but then, it just remains theory because they can't then put it into practice.” - Interview 01

“A lot of people just don't know. Younger people know. Because they are made aware of it. So for example, my daughter knows about the app from the consultation office, the portal of the consultation office, because she has been made aware of it.” - Interview 12

One trainer mentioned that the digitalisation of healthcare also involves a cultural change in how people interact with healthcare. Digital healthcare requires patients to take more initiative and, according to one interviewee, older adults and people from other cultures might not be used to this approach and need guidance to adjust to this new patient role.

“It's a big problem also culturally. So non-Western societies are much more hierarchical. My mother-in-law still has it very much, the doctor is still on a certain pedestal next to the mayor and the minister. And, for example, that is still the case in non-Western societies. So the idea that you can have your own direction in your health matters is completely insane to people.” - Interview 12

Collaborations with healthcare, welfare and community organizations

Most trainers regarded the establishment of collaborations with various partners as a solution to improve their reach to target groups. Five benefits from collaborations were mentioned: enlarging advertisement reach, increasing client referral, facilitation of support in the living space of the target group, improving awareness about digital health skills education among healthcare professionals and citizens, and opportunities to exchange information between libraries and organizations. The mentioned partners were governmental organizations, health organizations, local hospitals or general practitioners, municipalities, community centres, (local) social services, older adults organizations, computer clubs, local leisure and sport clubs and schools.

The libraries' national position in digital health skill development

The surge in (forced) digital health use during the COVID-19 pandemic revealed the gap in digital skills and digital health skills among the public, according to most trainers. As the need for digital health skills education was sudden, trainers felt that there was limited opportunity for the public library to fully establish their newly acquired position in the digital health field. Some trainers felt that due to the limited established position, healthcare organizations are unaware of the public libraries services or did not prioritize collaborations with the public library in the area of digital health skill development. Trainers also expressed that they felt that they didn't have the time or position to initiate larger scale collaborations. The enforcement of a network between the healthcare sector and the public library and a country-wide strategy for collaboration between the sectors is needed to improve the libraries' position and reach,

according to some trainers. Trainers shared that country-wide or larger collaborations could lead to improved awareness about the importance of digital health skills and the services of the library among patients and healthcare professionals. In return, trainers could benefit from being on top of the developments in the digital healthcare field. Additionally, these collaborations could provide opportunities for client referral to the library on a large scale.

“Yes, much better cooperation with GPs and hospitals and maybe even health insurance companies. Because a lot of GPs don't yet know about the existence of DigiVitaler courses and they say ‘we don't have time.’[...] I would say, yes, how do you reach them all? Because we distributed flyers to the GP practices. We very actively tried to raise our profile. And they say, ‘no time, little time.’ Yes, so in that we would very much like to cooperate more. Also hospitals very much like to cooperate.. Yes, that would be very convenient. From the hospitals and general practices and specialists people referred, actively referred to us” - Interview 04

“GPs and libraries, they have never had anything in common. So they have to start believing in each other first. You can't actually do that as an individual library. You have to do that nationwide.” - Interview 12

Local collaborations are an avenue towards hard-to-reach target groups

Trainers mentioned that by working together with local organizations, libraries can become part of a network within a neighbourhood which makes their services more accessible to potential clients. Trainers provide different examples to how they reach youth, people living in low socio-economic neighbourhoods, and older adults. One trainer elaborated upon a collaboration with local schools to reach youth by providing support at school. Multiple trainers mentioned collaborations with local organizations such as community centres and welfare organizations to facilitate education on locations within low SEP neighbourhoods or in towns without a public library. Others mentioned collaborations with older adults associations and computer associations to use their advertisement avenues and presence at events to reach older adults. According to the trainers, collaborations with schools, older adults organizations, and computer associations were successful. These collaborations provided opportunities to reach target groups and to gain insight in the needs of the public libraries' target groups. Some trainers mentioned that for libraries to be fully present in target groups' neighbourhoods, time and effort need to be invested in becoming locally known.

“With us, that goes through information staff, who have lots of contacts with schools and with all kinds of youth organizations, and they recently had a

brilliant pizza session. They invited young people to come and order pizzas, have a bite to eat with us and in exchange we will bother you with all kinds of questions, and that was actually quite a success, and that way you quickly get a feel for them.” - Interview 14

“In itself that is good, only there has to be some more awareness within those neighbourhoods too, that we are there. [...] Chatting, handing out flyers, then these things come to life as far as organizations are concerned [...]. And that just takes time and you have to keep repeating it, otherwise the information goes away again. So in itself I do think it works, but it could be much better.” - Interview 03

Awareness, client-referral and access to the newest digital healthcare updates

Some trainers reported that they are at the start of forming local collaborations with healthcare professionals, others mentioned that they wish to collaborate but have not yet found the time or the right contact person. The trainers found that collaborations with local healthcare organizations could improve the set-up of the digital health skills course by working together with healthcare professionals. According to the trainers, such collaborations would potentially provide opportunities for advertisement, client referral, and course locations.

“We now have a pilot with two GP practices [...] that we get a notification if they [potential clients] have digital questions or problems with digital skills or with Dutch language, because we are connected to our language house.” - Interview 03

“I am already trying to make contact with hospitals to see if maybe I can also give separate workshops about the hospital portal. And that the hospital then sends me patients or that I put information there in the form of a flyer. That they can go to the library if people just want to practice a bit more with the portal.” - Interview 09

Discussion

In this study, the perspective of trainers on digital health skills education in public libraries was evaluated. The aim of this study was to gain insight into trainers' perspectives regarding the challenges, successes, and possible future improvements in digital health skills education in the context of the Dutch public library.

Three main themes were identified that cover the experiences of the trainers of the digital health skills course offered by Dutch public libraries: (1) Trainers'

services, skills and experience, (2) the libraries' reach: improving engagement, perceived accessibility, and clients' barriers, and (3) collaborations with healthcare, welfare and community organizations. Trainers find the public library a fitting organization to facilitate support and education in digital health skills, however, to realize the public libraries' potential, improvements are needed in the reach of the public library and the accessibility of the digital health skills course.

Trainers view the establishment of new collaborations as key in broadening the reach of the public libraries services and to realize the library's intention to reach diverse target groups that are in need of support (Theme 3) (42). By forming these collaborations, trainers expect that the public library will gain traction with a diverse clientele, improve awareness around digital health skills, and information exchange. Our previous research and other findings showed that motivation to learn digital health skills stems from awareness of e-health and its potential benefits, a sense of urgency because of a health issue or the feeling that participation in the digital world is inevitable (47, 54–56). Ramtohl describes that the existence of support in e-health use lowered the barrier for e-health use, but that a general interest in health, a health need, and saving costs were main triggers for end-users to use e-health (54). Results from this study show that trainers also assumed that feelings of shame about digital illiteracy, limited awareness and limited access to devices might cause barriers to seek support in digital health skill development. In our view, the healthcare sector, social welfare sector and the government should actively encourage and support citizens to adopt and adhere to e-health services, emphasizing the importance of developing digital health skills. Coetzer et al. identified a equivalent sentiment emerging from existing literature (57). Literature described the barriers of e-health use more often as individual-bound whereas suggested solutions to overcome these barriers were more often systemic-bound (57). Coetzer et al. argues that the barriers in e-health use are often framed as individual-bound, disregarding the role of systemic factors within these barriers (57). Consequently, Coetzer et al. concluded that access to e-health is a systemic responsibility, rather than only an individual one (57). Additionally, the literature showed that it is unclear how to translate these systemic solutions into real world settings (57). Similarly, the potential of the public library to improve (digital) health literacy is often mentioned in literature (18, 35, 36, 58–60); yet, evidence on how to realize the libraries' potential is limited. Frank et al. describes how collaboration between the library and partners ensured access to devices, internet, and digital authentication via the library for vulnerable groups in rural America (61). Future research into collaborations between stakeholders from the healthcare sector, social welfare sector, and the

government, as well as the capacities of stakeholders involved in digital health skill development, is needed. Such research could provide valuable insights into the development and enhancement of partnerships between the healthcare and social welfare sectors and what these partnerships could deliver to reduce digital health inequalities.

Trainers reflections upon who would benefit from an e-health course revealed that diverse target groups are at risk to possess limited digital health skills (Theme 1). Furthermore, trainers experienced that this risk lies in socio-economic, cultural and age related factors. Consequently, the trainers assume that different target groups require different approaches to improve digital health skills. Regardless of the trainers' educational skills, awareness of their target groups needs and their intention to reach a wide population, predominantly older adults participate in the digital health skills courses (Theme 2). In reference to the Digital Divide model, trainers find that the course DigiVitaler resulted in the development of digital skills (mental resource), a formal point of contact that assists in digital health use (social resource) and the stimulus to form habits and stay up to date in digital health use (cultural resource) (13) for those who attend (Theme 2). Although the course is of quality according to the trainers, trainers experienced that some clients that did attend the digital health skills course have limited time and motivation to learn digital health skills. This causes trainers to provide workshops instead of multiple day courses to improve engagement, even though trainers assessed that this would be required for their clients to better develop digital health skills. The trainers mentioned that other and further course adjustments might be needed to successfully engage and educate different target groups.

Additionally, some trainers expressed concern that the perceived accessibility of the library might be a barrier for certain target groups, leading to the absence of target populations participating in the e-health course (Theme 2). The trainers mentioned that the prejudices regarding the library, the unfamiliarity with the library, and limited accessibility in terms of proximity and travel costs can pose a barrier to some target groups. Several researchers found similar findings (62–64). Results from Goedhart et al. describe that mothers with a low SEP view the library as an institute where people go who are already skilled in using the computer, and that they do not belong there (64). Evjen & Audunson and Goedhart et al. mention the importance of the integration of social services in one place to make the public spaces, such as the public library, more accessible (62, 64). A few scholars have provided practical insights into strategies that could improve libraries' promotion of services, evaluation of their services and appropriation of their services to vulnerable groups (28, 59, 61, 65, 66). Dervin

describes the need for collaborative approaches with the library consumer to improve the effectiveness of providing support in health information seeking and use (65). Two studies outside the library context provide examples of designing digital health skill education via co-creation with various stakeholders (67–69). Perestelo-Perez et al. described the co-creation process of massive open online courses (MOOC) to improve digital health literacy for specific groups such as youth, older adults, diabetes patients and pregnant or postpartum women (67). Whitney et al. provides examples of other education methods that were employed by libraries with the goal to reach and support a broader audience including children, older adults and people with a non-native language proficiency (66). These examples involved train-the-trainer principles, storytelling, and the use of new media such as virtual reality, gaming, and social media (66). Using such innovative methods can help reach and engage different target groups. Other studies describe different digital health skill development approaches. A literature study from Verweel et al. reports about the use of digital interventions to enhance digital health literacy skills from people with chronic illnesses, offering programs that often both target (digital) health literacy skills and the chronic condition at hand (70). These findings suggest that the integration of multiple goals in one program might be attractive for people who suffer from chronic illnesses. Dong et al. provided insight in the literature concerning digital health skills education for older adults, where both face-to-face and online educational approaches were described (71). Findings describe that theoretically underpinned, face-to-face education programmes with a duration of more than four weeks were more effective for improving e-health efficacy (71). Online methods were less effective but have other benefits according to Dong: flexibility in scheduling, opportunities to repeat lessons at home and improved access for those who already have sufficient digital skills and access to devices (71). Of the four identified online educational approaches one was co-created with the target group (69), one study recruited older adults with high digital skills (72), two were taught in a blended setting with help of a facilitator who provided technical assistance (73, 74). Findings suggests that both face-to-face and (blended) online educational approaches could be considered when designing digital health skill courses for older adults, the latter for those with sufficient digital skills and access to devices.

Our study had strengths and limitations. The interviewees were all experienced in digital skills education within the library setting and were recruited in different libraries across the country, ensuring a reliable information source to answer our research question. The interviews were conducted until data saturation was reached, indicating the robustness of our findings. A limitation of this study is that the findings are derived from a single perspective within the library

organization and should be interpreted as such. The perspective of trainers provides a grass-root level insight to the successes and challenges the public library faces in digital health skills education. Future research into the insights from the public libraries' leadership and relevant stakeholders such as the target groups, policy makers and health organization leaders would enrich the results from this study. Additionally, most of the interviewed trainers were employed by the library and had a high education level. This might have influenced the results of this study. Being highly educated and employed might influence the interviewees' ability to understand the perceptions of those with less education or financial stability. However, there were limited opportunities to overcome this potential bias. At the time of data collection, the DigiVitaler course was new and predominantly implemented and taught by library staff with a job description that requires a certain level of education. Among our interviewees there were two volunteers and one self-employed trainer, yet this did not enhance the diversity in terms of educational background.

Implications and directions for future research

Our findings showed that public libraries have potential to support Dutch citizens in the development of digital health skills. Our findings show that trainers have difficulties in establishing an effective outreach and education method. Regardless of their efforts to reach their intended target groups that ranged multiple age, socio-economic and cultural groups. Additionally, the trainers showed awareness of specific barriers for specific target groups, but potential solutions to increase engagement and reach lacked this detail. Literature reviews by Vassilakaki et al. and Barr-Walker identified similar challenges in American library settings (35, 36). These studies discussed the following solutions for creating effective health literacy programs: staff education, development of evaluation tools, beneficial partnerships and organizational leadership (35, 36). Our results and the literature reviews of Vassilakaki et al. and Barr-Walker (35, 36), imply that difficulties to effectively educate and reach diverse target groups is common among public libraries. These findings and the literature implicate two things. First, that the need for support in digital health skill development is not only caused by a socio-economic gradient, but that cultural and age related factors also play a role. Secondly, that there is limited insight into how public libraries can reach and educate their target groups and what the needs of target groups are in this matter. Most literature of the existing research within the library setting is focused on the American context. Findings outside this context indicate that co-creation of education materials with the target group, designing education materials that target multiple goals that are of importance for the target group and different online and offline approaches are potential avenues for improved reach and engagement (67–71). This

presents opportunities to explore and research the needs and methods for reach and engagement for different target groups in other contexts. Our findings underlined that the perceived accessibility of the public library by the public was of importance according to the trainers. This factor was not identified in the literature reviews of Vassilakaki et al. and Barr-Walker (35, 36). Therefore, it would be interesting to create further understanding on how the image of the public library affects its perceived accessibility and the attendance of support in digital health skill development.

Our findings from a trainers' perspective suggest that expanding library services to include support for digital health skills requires efforts at both local and national levels to fully realize its potential. Multiple models describe the process of interdisciplinary collaborations within the sphere of health and healthcare (75–77). Bronstein, Weinstein et al. and Corbin and Mittelmark all described a model with two levels of factors. First level factors describe the service users, practices, organizations and professions involved (75–77). Second level factors describe the process of interaction between different professions, people, organizations and practices (75–77). Several scholars have described the processes and in lesser extent the outcome of interdisciplinary collaborations between the healthcare sector and the social services sector. A literature review from Cameron et al. describes that organizational, cultural and contextual factors facilitate or hinder integrated collaboration efforts (78). Notably, studies reported the lack of appreciation of the contribution of different professions, the lack of understanding of the aims of integration and concern that the contribution of community health and social care services might be marginalized by the interests of the acute sector (78). Cameron finds that, although limited evidence is available, integrated collaborations can be effective upon health outcomes and reduce cost (78). Brewster et al. describes that within collaborations, high centrality of healthcare institution and co-sponsorship of healthcare institutions and social services for specific programs were correlated with high performing collaborations (79). The theoretical models and empirical results underline that successful integrated collaborations require careful design and demand at least (financial) commitment, clarity on aims and procedures and appreciation of all professions involved. At the organizational level, enhancing collaborative networks and improving coordination among stakeholders is essential to ensure that the support reaches those who it is meant for. Beyond trainers' reflections on the potential roles of stakeholders in terms of reach, it is crucial to consider the extent in which public libraries can effectively enhance the digital health skills of target groups and fulfil their needs.

Conclusion

Digitalisation of healthcare requires large, diverse groups of people to invest in their digital skills. Digital health skills trainers within a public library setting estimate, based upon their previous experiences, that different target groups have different needs for digital healthcare use. Additionally, teachers identified their target groups' needs to be socio-economic, cultural, and age-related. Challenges in providing support in digital health skill development are found in the accessibility of the digital health course, the reach of the public library, and clients' personal barriers towards digital health and digital health skill development. From a trainers perspective, collaborations with healthcare, welfare, and community organizations are essential to improve the public's and stakeholders' awareness of the libraries' services in digital health skill development. This study shows that the public library has potential to become a partner in enabling a successful digitalisation of the healthcare system. To realize this potential, research and practice should focus on identifying new methods to engage and educate different target groups. Furthermore, the enforcement of the network between the healthcare sector and the welfare sector is needed to realize access to digital health skill education for those who need it most.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

LS: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Project administration, Writing – original draft, Writing – review & editing. AI: Data curation, Formal Analysis, Methodology, Writing – original draft, Writing – review & editing. RvdV: Supervision, Writing – original draft, Writing – review & editing. BK: Writing – original draft, Writing – review & editing. RF: Supervision, Writing – original draft, Writing – review & editing. MB: Supervision, Writing – original draft, Writing – review & editing. LvT: Supervision, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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The authors declare that no Generative AI was used in the creation of this manuscript.

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Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fdgth.2024.1519964/full#supplementary-material>

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Chapter 6



A Systematic Literature Review to Identify Delivery Strategies of Digital Health for Low SEP Populations

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Abstract

Background: Inclusive implementation, tailored delivery of e-health applications, and support in e-health use could help overcome the digital divide between people with a low and a high socio-economic position (SEP). However, limited knowledge is available on how e-health and support is best delivered to people with a low SEP and whether these strategies are based upon scientific or experiential knowledge. This literature review aims to (1) provide an overview of strategies to deliver e-health to people with a low SEP, (2) offer insight into the effectivity in reach of people with a low SEP by these e-health delivery strategies, and (3) identify scientific and experiential underpinnings for e-health delivery strategies' design.

Methods: This systematic review followed the PRISMA 2022 guidelines. A systematic search was conducted using five databases: PsycINFO, Web of Science, Embase, PubMed and Sociological Abstracts. Search terms were built around the following key-concepts: socio-economic position, e-health and delivery strategy. Delivery strategies were categorized according to five delivery strategy components: place, point-of-contact, promotion, facilitation and incentive.

Results: The search strategy yielded 5141 papers. The included papers (n=35) described 33 studies. Place and point-of-contact strategies were most often applied and combined in e-health delivery. Some evidence for reach effectivity exists for the following strategies: e-health delivery at locations visited by target groups, delivery via authorities and via offline promotion. In health organization contexts, how and which healthcare professional delivers e-health is relevant for effective reach. Applied underpinnings for delivery strategy design included stakeholder involvement for implementation strategy design, and identification and operationalization of delivery strategies.

Conclusion: This literature review identified a gap in the existing knowledge concerning effective strategies for the delivery of e-health delivery to people with a low SEP. Results show that almost all strategies used multiple delivery strategy components of which place and point-of-contact were most common. The evidence regarding the reach effectiveness of delivery strategies is insufficient and too scattered to support definitive conclusions. Nonetheless, it offers valuable insights into potential effective approaches. Researchers report little on theoretical or experiential underpinnings used for the design of e-health delivery strategies, nor are real world evaluations often conducted.

Registration: PROSPERO: CRD42024572294 **Keywords:** e-health, health promotion, health marketing, socioeconomic, outreach, health equity, implementation

Introduction

As digital health becomes increasingly integrated into healthcare systems, concerns about equitable access and utilization are raised (1, 2). Digital health, or e-health, is the use of information and communications technologies in health care to manage illnesses and health risks and to promote wellbeing (3). E-health includes the use of wearable devices, mobile health, telehealth, health information technology, and telemedicine (3). Although access to digital devices and the internet is increasing, less frequent and diverse use of e-health is observed among people with a lower socio-economic position (SEP) (4-7).

Equitable delivery of e-health has proven to be difficult (7-10). Previous research shows that people with low SEP have diverse barriers in access and use of e-health (11, 12). These needs include improvement of digital health skills, language skills, knowledge about the healthcare system, and awareness about e-health and its potential value (8, 11, 13-15). Scaioli et al. (2024) found that the lack of awareness about the existence and value of a patient portal is associated with low SEP (8). Researchers underline the role of organizations in realizing inclusive implementation strategies and accessible e-health applications to facilitate equitable access to e-health (16-19). O'Connor et al. (2016) describes that awareness, implementation strategies, support and promotion are crucial for engagement with digital health (17). Although research indicates what factors are important in the reach of people with a low SEP (16-20), there is limited clarity on what strategies exist to deliver e-health to people with a low SEP.

Successful approaches in reaching people with a low SEP is studied in other health fields (21-23). Evidence shows that tailored delivery strategies and community engagement approaches are effective in reaching people with a low SEP (21-23). A literature review by O'Mara-Eves (2015) found that delivery of public health interventions for disadvantaged groups via community engagement approaches were effective to improve health outcomes (22). Approaches in which community peers were involved in the delivery of the public health intervention were particularly effective compared to interventions that empower the community or interventions that involved members in the design of the intervention (22). However, there is limited knowledge about what strategies successfully reach and introduce e-health to people with a low SEP (24-26).

Successful access and use of e-health requires inclusive implementation strategies. Implementation is defined by Palinkas & Soydan (2012, p.10) as: “a purposefully designed set of actions for the application of a purposefully

designed program or intervention to cause change" (27). The design and execution of e-health delivery strategies is one of the aspects of implementation. Insights into what e-health delivery strategies are employed and whether these are effective for people with a low SEP is vital for realizing equitable access to e-health in the real world context (17, 28, 29). The aim of this literature review is to provide insight into what e-health delivery strategies have been used to reach people with a low SEP. Secondly, it aims to gain insight in the effectivity in reach of these delivery strategies. Furthermore, this literature review focuses on whether the identified delivery strategies were derived from experiential knowledge or earlier scientific research. Such underpinnings might provide insight into why and how delivery strategies do or do not work. In this literature review, an e-health delivery strategy is defined as: a strategy employed to facilitate the use of e-health or e-health enabling services. This literature review is registered in the Prospero database under the registration number: CRD42024572294.

Methods

Search strategy

Five databases were searched on 07-06-2024 electronically to identify relevant literature: Embase.com, Pubmed, PsycINFO, Web of Science and Sociological Abstracts. The key search terms were built around the concepts: (low) socio-economic populations, e-health and delivery strategies of products and services. A complete overview of the search terms can be found in Appendix 1. Search terms were constructed in consultation with two librarians.

Study Design

The PRISMA guidelines (2020) were used to structure this literature review and to ensure a systematic and rigorous analysis (30). The PRISMA checklist can be found in Appendix 2. The software package Rayyan was used as a tool for manual detection and removal of duplicates and screening. There was no use of AI technology. Three researchers (LMBS, JM and LS) were involved in the screening process. Screening based upon title and abstract, and full-text screening were done independently. In the title and abstract screening phase, LMBS screened all articles and JM screened 3012/5127 (59%) articles. In the full-text screening phase, LMBS and LS both screened all papers. In both screening phases the researchers held regular meetings to discuss conflicts and find consensus. When consensus between the first and second reviewer could not be reached during the screening phase, a third researcher (LvT or RvdV) was consulted to resolve the conflict. The data extraction form was developed and pilot tested by LMBS. RvdV, LvT and LS reviewed the data

extraction form and provided suggestions for improvement. LMBS extracted the data from all the papers, LS extracted the data from 20% of the papers. Conflicts in data extraction were resolved between LMBS and LS. LS conducted the critical appraisal of all included articles, JM appraised 11/35 (31%) of the included papers. Conflicts in the critical appraisal were resolved by LMBS by rereading the articles.

Eligibility

Population

Studies were included when the delivery strategy was aimed at a low SEP population. To allow us to gain broader insight into SEP, three indicators were included: education, income and the socio-economic status of the living area. Education, income and socio-economic status of the living area are classic SEP indicators (31). It was expected that most research that described or evaluated e-health delivery strategies used one of these indicators to address SEP. Studies either had eligibility criteria that reflected a low SEP by one of the three previously mentioned SEP indicators or the study was held in a low SEP setting. If the study was conducted in a low SEP setting, demographics needed to provide insight into either education, income or neighbourhood status of the study sample to confirm that the intervention was targeted to people with a low SEP. Income could also be derived from insurance status, type of employment such as blue-collar or white-collar jobs, or, attendance to specific clinics when eligibility to access these services requires a low income.

Intervention

The papers revolved around an e-health application or e-health enabling service. An e-health application was defined as follows: *“The use of information and communications technology (ICT) in support of health and health related fields, including health care services, health surveillance, health literature, and health education, knowledge and research.”* (32). Additionally, SMS based interventions were also included as SMS involves the use of a mobile phone. Included articles concerned both digital health care applications and digital public health applications (33). Digital health care applications aim for individual improvement of health, for example a diabetes management application or a patient portal, whereas digital public health applications aim to improve health on a population level, such as an COVID-19 tracking application or public health website (33).

Support services are services that are tailored to enable people to adopt e-health. These services can either enable the individuals from vulnerable groups to gain access and use to e-health or improve the inclusivity of surroundings

and services to be able to service vulnerable groups better. Examples of services that enable vulnerable individuals are: skills education, access to devices or increasing awareness around e-health.

Delivery strategy & delivery strategy components

The papers described a delivery strategy which was employed to facilitate the use of e-health or e-health enabling services. A delivery strategy can consist of one or multiple components that contribute to the reach of an e-health application or e-health enabling service. This literature review defined five delivery strategy components: place, point of contact, facilitation promotion and, incentive. The definitions of the delivery strategy components were derived from the marketing mix model described by McCarthy (1964) (34, 35). The marketing mix model described the 4 P's: product, price, place and promotion (34, 35). As this review's focus is to understand how low SEP populations are reached and how e-health is delivered, there was no focus on the product itself. McCarthy's concept of 'place' encompassed place, the point-of-contact and facilitation. In our review those three elements of 'place' are discussed separately. McCarthy's concept of price was interpreted as 'incentive' in this review, as digital health is often offered for free or as part of users' healthcare plans. Digital health use is, therefore, often stimulated via other means rather than the price of the product. The delivery strategy components were used a priori as a tool to categorize the actions executed as part of delivery strategies.

Place: the location where people can access the product. This includes the physical location but also the accessibility of the location in terms of opening hours and accessibility via (public) transport. Online products don't have a "place" as online services are not bound to a location or opening hours. Example of an intended delivery strategy: a mobile health clinic in the center of a low socioeconomic neighbourhood that provides information and support for use of e-health.

Point of contact: Organizations and people that provide information, goods and services to facilitate the delivery of the product. Point of contact can be particularly important when the person involved is someone with specific authority or skill, for example health care professionals or the municipality.

Promotion: All the activities that are intended to convey the message about the product or the place, point of contact or facilitation of the product. The following are considered promotion activities: online and offline advertisement, promotional items, promotional events, and, face-to-face selling.

Facilitation: The provided information, goods and support that enable use of the product. Examples can be: an helpdesk that aids potential clients to use an e-health application or facilitation of devices and data plans.

Incentive: the efforts done to stimulate potential users to use e-health or the e-health enabling service. Incentives can be financial, time-based, leisure, material or mental. Examples are: free health check, free gym membership or, coupons for a grocery store.

Inclusion criteria

The following inclusion criteria had to be met to be included in the review. The papers described the delivery strategy, the description had to include who performed the delivery, what the delivery strategy entailed and how the delivery strategy was performed. The study objective concerned the evaluation of an e-health application, e-health enabling service or, e-health delivery strategy with the aim to serve people with a low SEP. Demographics reported SEP by education, income or socio-economic status of the living area of the target population. Included study designs were: randomized controlled trial (RCT), quasi-experimental studies, mixed-method studies and observational study designs. Papers were required to be peer-reviewed and published on 01-01-2014 and onwards and written in the English or Dutch language. The research took place within Western societies, namely: Countries in Europe, the United States of America, Canada, Australia or New-Zealand.

Exclusion criteria

Qualitative and meta study designs were excluded. Papers that were protocols or pilot studies for future RCTs were excluded as these strategies were not executed on a full scale.

Data extraction

Overview of strategies

For all papers the following data were extracted and presented in Supplementary file 1. In case papers referred to other published work for more information about the data of interest, this literature was used to gain more insight. Additional references were noted in the tables and appendices.

Bibliographic information: title, first author, year of publication, doi;

E-health or e-health enabling service: e-health application or e-health enabling service, type of e-health (web application, mobile application, electronic health record, video communication, wearable, domotics, robotics, medical integration networks, general integration networks, business intelligence and big data solutions and telehealth) (36) and, description primary health outcome;

Context of study: type of study, delivery strategy (described/evaluated), country of study and, description of the research setting;

Intervention: description of the delivery strategy , category of stakeholders involved in the delivery strategy (research, healthcare, education, social services, community, commercial, citizens), description of roles of the stakeholders, components of delivery strategy (X if applicable): place, point of contact, promotion, facilitation and incentive; authors reflections upon delivery strategies;

Population: SEP selection criteria (individual, clinic or area characteristics), description of target population, description of inclusion criteria, description of exclusion criteria, information available of SEP variables of study participants (education, income, neighbourhood), number of participants at baseline and, demographic data on socio-economic variables.

The types of e-health are derived from an e-health application overview created by Krijgsman & Klein-Wolterink (2012) (36). The category 'telehealth' was added and represented all text-message based interventions. If the paper described and evaluated the reach or described scientific or experiential underpinnings of the delivery strategy, additional data was extracted.

Reach

Reach was defined by the number of people reached by the delivery strategy. Reach effectivity was measured by studies if the results showed a comparative analysis of the number of people reached between delivery strategies, between contexts that employed similar de strategies or between time points. Evidence for reach effectivity was found when the comparative analysis between delivery strategies was significant ($p < 0.05$). Data that described the reach per delivery strategy component or provided evidence for reach effectivity was extracted. Included data points for evaluation of delivery strategies: statistical analyses used, description of outcome measurements, the aim of the evaluation study, description outcome, exact outcome, and outcome significant (yes/no).

Scientific and experiential underpinning of delivery strategies

Data describing scientific or experiential underpinnings were systematically extracted from the articles. Scientific underpinning refers to theories or findings about the design of delivery strategies that were published in scientific literature. Experiential underpinnings refer to knowledge derived from experience from researchers or other stakeholders that was used to design the delivery strategy. Experiential underpinnings might be published in scientific literature, especially if stakeholders were involved during the design of the RCT or other prior conducted research. If this is the case, the underpinning is considered both

scientific and experiential. Included data points for scientific or experiential underpinnings: scientific or experiential underpinning used (yes/no, if yes, experiential/scientific/experiential and scientific), description scientific or experiential underpinning, and sources scientific underpinning ((type of scientific underpinning: theory (name theory), scientific publications, prior research author), (focus: implementation, delivery, incentivization, or advertisement), doi or citation).

Report on reach effectivity, and used scientific and experiential underpinnings for delivery strategies might be susceptible to missing values as it's not common practice to discuss these findings in evaluation studies. Researchers might have the data to evaluate reach effectivity but did not include these results. All researchers used a delivery strategy to conduct their research and it is possible that researchers made decisions based upon knowledge or experience that was not described in the paper. When these data points were missing, the assumptions were made respectively: no evaluation of reach effectivity was performed, and no scientific or experiential underpinnings were used.

Data synthesis

First, papers were described upon study characteristics: type of study, setting, target group, type of e-health application, target health outcome and, how studies aimed to recruit a low SEP population, either via individual, clinic or area characteristics. Overview of papers' characteristics are presented in Table 1. Secondly, an overview was created of the delivery strategy components and presented in Table 2. An overview of the stakeholders involved in the delivery strategy, the delivery strategy components and, theoretical and experiential underpinnings were described. Thirdly, the communalities and irregularities within each delivery strategy were assessed. Assessment was done via grouping studies by context, stakeholders involved and, the mechanisms of the delivery strategies used, including reported reach effectivity derived from the evaluation studies. Fourthly, the results were assessed across components by reviewing the occurrence of components, the combinations of components and whether studies that used scientific or experiential underpinnings had characteristics in common. Fifthly, an overview of the studies that described or evaluated reach was described and presented in Table 3.

Quality Appraisal

Joanna Briggs Institute (JBI) Critical appraisal tools for RCT, cross-sectional studies, quasi-experimental studies and cohort studies were applied to review the quality of the literature, see Supplementary file 2 for the critical appraisal including scores per question (37). Studies were scored by counting the number of questions that were answered with yes divided by the total number of

questions. Longitudinal studies were appraised using the checklist for analytical cross sectional studies (37). Most studies included reported but did not evaluate e-health delivery strategies. The quality appraisal of these studies evaluate the aim of the study as is, which was the effect of the e-health intervention itself and not the delivery strategy. Articles that had a score of 75% or more were deemed of high quality. Articles were not excluded based upon quality appraisal.

Results

Study selection

The screening process is described in detail in the PRISMA flowchart in Figure 1. The search term yielded 7361 articles. After duplicate removal, 5127 articles were included. LMBS and JM screened 3014 (59%) articles on title and abstract independently. Cohen's kappa was 0.56 which is considered a moderate agreement, percentage of agreement was 96% (2903/3014) (38). Thereafter, LMBS screened all remaining articles which resulted in 202 articles that were considered for full text screening. Additionally, LMBS screened three literature reviews (39-41) that were identified during the title and abstract screening. This yielded 7 more articles. LMBS and LS independently screened the full text of all 209 articles. A list of all the full-text screened articles can be found in Supplementary file 3. After screening on the eligibility criteria 35 articles were included. Cohen's kappa was 0.64, which is considered a substantial agreement, percentage of agreement was 89% (186/209) (38). The 35 included articles described 33 research projects.

Critical appraisal

Critical appraisal revealed that 14 studies had a quality score of 75% or higher, these studies were considered to be of high quality. Risk for bias related to selection and administration was identified in many studies (n=19), all considering the blinding of participants or administrators. Furthermore, studies (n=12) failed to identify and manage confounding factors. A detailed overview can be found in Supplementary file 2.

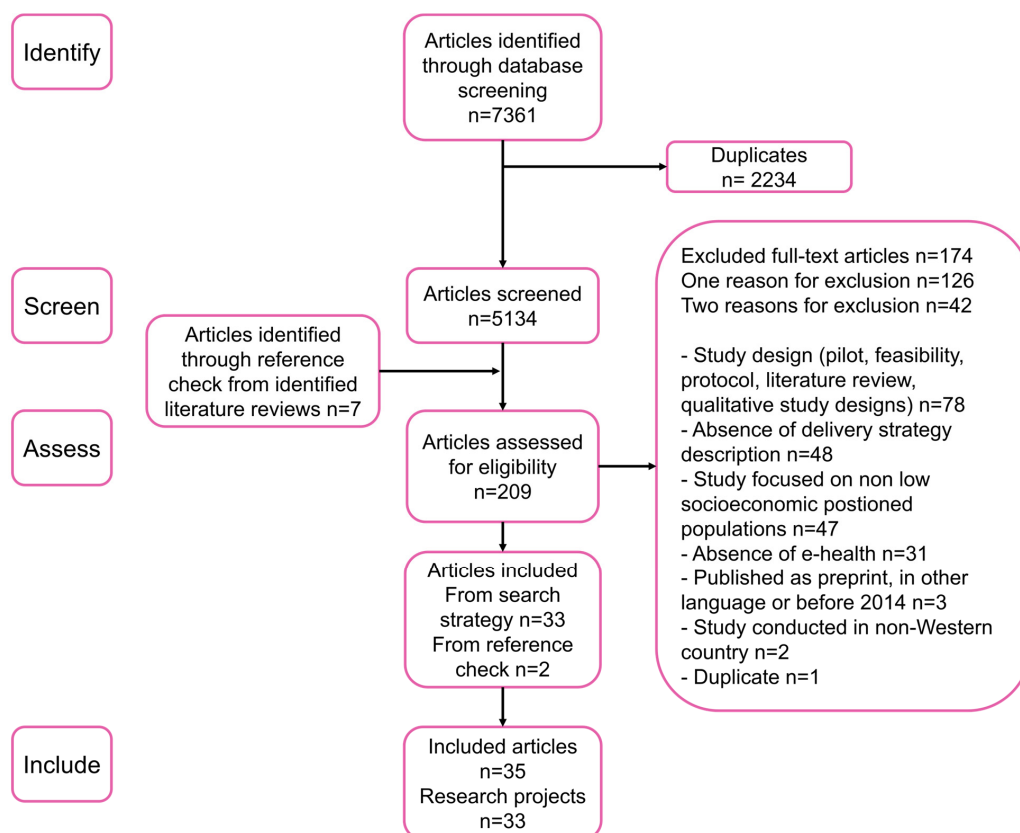


Figure 1. PRISMA Flowchart

General study characteristics

The search strategy resulted in the inclusion of 35 papers that described 33 research projects (42-85). An overview of the characteristics of the papers can be found in Table 1. Table 1 presents a subset of the following data: type of study, e-health type, primary health outcome, description target population, SEP selection criteria. Majority of the included papers were RCT's (n=19) (43-50, 52-55, 61, 65, 68, 73-79, 83-85). Furthermore, the following study designs were identified: cross sectional (n=8) (58-60, 66, 70, 71, 80-82), longitudinal (n=4) (48, 49, 62-64, 69, 72), cohort (n=2) (42, 56, 57), and quasi-experimental (n=2) (51, 67). Eight papers (48, 49, 56-59, 62-64, 70, 71, 82) concerned secondary analyses from RCT studies. Twelve papers (42, 47, 51, 56-60, 62-64, 69-71, 80, 81) evaluated the reach of the applied delivery strategy. Other papers (n=23) only described the delivery strategy as part of the research design. Most studies were conducted in the United States (US) (n=29), other countries were Australia (n=3) (42, 61, 83), the UK (n=2) (62-64, 68) and the Netherlands (n=1) (71). Most studies were published between 2020-2024 (n=25) (42, 46-51, 56-65, 68-76, 78-81, 83).

The majority of papers (n=34) focused on an e-health application. Different types of e-health were studied: mobile applications (n=10), web applications (n=9), wearables (n=6), telehealth (n=11), video communication (n=6), and electronic health records (n=4). Alcaraz, Vereen & Burnham evaluated the reach from an e-health enabling service (n=1): a national-wide information and referral system, that aimed to connect people with a low SEP with resources to meet their basic human needs (81). Papers focused on the management of disease (n=15): diabetes, COVID19, asthma, dementia, glaucoma, and children's development. Twelve papers concerned behaviour-related health topics, with the focus on weight, physical activity, and alcohol consumption. Five papers focused on healthcare processes: patient screening to identify needs and family history, and access to care. Three papers focused on mental health related conditions.

The papers' range in number of participants was n= 33 – 32.523 (mean: 2.259) (42-85). Target populations were mainly adults except for two papers which included: all residents including children (60) and adolescents and their parents (85). Some papers focused on specific adult groups: parents (n=11), adults from ethnic minority populations (n=5), and older adults (n=2) or pregnant women (n=1). Staples et al. and McEntee et al. recruited adults with a high and low SEP (42, 76-78). Danila et al. recruited older adults and adults with a low SEP (73). Eight papers enacted individual-bound low SEP eligibility criteria or recruited participants in low SEP-bound contexts (42, 45-49, 68, 69, 75-78). Other papers (n=27) recruited participants in low SEP contexts: clinics that predominantly serve low SEP populations or areas where predominantly low SEP populations live or visit. Twelve papers had in- or exclusion criteria based upon having digital skills or having access to devices and text- or data plans (52-55, 62-65, 67, 68, 70-73, 75). Nelson et al. offered training to use the intervention as part of their recruitment procedure, where participants that could not successfully use the intervention after training were excluded (72).

Table 1. Summary of paper characteristics (N=35).

Study ID	Type of study	E-health type	Primary health outcome	Description target population	SEP ^h selection criteria
1. Staples et al. (42), 2022	Cohort	Web applications	Mental health	Adults living in Western Australia suffering from depression	Individual
2. Steinberg et al (43), 2014 [(44)]	RCT ^b	Telehealth	Weight	FQHC ^c enrolled overweight black female patients	Clinic
3. Kling et al. (45), 2020 [(46)]	RCT	EHR ^e	Weight	Mothers who are eligible to receive publicly funded childcare	Clinic
4. Garg et al. (47), 2023	RCT	EHR	Social needs	Medicaid-insured healthy low-income children	Clinic, individual
5. Vaughan et al. (48), 2021	RCT	Mobile application	Diabetes	Non-profit clinic enrolled Latino adults with type 2 diabetes	Clinic
5.1 Vaughan et al. (49), 2022	Longitudinal	Mobile application	Diabetes	Non-profit clinic enrolled Latino adults with type 2 diabetes	Clinic
6. Heister et al. (50), 2014	RCT	Mobile application	Diabetes	FQHC enrolled patients with type 2 diabetes	Clinic

Study ID	Type of study	E-health type	Primary health outcome	Description target population	SEP^h selection criteria
7. Ehmer et al. (51), 2021	Quasi-experimental	EHR, video communication	Mental health	Postpartum women and their children	Clinic
8. Pyne et al. (52), 2015 [(53)]	RCT	Web application, video communication	Mental health	FQHC enrolled patients suffering from depression	Clinic
9. Bennett et al. (54), 2018	RCT	Telehealth, wearable	Weight	Patients enrolled in a private non-profit healthcare facility with obesity and elevated risk of diabetes and cardiovascular disease	Clinic
9.1 Foley et al. (55), 2016	RCT	Telehealth, wearable	Weight	Patients enrolled in a private non-profit healthcare facility with obesity and elevated risk of diabetes and cardiovascular disease	Clinic
10. Elam et al. (56), 2023 [(57)]	Cohort	EHR, web application	Glaucoma	Adults enrolled in a free clinic or FQHC	Clinic

Study ID	Type of study	E-health type	Primary health outcome	Description target population	SEP^h selection criteria
11. Simone et al. (58), 2024 [[59]]	Cross sectional	Telehealth, web application	Weight	Parents of children ages 2-12 years with elevated BMI ⁹ , enrolled in a FQHC, community health center or family medicine practice	Clinic
12. Levy et al. (60), 2021	Cross sectional	Telehealth	COVID19	People living in areas with increased social vulnerability	Area
13. Smithers et al. (61), 2024	RCT	Mobile application	Social needs	Parents at the children's ward	Clinic
14. Oldham et al. (62), 2024 [[63, 64]]	Longitudinal	Mobile application	Alcohol consumption	Adults in the UK who want to drink less	N/A
15. Castellon-Lopez et al. (65), 2024	RCT	Web application	COVID19	Latino parents and caretakers of minors living in areas with low vaccine uptake	Area
16. Thomas et al. (66), 2016	Cross sectional	Wearable	Physical activity	Church attending adult African-American women living in areas with high poverty	Area

Study ID	Type of study	E-health type	Primary health outcome	Description target population	SEP^h selection criteria
17. Griffin et al. (67), 2018	Quasi-experimental	Telehealth	Weight	Low-income, primarily overweight / obese women	Area
18. Moll van Charante et al. (68), 2024 ^a	RCT	Mobile application	Dementia	Community dwelling adults aged 55–75 years with a low socioeconomic status	Area
19. Baker et al. (69), 2021	Longitudinal	Video communication	COVID19	Residents and Medicaid-insured residents with a high risk of severe COVID complications from socially vulnerable areas	Individual, area
20. Miller et al. (70), 2023	Cross-sectional	Telehealth, wearable	Weight	Adult (>21) patients enrolled at a FQHC	Clinic
21. Collombon et al. (71), 2024	Cross-sectional	Web application, mobile application	Physical activity	Low SEP people with and without a chronic disease, aged 50 years and older in Dutch low socioeconomic neighbourhoods	Area
22. Nelson et al. (72), 2021	Longitudinal	Telehealth	Diabetes	Adults with type 2 diabetes who are public	Clinic, individual

Study ID	Type of study	E-health type	Primary health outcome	Description target population	SEP ^h selection criteria
				health insured or enrolled in safety net clinics	
23. Danila et al. (73), 2022	RCT	Video communication	Access to care	Older or public health insured patients	Area, individual
24. Bagner et al. (74), 2023	RCT	Video communication	Children's development	Caregivers who have children with developmental delay	Clinic
25. Coker et al. (75), 2022	RCT	Telehealth	Asthma	Parents from Medicaid-insured children	Individual
26. McEntee et al. (76), 2023 [[77, 78]]	RCT	Telehealth, wearable	Physical activity	Insufficiently active adults living in low and high socioeconomic neighbourhoods	Area
27. Horwitz et al. (79), 2023	RCT	Telehealth	Diabetes	Pregnant women enrolled in a safety-net healthcare setting	Clinic
28. Baggett et al. (80), 2020	Cross-sectional	Web application, video	Children's development	Mothers / adopters of babies living in a poor metropolitan area	Area

Study ID	Type of study	E-health type	Primary health outcome	Description target population	SEP^h selection criteria
		communication		attending an NICU ⁱ serving the urban poor	
29. Alcaraz, Vereen & Burnham (81), 2020	Cross-sectional	E-health enabling service	Access to care	Adults who use a support service for access to care and social support	Clinic
30. Obeid et al. (82), 2019	Cross-sectional	Mobile application	Children's development	High risk, urban children and their caregivers attending an urban community clinic	Clinic
31. Wang et al. (83), 2021	RCT	Mobile application	Family health history	Adult patients enrolled in a safety net hospital	Clinic
32. Wayne et al. (84), 2015	RCT	Mobile application	Diabetes	Patients with diabetes enrolled in primary health clinic	Clinic
33. Smith et al. (85), 2014	RCT	Mobile application web application, wearable	Weight	Adolescent boys	Area

^a Only the data concerning the United Kingdom population was included in this literature review

^b RCT: Randomized Controlled Trial

^c USA: United States of America

^d UK: United Kingdom

^e EHR: Electronic Health Record

^f FQHC: Federally Qualified Healthcare Centre

^g BMI: Body Mass Index

^h SEP: Socioeconomic Position

ⁱ NICU: Neonatal Intensive Care Unit

Description and evaluation of delivery strategies

An overview of the delivery strategies is presented in Table 2. From here onwards, the results are described per research project (n=33) and are referred to as study. First, a general description of the delivery strategies are discussed which include: the occurrence of delivery strategies and the stakeholders involved. After the general overview, a description of each delivery strategy component is presented. Followed by a description of the combinations of delivery strategy components. Finally, the studies that evaluated the reach effectivity of delivery strategies are presented.

General overview

Delivery strategies consisted mostly of three (n=10), four (n=10) or two (n=9) delivery strategy components. Less frequent were delivery strategies with five (n=3) or one (n=1) delivery strategy components. Delivery strategies were often organized with stakeholders. Healthcare organizations (n=26) were often involved in the execution of delivery strategies. Furthermore, collaborations with community partners (n=6), citizens (n=2), commercial parties (n=3), social services (n=2), government (n=3) and education (n=1) were also described.

1. Point of contact

Point of contact was used in 31 studies (42-59, 61-75, 79-85). Literature shows that research staff, healthcare professionals or healthcare organization staff were often the person that introduced participants to the e-health application or e-health enabling service (n=29) (42-59, 61-64, 67-75, 79-85). Community organizations, governmental bodies, social services and key figures were also used for e-health delivery (54-57, 62-66, 71). Invitation letters in the study from Bennett et al. were signed by the head of the healthcare clinic, a key figure in the area, for a personal approach (54, 55). Personal recruitment occurred via in-person recruitment (n=10), phone call recruitment (n=10), referrals (n=9), invitation letters (n=9), e-mail recruitment (n=4) or text message recruitment (n=1).

2. Place

Twenty-seven studies deployed their delivery strategies at places that were commonly visited by people with a low SEP (43-61, 65-70, 72-74, 79-85). Two studies recruited participants online and used location targeted social media advertisements to reach low SEP participants (71, 76-78), locations were determined via geographical deprivation indexes.

Fifteen studies executed the delivery of e-health within specific healthcare organizations that have to treat patients regardless of their insurance status, which attracts low SEP populations (43, 44, 47-59, 70, 72, 79, 80, 82, 83).

Studies reported conducting research in American safety-net hospitals, community healthcare centres, federally qualified healthcare centres, free clinics and private non-profit clinics. Three studies recruited participants during healthcare that is only available for people with a public health insurance, such as during Women, Infants and Children appointments (45, 46, 58, 59, 79). Fourteen studies delivered e-health in the following settings that were located in low SEP areas: healthcare clinics (n=10) (45, 46, 58-61, 65, 68, 69, 73, 74, 84), social service organizations (n=2) (56, 57, 67), schools (n=1) (85), and church (n=1) (66). Several studies used geographical deprivation data to first select low SEP areas before identifying study sites within the selected areas (60, 66, 68, 69, 71, 76-78, 85). Kling et al. reviewed patient data to identify the number of low SEP participants to determine that clinics were located in a low SEP area (45, 46).

3. Promotion

Fifteen studies used offline promotion (n=11) (43-46, 54-57, 60, 62-64, 66, 70-72, 74, 84), online promotion (n=8) (45, 46, 56, 57, 62-65, 71, 74, 76-78, 80) and word-of-mouth (n=3) (56, 57, 69, 71) promotional means to reach low SEP target populations. Promotion activities performed in collaboration with authorities such as healthcare professionals, well-known health services or municipalities were described (54-57, 62-66, 71, 84). Some researchers collaborated with other parties to use their advertisement outlets to improve their reach, partners reported were: municipalities from low SEP areas (71), gyms located in low SEP areas (71), the national health institute (62-64), a smoking cessation app (62-64), health or social service programs (56, 57, 66, 84) and, local community organizations (65). Furthermore, three studies reported the recruitment via family, friends or others (56, 57, 69, 71).

4. Facilitation

Facilitation of e-health use (n=16) was reported in the forms of providing education and technical support (n=11) and facilitation of devices (n=9) (47-49, 51, 60, 62-66, 69, 72, 74-78, 80, 82, 84, 85). In few studies technical support was available upon participants' request (62-64, 75). In other studies support was part of the recruitment process; participants would get educated on the use of the device and e-health application at the start of the study (47-49, 51, 60, 62-66, 69, 72, 74-78, 80, 82, 84, 85). Garg et al. included a peer patient navigator who helped participants navigate online application forms for social support (47). Baggett et al. and Baker et al. delivered support in e-health use at home, saving traveling time and overcoming logistic barriers (69, 80). Facilitation of devices (n=9) was organized to enable e-health use (51, 60, 69,

74, 76-78, 80, 82, 84, 85). I-pads, phones or laptops (n=7) and physical activity trackers (n=2) were lend out for the duration of the study.

5. Incentives

Incentivization (n=15) was applied by offering financial means, a service, or a device (43, 44, 47-50, 54, 55, 60, 62-65, 67, 69, 74-78, 81, 84). Financial incentives (n=8) were provided in the forms of stipends or gift cards, the minimum amount of financial incentive was 6\$ (62-64) and the maximum was 415\$ (76-78) (50, 62-65, 67, 74-78, 81). Four studies applied a staggered financial incentive approach, whereby participants would receive financial compensation for completion of each survey or progressive use of the e-health application (62-64, 74-78).

Studies (n=7) also offered other types of incentivization which are categorized as a service incentive (43, 44, 47-49, 60, 69, 84). These incentives are not financial but provide a service or information. Services provided were: exercise program or gym membership (43, 44, 84), a local resource guide (81), free support for social needs (47), free food, childcare and healthcare (48, 49), free Wi-Fi (60), and free healthcare (69). Bennett et al. and Griffin et al. provided devices for participants to keep: a cellular scale (54, 55, 67) and a physical activity tracking meter (67).

Combinations of delivery strategy components

The combination of the delivery strategies place and point of contact were most common in the identified literature (n=26) (43-59, 61, 65-70, 72-74, 79, 80, 82-85). In case of the studies that employed two delivery strategies components, 7 of 9 studies combined place and point-of-contact strategy components (52, 53, 58, 59, 61, 68, 73, 79, 83). The other two studies employed point-of-contact and promotion, and point-of-contact and incentive strategy components (71, 81). Delivery strategy components promotion, facilitation and incentive were employed in equal measures when studies used three or more delivery strategy components. McEntee et al. is the only study that does not deliver e-health through place nor point of contact strategies (76-78). This delivery strategy made use of promotion, facilitation and incentive strategies and used location specific online promotion activities in high and low SEP areas. Additionally, this study reported the highest maximal financial incentive of \$415 (76-78).

Point of contact strategies also combined with promotion strategies and incentive strategies

Six studies (n=6) (42, 62-64, 71, 75-78, 81) did not recruit participants via strategy component place. The majority of these studies (n=5) recruited via point of contact combined with promotion and, incentivization strategy

components (42, 62-64, 71, 75, 81). Five studies covered a greater area (municipalities to country-wide areas) (42, 62-64, 71, 76-78, 81) and four of these studies delivered e-health via authorities or well-known institutions (42, 62-64, 71, 81). Collombon et al. recruited participants living in low SEP areas via written invitations sent out from the municipality office and via online advertorials spread via gyms that were located in low SEP areas (71). Alcaraz, Vereen & Burnham studied the reach of a well-known nation-wide social service to evaluate whether this institution was a suitable avenue for recruitment of people with socioeconomic disadvantages for health disparities research (81). Three studies provided a financial incentive (62-64, 76-78, 81). Oldham et al. and McEntee et al. used theoretical underpinnings to determine the financial incentivization strategies (62-64, 76-78)

Table 2. Overview of the stakeholders, means and components of the employed delivery strategies. Studies are sorted to the number of applied delivery strategy components. The teal shaded studies are the studies that proved significance ($p<0.05$) in the evaluation of the delivery strategies' reach of low SEP participants. The lilac shaded studies are the studies that used a scientific or experiential underpinning for designing the delivery strategies. The yellow shaded studies are studies that both had a significant outcome in the evaluation of the delivery strategies' reach for low SEP participants and used an underpinning for their delivery strategy design.

Study ID	Stakeholders in delivery strategy execution	Delivery strategy activities	Type of incentive	Components delivery strategy (X)				
				Place	Point of Contact	Promotion	Facilitation	Incentive
Five delivery strategy components								
15. Castellon-Lopez et al. (65), 2024	Community, research	In-person recruitment, online promotion, support with online screening, flyers, information sessions, 40\$ gift card	Financial	X	X	X	X	X
19. Baker et al. (69), 2021	Healthcare, citizens	Location mobile health van, phone call recruitment, word of mouth,	Financial, temporal	X	X	X	X	X

Study ID	Stakeholders in delivery strategy execution	Delivery strategy activities	Type of incentive	Components delivery strategy (X)				
				Place	Point of Contact	Promotion	Facilitation	Incentive
		healthcare delivered at home, free healthcare						
24. Bagner et al. (74), 2023	Healthcare, research	Location clinic, clinic type, in person recruitment, brochures and website, facilitation of i-pad and in-ear Bluetooth device and support in setting up video meeting, max 100\$ financial incentive	Financial	X	X	X	X	X
Four delivery strategy components								
2. Steinberg et al (43), 2014 [(44)]	Healthcare, research	Invitation letters, brochures, location clinic, clinic type, 12-month gym membership	Service	X	X	X		X

Study ID	Stakeholders in delivery strategy execution	Delivery strategy activities	Type of incentive	Components delivery strategy (X)					
				Place	Point of Contact	Promotion	Facilitation	Incentive	
4. Garg et al. (47), 2023	Healthcare	Referral, free support social needs, location clinic, type clinic	Service	X	X		X	X	
5, 5.1. Vaughan et al. (48), 2021, Vaughan et al. (49), 2022	Healthcare, research	Referral, phone call recruitment, word of mouth, free food, free healthcare, clinic type	Service	X	X		X	X	
9, 9.1. Bennett et al. (54), 2018, Foley et al. (55), 2016	Healthcare, research	Invitation letter, brochure, location clinic, type clinic, free scale	Device	X	X	X		X	
12. Levy et al. (60), 2021	Healthcare, research, commercial, community	The van located where most vulnerable people live, promotion on the van, support with	Service	X		X	X	X	

Study ID	Stakeholders in delivery strategy execution	Delivery strategy activities	Type of incentive	Components delivery strategy (X)					
				Place	Point of Contact	Promotion	Facilitation	Incentive	
		digital health use, free Wi-Fi							
14. Oldham et al. (62), 2024 [(63, 64)]	Healthcare, research, commercial government	Targeted and untargeted social media advertisements, advertisement through governmental and health organizations, radio, television, e-mail recruitment of users smoking cessation application, technical support, gift vouchers of up to £36	Financial		X	X	X	X	
16. Thomas et al. (66), 2016	Community	In-person recruitment,		X	X	X	X		

Study ID	Stakeholders in delivery strategy execution	Delivery strategy activities	Type of incentive	Components delivery strategy (X)				
				Place	Point of Contact	Promotion	Facilitation	Incentive
		promotion in church and health events, incentive via physical activity trackers, training in m-health use and technical support, recruitment and intervention in local church in low SEP ^a area						
22. Nelson et al. (72), 2021	Healthcare, research	Invitation letters, referral, in-person recruitment during events and in waiting room, flyers, phone call recruitment, clinic type		X	X	X	X	

Study ID	Stakeholders in delivery strategy execution	Delivery strategy activities	Type of incentive	Components delivery strategy (X)				
				Place	Point of Contact	Promotion	Facilitation	Incentive
28. Baggett et al. (80), 2020	Healthcare, research	Location clinic, clinic type posters, interest cards, invitation letters, referral, borrowed i-phone, unlimited data, text and call plan, at home assistance at set up of application		X	X	X	X	
32. Wayne et al. (84), 2015	Healthcare, research	Phone call recruitment, e-mail recruitment, in person recruitment, free sports plan, access to borrowed phone and data plan, location clinic, type clinic	Service	X	X		X	X
Three delivery strategy components								

Study ID	Stakeholders in delivery strategy execution	Delivery strategy activities	Type of incentive	Components delivery strategy (X)				
				Place	Point of Contact	Promotion	Facilitation	Incentive
3. Kling et al. (45), 2020 [(46)]	Healthcare	In-person recruitment, phone call recruitment, clinic type, flyer, social media advertisement		X	X	X		
6. Heisler et al. (50), 2014	Healthcare, research	Invitation letters, phone call recruitment, 20\$ stipend after each assessment, location clinic, clinic type	Financial	X	X			X
7. Ehmer et al. (51), 2021	Healthcare	Phone call recruitment, referral, facilitation of space and devices for e-health use, location clinic, clinic type		X	X		X	

Study ID	Stakeholders in delivery strategy execution	Delivery strategy activities	Type of incentive	Components delivery strategy (X)				
				Place	Point of Contact	Promotion	Facilitation	Incentive
10. Elam et al. (56), 2023 [(57)]	Healthcare, social services, community, citizens	Referral, in person recruitment, phone call recruitment, social media, offline advertisement, word of mouth, location clinic, clinic type		X	X	X		
17. Griffin et al. (67), 2018	Community, government	In person recruitment, recruitment at food bank, scale, pedometer and 20\$ financial incentive	Device, financial	X	X			X
20. Miller et al. (70), 2023	Healthcare, research	Referral, e-mail recruitment, type clinic		X	X	X		
25. Coker et al. (75), 2022	Healthcare, research	In person recruitment, support in e-health use, max	Financial		X		X	X

Study ID	Stakeholders in delivery strategy execution	Delivery strategy activities	Type of incentive	Components delivery strategy (X)				
				Place	Point of Contact	Promotion	Facilitation	Incentive
		110\$ financial incentive						
26. McEntee et al. (76), 2023 [(77, 78)]	Research	Targeted social media advertisement, facilitation accelerometer, max 415\$ financial incentive	Financial			X	X	X
30. Obeid et al. (82), 2019	Healthcare, research	In person recruitment, location clinic, type clinic, facilitation i-pad		X	X		X	
31. Smith et al. (85), 2014	Research, education	Location schools, facilitation pedometer, invitation letter		X	X		X	
Two delivery strategy components								

Study ID	Stakeholders in delivery strategy execution	Delivery strategy activities	Type of incentive	Components delivery strategy (X)				
				Place	Point of Contact	Promotion	Facilitation	Incentive
8. Pyne et al. (52), 2015 [(53)]	Healthcare, research	Referral, location clinic, clinic type		X	X			
11. Simone et al. (58), 2024 [(59)]	Healthcare	Referral, location clinic, clinic type		X	X			
13. Smithers et al. (61), 2024	Healthcare	Location clinic, in person recruitment		X	X			
18. Moll van Charante et al. (68), 2024	Healthcare	Invitation letter, text message recruitment, location clinic		X	X			
21. Collombon et al. (71), 2024	Government, commercial, research	Invitation letter, e-mail recruitment via affiliated gyms, social media promotion via affiliated gyms'		X	X	X		

Study ID	Stakeholders in delivery strategy execution	Delivery strategy activities	Type of incentive	Components delivery strategy (X)				
				Place	Point of Contact	Promotion	Facilitation	Incentive
		outreach channels, targeted social media advertisements						
23. Danila et al. (73), 2022	Healthcare, research	Phone call recruitment, location clinic		X	X			
27. Horwitz et al. (79), 2023	Healthcare	Phone call recruitment, location clinic, clinic type		X	X			
29. Alcaraz, Vereen & Burnham (81), 2020	Research, social services	Infrastructure for recruitment that is known among low SEP populations, phone and online recruitment, 15\$ financial incentive and online local resource guide	Financial, service		X			X

Study ID	Stakeholders in delivery strategy execution	Delivery strategy activities	Type of incentive	Components delivery strategy (X)				
				Place	Point of Contact	Promotion	Facilitation	Incentive
31. Wang et al. (83), 2021	Healthcare, research	Invitation letter, clinic type		X	X			
One delivery strategy components								
1. Staples et al. (42), 2022	Healthcare, citizens	Referral, self-referral			X			

^aSEP: Socioeconomic Position

Evaluation of delivery strategies' reach and reach effectivity

An overview of the twelve studies that evaluated the effectiveness of reach of the delivery strategies can be found in Table 3. Four studies presented descriptive statistics about the effectivity of reach (58, 59, 62-64, 69, 80). Eight studies conducted statistical analysis to determine whether delivery strategies were effective in reach (42, 47, 51, 56, 57, 60, 70, 71, 81). The majority of these studies (n=7) showed statistical significance and provided evidence for reach effectivity (42, 47, 56, 57, 60, 70, 71, 81). Studies were deemed significant if there was a $p < 0.05$ outcome for differences in reach between included conditions in the study. Delivery strategies containing the following delivery strategy components were evaluated: point of contact (42, 47, 51, 58, 59, 80), promotion (56, 57, 62-64, 70, 71, 81), place (56, 57, 60, 69), and facilitation (51). Significant evidence was found in the delivery strategy components point-of-contact (n=2) (42, 47), place (n=1) (56, 57) and promotion (n=4) (56, 57, 70, 71, 81). There were no evaluation studies that evaluated incentive delivery strategies. Elam et al. and Ehmer et al. both performed two evaluations (51, 56, 57). In Table 3 these evaluations are referred to as StudyID 7 and 7a, and, 10 and 10a (51, 56, 57).

1. Point of contact

Five studies evaluated point of contact delivery strategies which concern the role of a healthcare professional and the organization of their work processes (42, 47, 51, 58, 59, 80). Staples et al. compared the reach of self-referral and physician-led referral to two similar online mental health treatment websites (42). The self-referral website was well-known among the public. Physicians were trained to identify low SEP status of patients and refer these patients to the website. Physician-led referral significantly reached more people with a lower education ($X^2 = 321.8$, $p < 0.001$), less likely to be employed ($X^2 = 145.6$, $p < 0.001$) and living in a disadvantaged area ($X^2 = 173.2$, $p < 0.001$) compared to self-referral (42).

Task allocation and organization of personnel in healthcare contexts are relevant in reach of low SEP populations. Garg et al, Simone et al., and Baggett et al. compared differences in the e-health referrals (47, 58, 59, 80). Garg et al. showed that clinics with social needs screening and extra personnel that support patients with digital health use showed significantly more referrals (OR 4.6 95CI 2.0-5.9) (47). Descriptive analysis from Simone et al. showed that medical assistants were more consistent and reached more patients compared to physicians (54% compared to 17% or 12%) in following up with an e-health referral (58, 59). Baggett et al. compared a gatekeeper referral approach vs open and shared referral approach in three similar neonatal intensive care units.

The clinic adopting the latter approach had 13 referrals/quarter, clinics adopting a gatekeepers approach had 4.2 and 3.4 referrals/quarter (80).

2. Place

Elam et al., Levy et al., and Baker et al. evaluated place delivery strategies (56, 57, 60, 69). Elam et al. showed that the free clinic recruited significantly more patients without a medical insurance compared to the federally qualified healthcare centre (FQHC) (47.8% vs. 7.8%, respectively; $P < 0.0001$) (56, 57). Clinic phone call recruitment significantly recruited more patients in the FQHC (6.5% vs. 49.8%, respectively; $P < 0.0001$) (56, 57). Community based strategies were significantly more effective in the free clinic: recruitment by a non-medical staff member (24.6% vs. 4.5%; $P < 0.0001$), a flyer outside the clinic (10.7% vs. 2.1%; $P < 0.0001$), or the clinics website or social media (7.3% vs. 0.7%; $P < 0.0001$) (56, 57). Furthermore, the FQHC patients with diabetes were actively approached for a glaucoma screening. The authors noted that diabetes patients may be more motivated to attend the glaucoma screening and are more likely to have a public health insurance (56, 57).

Levy et al. and Baker et al. used multiple databases to identify low SEP individuals (69) or regions (60) and used a mobile health van to deploy e-health at home (69), or in the community (60, 69). Results by Levy et al. showed that a mobile health van was more effective in reaching citizens living in low SEP neighbourhoods compared to a permanently located drive through location (25% vs 27%, $p=0.01$) (60). After introducing the determination of mobile health vans locations based on real-time COVID-19 prevalence, socioeconomic status of the area and, disease burden, a significant positive trend in reaching low SEP populations ($P>0.001$) was found (60). Baker et al. described that home visits with the mobile van was less successful in reaching Medicaid-insured citizens with a high risk of severe COVID complications than a permanent health facility location within the low SEP area (69).

3. Promotion

Five studies evaluated the differences in the reach of low SEP participants between offline and online promotion strategies (56, 57, 62-64, 70, 71, 81). Elam et al, Miller et al., and Alcaraz, Vereen & Burnham showed similar significant results; offline promotion strategies are more effective compared to online promotion strategies. Miller et al. showed that outreach via e-mail is significantly less effective for people with a high school degree (14%) compared to some college (35%) or college degree (38%) ($P<0.0001$) (70). Alcaraz, Vereen & Burnham found that people with higher educational attainment (OR 2.17, 95% CI 1.67-2.82), higher income (OR 2.02, 95% CI 1.56-2.61) and who are not publicly insured (OR 0.75, IC95 0.62-0.90) were more often recruited

via digital recruitment compared to telephone call recruitment (81). In the study from Elam et al. participants without medical insurance reported hearing about the program more often directly from a clinic doctor (23.9% vs. 2.8%; Holm-adjusted $P < 0.0001$) or nonmedical staff (34.4% vs. 16.7%; Holm-adjusted $P = 0.0011$) (56, 57). Participants who had medical insurance significantly heard more often about the program via a friend, a flyer outside the clinic, the clinic website or social media or other (56, 57).

Collombon et al. aimed to recruit older low SEP citizens using the outreach avenues from the municipality and gyms located in low SEP areas (71). Significantly more low-educated participants were reached via personal invitation letters that were sent out by the municipality ($N = 128/281$, 45.6%) compared to the online newsletters and social media advertisements from gyms ($N = 8/45$, 17.8%) and regular social media advertisements ($N = 9/71$, 12.7%) ($\chi^2 = 50.429$, $P < .001$). Descriptive outcomes from Oldham et al. also show that promotion via well-known health institutes such as the British National Health System (NHS) website was more successful in reaching low SES participants compared to other promotion avenues (62-64).

4. Facilitation

Ehmer et al. evaluated a facilitation delivery strategy (51). In this study no differences were found between the population's public insurance status before and after implementation of safe spaces and devices at the clinic for mothers to enable access to their video consultation calls (51).

Underpinning of delivery strategies

Review of literature and consultations of stakeholders were used in studies ($n=10$) for the design of implementation strategies or to identify and operationalize delivery strategies (48, 49, 56-59, 62-66, 71, 76-78, 80, 82). Other studies ($n=23$) did not report motivations for chosen delivery strategy designs. Scientific ($n=5$) (48, 49, 71, 76-78, 82), experiential ($n=1$) (65) or scientific and experiential ($n=4$) (56-59, 62-64, 66, 80) underpinnings were used. Researchers that used scientific publications for the design of delivery strategies consulted their own prior work ($n=6$) (48, 49, 56-59, 66, 71, 76-78), findings of other researchers ($n=6$) (48, 49, 58, 59, 62-64, 76-78, 80, 82) or theory ($n=2$) (58, 59, 76-78). The literature and experiential knowledge from stakeholders were used for the design of implementation strategies and operationalization of delivery strategies.

Several researchers ($n=4$) consulted literature and involved stakeholders to improve the implementation strategy design (56-59, 65, 66, 80). In these studies, the literature and stakeholders had influence on a tactical level,

informing researchers' methods for implementation of e-health interventions in specific contexts. Elam et al. and Thomas et al. had a permanent community advisory board that would advise the research team on recruitment and retainment strategies (56, 57, 66). Simione et al. were the only researchers using an implementation theory (58, 59). The Consolidated Framework for Implementation Research (CFIR) (86) guided the researchers on how to engage stakeholders (families, healthcare professionals, and hospital leadership) and tailor the implementation strategies to suit the intervention context (58, 59). Baggett et al. designed e-health referral processes and the according implementation strategies with healthcare professionals in three neonatal intensive care units (80). The use of dissemination and implementation literature was mentioned but not specified (80).

Literature and stakeholders were used for identification and operationalization of delivery strategies in all the studies that reported a scientific and/or experiential underpinning (n=10) (48, 49, 56-59, 62-66, 71, 76-78, 80, 82). Literature and stakeholders were involved on a operational level, informing the researchers how to execute their delivery strategies. Researchers reviewed literature that described delivery strategies for similar interventions (58, 59, 62-64, 80, 82) or articles that discussed researchers' learnings regarding delivery strategies for people with a low SEP (48, 49, 76-78). Collombon et al., Vaughan et al. and McEntee et al. reviewed their prior work to other interventions to determine the best outreach strategies for people with a low SEP (48, 49, 71, 76-78). Stakeholders and literature were consulted for the content of promotional activities (56, 57, 62-66, 71). Co-development of advertorials with target population or target population representatives was done to overcome language and cultural barriers. Literature was used to inform incentivization delivery strategies (48, 49, 62-64, 76-78). McEntee et al. referred to the behavioural choice theory (87) to inform financial incentivization strategies (76-78).

Researchers' reflections upon delivery strategies

Only authors (n=10) that evaluated delivery strategies provided additional reflections upon delivery strategies (47, 56-59, 62-64, 69-71, 80, 81). Five authors reflected on the importance of the integration of e-health in the practice and culture healthcare organizations (47, 58, 59, 70, 80). It was noted that clear task allocation for referral, stakeholder engagement within the healthcare organization, training of healthcare professionals, championship by designated employees, and technical and work process integration was deemed important for successful delivery of e-health (47, 58, 59, 70, 80). Other studies underlined the role of non-medical professionals in healthcare contexts (47, 56, 57). Garg

et al. concluded that the presence of social workers who supported patients in e-health use increased the number of referrals to e-health and support by physicians (47). Elam et al. reflected upon the different reach effectivity outcomes between a free clinic and a FQHC while employing similar promotion strategies. Free clinics is the only clinic type that serve illegal citizens or American citizens who have a green card for less than five years, whereas FQHCs serve citizens who are eligible for a public health care insurance (56, 57). Patients in free clinics were recruited more often via non-medical staff such as translators who explained the intervention to people with limited English language skills (56, 57).

Several authors reflected upon culturally-, skill- or need adapted, personal, and prolonged delivery strategy approaches (56, 57, 62-64, 69-71, 81). Elam et al, Miller et al., and Oldham et al. mentioned the importance of the use of culturally and language adapted (56, 57, 70) and literacy skill adapted (62-64) promotional and information materials in their research. Alcaraz et al. suggested that profiling of socio-economic groups' needs and channel use in social service and other recruitment settings could improve recruitment strategies (79). Baker et al. and Collombon et al. noted reflections concerning the personal approaches employed during e-health delivery (69, 71). Baker et al. observed that attempts to organize at-home appointments during COVID-19 pandemic scared potential participants as they were afraid of contracting COVID-19 and allowing unfamiliar people at home (69). Collombon et al. found that personal invitation letters sent out by the municipality contributed to higher participation rates, additionally recruitment via family and friends was reported, which was a recruitment strategy that evolved during the study (71). Collombon et al. suggested that both recruitment strategies should be investigated further. Baker et al. and Oldham et al. noted cumulation of participant recruitment due to long periods of promotional activity (62-64, 69). Oldham et al. advises the use of multiple recruitment methods, including targeted approaches for underrecruited groups and monitoring of the demographic composition during the recruitment phase (62-64). Additionally, Oldham et al. stated that people with a low SEP via general practitioners was promising but limited in their study due to COVID-19 lockdowns (62-64).

Table 3. Overview of the studies (n=12) that evaluated delivery strategies. Outcomes of evaluations are categorized upon the delivery strategy components. Studies were deemed significant if there was a $p < 0.05$ outcome for differences in reach. between included conditions in the study. Elam et al. and Ehmer et al. both performed two evaluations, these evaluations are referred to as StudyID 7 and 7a, and, 10 and 10a.

Study ID	Statistical analysis methods	Aim evaluation	Number of participants (total, and if applicable intervention, control or before, after)	Outcome	Outcome significant (yes/no)
Point of contact					
1. Staples et al. (42), 2022	Descriptives, chi-square, ANOVA	Difference in socioeconomic status of the patient population between physician-led referred patients and self-referred patients	Total: 9002 Physician-led referral): 4848 Self-referral: 4154	Physician-led referred patients were less likely to have a tertiary education and less likely to be employed. These patients were more likely to reside in urban regions, and in areas of higher socioeconomic disadvantage. Differences in education ($X^2 = 321.8$, $p < 0.001^{***}$), employment ($X^2 = 145.6$, $p < 0.001^{***}$) and IRSD ^a ($X^2 = 173.2$, $p < 0.001^{***}$).	Yes

Study ID	Statistical analysis methods	Aim evaluation	Number of participants (total, and if applicable intervention, control or before, after)	Outcome	Outcome significant (yes/no)
4. Garg et al. (47), 2023	Descriptives, generalize mixed-effects models	Difference in number of referrals to online social need resources between clinics that provide social needs screening and, e-health support and control clinics	Total: 878 Intervention: 524 Control: 354	Families at intervention clinics received significantly more referrals to online social need resources than families in control clinics (43.1% vs 1.9%; OR 4.6; 95% CI, 2.0–5.6).	Yes
7a. Ehmer et al. (51), 2021	Descriptives, Chi-square, t-test	Differences in patients' insurance status between before and after the implementation of video consultations	Total: 1195 Before: 397 After: 798	There were no statistically significant differences in the distribution of insurance status.	No
11. Simone et al. (58), 2024 [(59)	Descriptives	Differences in number of referrals to an e-health weight management application after best practice alert between medical assistant initiated referral (Denver) and	Total: 18,333 Denver: 8480 (46%) MGH: 6190 (34%)	Medical assistant initiated referral (Denver Health) showed the most consistent follow-up from the intervention to e-health weight management application referral. After the intervention alert, for 5073/8480 (60%) of the patients	N/A

Study ID	Statistical analysis methods	Aim evaluation	Number of participants (total, and if applicable intervention, control or before, after)	Outcome	Outcome significant (yes/no)
		physician initiated referral (MHG and Prisma)	Prisma: 3663 (20%)	action was taken, resulting in use of the tool kit by medical assistants for 4938/8480 (58%) of the patients and weight management application order for 4553/8480 (54%) of the patients. In physician initiated referral less follow up was observed (MHG 2545/6190, 41%, Prisma 1100/3663, 30%). Decline in both tool kit use (1007/6190, 16%) by physicians and referral to weight management application (1074/6190, 17%) was observed in MHG. Tool kit use (1146/3663, 31%) was equal to initial follow-up in Prisma, however referral to weight management application	

Study ID	Statistical analysis methods	Aim evaluation	Number of participants (total, and if applicable intervention, control or before, after)	Outcome	Outcome significant (yes/no)
				was applied in 423/3663 (12%) of all Prisma patients.	
28. Baggett et al. (80), 2020	Descriptives	Difference in number of referrals between gatekeeper referral strategy (site 1 and 2) and shared referral strategy (site 3)	Total: 86	Gatekeeper referral strategies had a lower mean quarterly rate of 4.2 (Site 1) and 3.4 (Site 2) referrals per quarter compared to the shared referral strategy (site 3) which resulted into a quarterly rate of 13 referrals per quarter.	N/A
Promotion					
10. Elam et al. (56), 2023 [(57)]	Descriptives, post-hoc Tukey-adjusted pairwise comparisons, Chi-square,	Differences in population's insurance status between a free clinic and a federally qualified healthcare center (FQHC) and outreach strategies	Total: 647 Free clinic: 356 FQHC: 291	Participants who had medical insurance compared to those who did not, a larger percentage reported hearing about the program from a friend (26.7% vs. 12.9%; Holm-adjusted $P = 0.0074$), a flyer outside the clinic (16.1% vs. 4.9%; Holm-adjusted $P = 0.0050$), the clinic website or social media	Yes

Study ID	Statistical analysis methods	Aim evaluation	Number of participants (total, and if applicable intervention, control or before, after)	Outcome	Outcome significant (yes/no)
	Fisher exact tests, post-hoc Holm-adjusted pairwise comparisons			(11.1% vs. 2.5%; Holm-adjusted P = 0.0092), or from a source reported as "Other" (13.3% vs. 5.5%; Holm-adjusted P = 0.0428). Alternatively, a larger percentage of those without medical insurance compared to those with medical insurance reported hearing about the program from a clinic doctor (23.9% vs. 2.8%; Holm-adjusted P < 0.0001) or nonmedical staff (34.4% vs. 16.7%; Holm-adjusted P = 0.0011).	

Study ID	Statistical analysis methods	Aim evaluation	Number of participants (total, and if applicable intervention, control or before, after)	Outcome	Outcome significant (yes/no)
14. Oldham et al. (62), 2024 [(63, 64)]	Descriptives	Differences in reach of low SES participants between outreach strategies	Total: 5602	In total, 1451/5602 (25.9%) low SES participants were recruited. Recruitment via the National Health Service website (570/1961 (29.07%)), word of mouth (41/142 (28.87%)), and Google (50/159 (31.45%)) showed the highest percentage of low SES participant recruitment. However, both Google (159/5602, 2.84%) and word of mouth (142/5602, 2.53%) recruited a small proportion of participants in total. The National Health Service website (n=570), untargeted social media (n=507), and radio or newspapers (n=167) recruited most low SEP participants in absolute terms.	N/A

Study ID	Statistical analysis methods	Aim evaluation	Number of participants (total, and if applicable intervention, control or before, after)	Outcome	Outcome significant (yes/no)
20. Miller et al. (70), 2023	Descriptives, Chi-square, t-tests	Differences in reach between in-person recruitment, e-mail recruitment or a combined recruitment approach	Total: 848 In-person: 478 E-mail: 208 Combined: 162	People with some college education or a college degree were significant more likely to be recruited via e-mail recruitment compared to those with a high school education (38 and 35% vs. 14%, $p < 0.0001$).	Yes
21. Collombon et al. (71), 2024	Descriptives, Chi-square, ANOVA	Difference in reach of low socioeconomic participants between outreach strategies from municipalities, gyms, social media and word-of-mouth	Total: 407 Municipality: 281 Gyms: 45 Social media: 71 Family & friends: 10	In total, more low- (N = 150, 36.9%) and middle educated participants (N = 149, 36.6%) were reached than high-educated participants (N = 108, 26.5%). Significantly more low-educated participants were reached via the municipality (N = 128, 45.6%) than via gyms (N = 8, 17.8%) and social media (N = 9, 12.7%) ($\chi^2 = 50.429$, $P < .001$).	Yes

Study ID	Statistical analysis methods	Aim evaluation	Number of participants (total, and if applicable intervention, control or before, after)	Outcome	Outcome significant (yes/no)
29. Alcaraz, Vereen & Burnham (81), 2020	Descriptive, Chi-square, t-tests, multivariable binary logistic regression	Differences in education, income and public insurance status between patients recruited via phone-recruitment and digital recruitment.	Total: 3293 Phone: 1907 E-mail: 28 Web-based chat: 371 Text message: 494 Website: 493	Respondents who were recruited via phone calls were more likely than respondents recruited by digital channels to have less educational attainment (310 (16.26%) VS 120 (8.66%), $p<0.001$), have less income (798 (41.85%) VS 424 (30.59%), $p<0.001$) and more likely to have public health insurance (947 (49.66%) VS 519 (37.45%), $p<0.001$). The odds of having a higher education (OR: 2.17, 95% CI 1.67-2.82), income (OR: 2.02, 95% CI 1.56-2.61) and other insurance than public insurance (OR: 0.75, 95% CI 0.62-0.90) is higher for those recruited via digital recruitment strategies.	Yes

Study ID	Statistical analysis methods	Aim evaluation	Number of participants (total, and if applicable intervention, control or before, after)	Outcome	Outcome significant (yes/no)
Place					
10a. Elam et al. (56), 2023 [(57)]	Descriptives, post-hoc Tukey-adjusted pairwise comparisons, Chi-square, Fisher exact tests, post-hoc Holm-adjusted pairwise comparisons	Differences in reach between community- and clinic-based outreach strategies between a free clinic and a federally qualified healthcare center (FQHC)	Total: 647 Free clinic: 356 FQHC: 291	Community-based recruitment was more effective in the free clinic compared to the FQHC, community-based recruitment counted for 72.6% of the recruited patients in the free clinic versus 31.6% of the recruited patients in the FQHC. Community outreach resulted in 265% additional recruitment in the free clinic and 46% additional recruitment in the FQHC. The free clinic recruited significantly more patients without a medical insurance compared to the	Yes

Study ID	Statistical analysis methods	Aim evaluation	Number of participants (total, and if applicable intervention, control or before, after)	Outcome	Outcome significant (yes/no)
				FQHC (47.8% vs. 7.8%, respectively; $P < 0.0001$). Clinic phone call recruitment significantly recruited more patients in the FQHC (6.5% vs. 49.8%, respectively; $P < 0.0001$). Community based strategies were significantly more effective in the free clinic: recruitment a non-medical staff member (24.6% vs. 4.5%; $P < 0.0001$), a flyer outside the clinic (10.7% vs. 2.1%; $P < 0.0001$), or the clinics website or social media (7.3% vs. 0.7%; $P < 0.0001$).	

Study ID	Statistical analysis methods	Aim evaluation	Number of participants (total, and if applicable intervention, control or before, after)	Outcome	Outcome significant (yes/no)
12. Levy et al. (60), 2021	Chi-square and the Cochrane Armitage test	Comparison in reach of citizens living in vulnerable communities between three consecutively executed COVID-19 testing interventions: drive through, a mobile van and a mobile van located based upon on data-driven location determination.	Total: 32:523	The permanent drive through (method A) testing site was least effective in recruiting people living in low socioeconomic neighbourhoods (25% of the recruited population) followed by the use of the mobile COVID-19 health unit (method B) where location was determined via COVID-19 prevalence data only (27% of recruited population). The mobile COVID-19 health unit in combination with determination of the location of the mobile COVID-19 health unit based upon socioeconomic, disease burden and real time COVID-19 prevalence data (method C) was most effective for recruiting people	Yes

Study ID	Statistical analysis methods	Aim evaluation	Number of participants (total, and if applicable intervention, control or before, after)	Outcome	Outcome significant (yes/no)
				who live in low socioeconomic neighbourhoods (41% of total recruited population). The drive-through approach was significantly less effective compared to mobile unit ($p=0.01$). The Cochrane Armitage test for trends shows significant improvement in recruitment of people who live in low socioeconomic neighbourhoods, sequentially from method A to C ($p<0.001$).	
19. Baker et al. (69), 2021	Descriptives	Differences in reach of identified Medicaid insured citizens with a high risk of COVID-19 morbidity between a COVID-19 mobile health van approach and a	Total: 316 Mobile health van: 156 Permanent facility: 160	Participants in the pilot totalled 316 out of an initial contact list of 720 eligible high risk community residents. The mobile health van reached 156/720 (21.7%) of the high risk residents. By week five of this initiative, when screening	N/A

Study ID	Statistical analysis methods	Aim evaluation	Number of participants (total, and if applicable intervention, control or before, after)	Outcome	Outcome significant (yes/no)
		permanently located COVID-19 health facility		shifted largely to a permanent COVID-19 facility. In the last two weeks of the intervention, the permanent location reached 160/720 (22.2%) of the high risk residents.	
Facilitation					
7. Ehmer et al. (51), 2021	Descriptives, Chi-square, t-tests	Before and after implementation of COVID-19 safe spaces and devices for video consultations	Total: 74 Before: 33 After: 41	There were no significant differences in the insurance status of patients recruited before and after implementation of video consultations.	No

^aIRSD: Statistics Index of Relative Socio-economic Disadvantage

Discussion

This review presented an overview of e-health delivery strategies aimed at engaging individuals with a low socioeconomic position (SEP). We used an *a priori* adjusted version of the marketing mix model to define the mechanisms of delivery strategies (34). The adjusted model defines five delivery strategy components: place, point of contact, promotion, facilitation and incentive. Almost all delivery strategies identified in this review consisted of more than one delivery strategy component. Place and point of contact were the most often used and combined delivery strategy components. Those studies that evaluated their delivery strategies revealed that place, point-of-contact and, promotion strategy components can have a significant effect on reach effectivity. E-health delivery in settings commonly accessed by people with a low SEP, offline promotion and recruitment through trusted authorities, proved to be more effective compared to, respectively, delivery in less familiar settings, online promotion and recruitment through organizations and people with less authority or self-recruitment. Evidence and researchers' reflections also suggests that adoption of e-health and e-health delivery strategies by healthcare professionals and organizations are relevant in reaching people with a low SEP. Nevertheless, the evidence available is insufficient and too scattered to state solid conclusions. Additionally, most studies were e-health intervention studies, implying that delivery strategies were used for recruitment in a research context, which is different from e-health delivery in a real life context.

Our results show that delivery strategies often consist of multiple components, of which place and point-of-contact delivery strategy components are employed and combined most often. The location, person and medium through which e-health delivery takes place is important for strategies to be effective. The importance of the delivery of health interventions in contexts and by people that are familiar for people with a low SEP is also found in other studies (20, 23, 88, 89). Bonevski's (2014) literature review finds that in clinical trials low SEP participants were often sampled via location or network targeted sampling or through community organizations (88). For recruitment, researcher – community partnerships and health professional support for the study were often employed in recruitment (88). A literature review by Al-Dhahir et al. focused on the barriers and facilitators of eHealth-based lifestyle intervention programs for people with a low SEP. Al-Dhahir described that personal e-health delivery was most promising in reaching people with a low SEP (20). Successful delivery of e-health to people with a low SEP involves understanding and tailoring delivery strategies to the context of people with low SEP.

The lack of real-world evaluations limits understanding of the feasibility and effectiveness of e-health delivery strategies. Most findings in this review are based on RCTs, which differ significantly from real-world contexts in terms of implementation and delivery (90). Limited digital health skills and limited access to devices are main barriers in e-health access and use and is often associated with people with a low SEP (8, 91-95). Understanding how to deliver e-health to people with limited digital health skills and limited access to devices is crucial for equitable access to digital health. E-health evaluation studies often address barriers such as limited material access or digital skills, however this does not always reflect real-world feasibility. Some studies exclude individuals with low digital literacy or limited access to devices, preventing insight into whether the delivery strategies are effective for this population. Others provide devices and technical support to facilitate participation, but this may inflate the apparent effectiveness of delivery strategies, as such support might not be feasible outside of funded trials. RCTs with larger budgets are more likely to overcome recruitment challenges and avoid early termination (96). These studies are more likely to be published, potentially skewing the evidence base toward strategies that are resource-intensive and less generalizable. This creates a biased understanding of what works in both trial and real-world settings. Gitlin and Czaja argue that findings from real-world contexts are essential to inform future intervention research, enhancing the ecological validity of outcomes (97). Future research should therefore assess the reach and retention of implemented e-health applications and enabling services, to better understand which delivery strategies are effective, for whom, and under what conditions. These insights can guide both future research and practical implementation efforts.

Effectivity of e-health delivery strategies was studied via reported effectivity, scientific and experiential underpinnings and researchers' reflections upon delivery strategies. The results point towards the importance of the implementation of e-health in health organizations. Other scholars describe that adoption of e-health by professionals and organizations is crucial for patients' access to e-health (98-100). According to Schiffelaar et al. (2025) a digital health transition in hospitals requires cultural, practical, political, and financial alignment throughout the organization, high-qualitative technical solutions that integrate within technical infrastructures and opportunities for staff and patients to access resources and training for e-health access and use (99). The Nonadoption, Abandonment, Scale-up, Spread and Sustainability (NASSS) framework by Greenhalgh et al. and the Consolidated Framework for Implementation Research (CFIR) by Damschroder et al. describe the importance of the context of direct end-users and the organizations' capacity

and readiness to implement, change, and innovate for successful and sustainable implementation of interventions (86, 100). Design thinking methods such as co-creation, prototyping and human-centred design are often used in digital health intervention research with the aim to involve end-users and the context to improve the intervention (101). However, Bodell et al. finds that researchers involve stakeholders to address health outcomes and user-friendliness of interventions but fail to involve stakeholders in later phases of implementation; the embedding in the organizational context and in patients' lives (101). Bodell's findings align with the results in our review; five studies consulted stakeholders and one study consulted implementation theory for the design of delivery strategies. Future research should consider involvement of direct end-users, that include patients, staff, caregivers and healthcare professionals, and organizations in the design of delivery strategies.

The majority of the studies were conducted in the United States (US). The US healthcare system has specific safety-net clinics or not-for-profit clinics that only serve those who live in disadvantaged circumstances (102, 103). The high poverty rate and the limited access to healthcare in the US cause people with a low SEP to frequent these clinics, providing a model setting for the delivery of e-health (102-104). The learning from these findings is that delivery of e-health to people with low SEP in specific low SEP (healthcare) contexts can be effective. This setting is, however, unique for the US healthcare system and results might be less generalizable to other countries and other healthcare systems. This poses the question whether other countries can identify similar places or adhere to other methods to reach people with a low SEP. Insights in how e-health is effectively delivered to people with low SEP in other countries and other healthcare systems is needed to inform research and practice in e-health delivery in other settings.

This literature review has strengths and limitations. A strength of this study was that we searched multiple databases to ensure the identification of all potential relevant articles. Furthermore, the results of this study allowed for a detailed overview of the delivery strategies used specifically to reach people with a low SEP. Additionally, articles were screened and selected by the primary author and two secondary reviewers independently to minimise selection bias. A limitation of this study was the absence of grey literature. We expect that different delivery strategies have been tested in practice but have not been published in scientific literature, bearing findings that were not discussed or documented in scientific literature. Additionally, the critical appraisal showed risk for selection bias. Critical appraisals are constructed to appraise evaluation studies that evaluate medication treatments in which blinded approaches for

both patient and administrator are highly valued and feasible via placebo medications. Blinded approaches are not feasible in e-health evaluation studies; therefore, critical appraisal scores are less high.

Implications and future research

This literature review reveals a knowledge gap in what the mechanisms of delivery strategies are and how these strategies can support e-health introduction for people with a low SEP in real world contexts. Although the current literature provides valuable insights, the evidence available is insufficient to create a solid understanding, and by extension theory, about the mechanisms of delivery strategies. There are too few studies that have evaluated delivery strategies and studies evaluated different delivery strategies in a variety of contexts, study designs and e-health interventions. Additionally, there are no or very few studies that evaluated delivery strategies that had facilitation or incentive components; even though, almost half of delivery strategies employed these components. There was only one paper describing delivery of e-health enabling services. Other research underlines the importance of providing resources for low SEP populations to enable participation (105, 106), which provides an argument to study the reach of facilitation and incentive e-health delivery strategies and evaluate the reach of e-health enabling services. Future research should aim to create a greater understanding of mechanisms of e-health delivery strategies in real world settings.

Successful e-health interventions consist of an effective and accessible application and an inclusive implementation strategy. Adjustments of delivery strategies to the context of people with a low SEP requires effort but is vital for recruitment and retention (23, 28, 88, 107). Andersen (1995) argues that the adaptability of populations' abilities to access healthcare are low and that healthcare services should be designed and implemented in differentiated ways to realize equitable access for different groups (107). Additionally, e-health implementation strategies need to consider the professional and organizational context. Bodell et al. argue that the field of e-health implementation should draw upon both positivist and constructivist epistemologies (101). Health science traditionally adopts a positivist approach, aiming to assess the effects of interventions through systematic, rigorous methods that seek to minimize contextual influences or bias. In contrast, implementation science is grounded in a constructivist perspective, focusing on understanding how context shapes both the implementation process and the effectiveness of interventions (101). Successful e-health interventions require the integration of knowledge from both paradigms. Future e-health intervention research should therefore

conceptualize implementation as an integral part of the intervention itself and place greater emphasis on understanding the influence of end-user, professional, and organizational contexts.

Results show limited use of scientific and experiential underpinnings, and few reflections upon employed delivery strategies. Although there is emphasis on equitable recruitment of people with a low SEP in health research, multiple literature reviews found that authors report too little about delivery strategies (88, 89, 104, 108). Similarly to our literature scholars found that authors lack in report about the design of delivery strategies, lack in performing statistical analysis and scarcely share reflections upon whether the delivery strategy was successful (88, 89, 104, 108, 109). All papers that evaluated an e-health delivery strategy were published after 2020, this might indicate that e-health delivery and reach is becoming an increasingly relevant topic within the field of digital health. To maximize future knowledge synthesis, future research should adhere to systematic reporting and evaluations concerning delivery strategies to create a stronger knowledge base.

Conclusion

There remains a significant knowledge gap regarding which delivery strategies are most effective in reaching individuals with low socio-economic positions (SEP) via e-health interventions in real-world contexts. Among the various components of delivery strategies, place and point-of-contact are the most frequently employed and combined. The majority of the literature focuses on e-health delivery strategies within clinical trial settings, with limited reporting on the use of scientific or experiential knowledge in the design of these strategies. Existing evaluation studies provide some evidence supporting the effectiveness of place, point-of-contact, and promotion strategies in reaching low SEP populations. Still, this evidence is insufficient and too scattered to state solid conclusions in terms of reach effectivity. Despite these limitations, the current body of evidence offers a valuable foundation for further exploration and evaluation of delivery strategies. We are at the beginning of opening up a new area of research. The success of equitable e-health interventions depends on the effectiveness of e-health applications and inclusive and context-sensitive implementation strategies - including delivery strategies. Given the tremendous pace at which healthcare access and use is becoming dependent on e-health, there is a great urgency to develop this area of research. Researchers are encouraged to view implementation as an integral component of the intervention and should consider how the contexts of end users, healthcare professionals, and organizations shape the delivery and uptake of e-health

interventions. Future research should aim to understand the mechanisms by which e-health delivery strategies can effectively engage people with low SEP across diverse healthcare systems and real-world conditions.

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and materials

Included papers, the extracted data, critical appraisal and a list of all the articles that were included for full-text screening can be found in the Supplementary file 3.

Competing interests

The researchers report no conflict of interest.

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Authors' contributions

LMBS contributed to the conception, the design of the literature review, the analysis and interpretation of data and the writing of the paper. RvdV, RDF and LHDvT contributed to the conception and the design of the literature review and provided extensive feedback. KL provided extensive feedback. All authors approve of the submitted version.

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Appendices

Appendix 1 - Description of pilot testing, development of search term and final search term

First, a broader e-health search term was tested but was found too broad and inaccurate to answer the research question. Appropriateness of the search term was tested by reviewing the first 100 entries of the search output. Search string was found too broad as many articles were found that were not digital health related, but involved the use of a computer, SMS and equivalent commonly used device or service either as the study subject or as part of the study design.

Abstract/Title: "telemed*" OR "telecommunication" OR "telehealth" OR "tele-health" OR "tele health" OR "telecare" OR "tele-care" OR "tele care" OR "electronic health" OR "electronic healthcare" OR "eHealth" OR "telemonitoring" OR "m-Health" OR "e-Health" OR "mobile health" OR "mobile healthcare" OR "mHealth" OR "mobile phone" OR "cell phone*" OR "cellular phone*" OR "wearable" OR "smartphone" OR "smart phone*" OR "mobile technology" OR "wireless" OR "internet intervention*" OR "internet-based" OR "computer-based*" OR "web-based" OR "website*" OR "app" OR "apps" OR "digital health" OR "digital healthcare" OR "text message*" OR "SMS" OR "short message service" OR "remote consult*" OR "health information technology" OR "health information systems" OR "interactive health communication" OR "patient portal" OR "teleconsult*" OR "webbased" OR "webpage*"

The following search term was reduced to the following and deemed appropriate after similar review of the results.

Abstract/Title: 'telemed*' OR "virtual medicine" OR 'telemed*' OR 'telecommunication' OR 'telehealth*' OR 'tele-health*' OR "tele health*" OR "telecare" OR 'tele-care' OR "tele care" OR "electronic health*" OR 'ehealth*' OR 'telemonitoring' OR 'm-health*' OR 'e-health*' OR "mobile health*" OR 'mhealth*' OR "digital health*" OR "health* information technology" OR "health* information systems" OR "interactive health* communication" OR "health* app*" OR "internet intervention*"

PsycINFO 07-06-2024

No.	Query	Results
#1	TI (socioeconomic* OR "social class*" OR "socio-economic*" OR "social economic*" OR SES OR SEP OR socio* OR "social status") OR AB (socioeconomic* OR "social class*" OR "socio-	270,991

	economic*" OR "social economic*" OR SES OR SEP OR socio* OR "social status") *	
#2	AB ("vulnerable minorit*" OR "vulnerable minority population*" OR "vulnerable people*" OR "vulnerable person*" OR "vulnerable population*" OR "marginal*" OR "disadvantag*" OR "disparity in health" OR "health disparit*" OR "health economic disparit*" OR "health inequalit*" OR "health inequit*" OR "inequalit* in health" OR "inequit* in health" OR "underserv*" OR "povert*" OR "risk*" OR "neighb*" OR "communit*") OR TI ("vulnerable minorit*" OR "vulnerable minority population*" OR "vulnerable people*" OR "vulnerable person*" OR "vulnerable population*" OR "marginal*" OR "disadvantag*" OR "disparity in health" OR "health disparit*" OR "health economic disparit*" OR "health inequalit*" OR "health inequit*" OR "inequalit* in health" OR "inequit* in health" OR "underserv*" OR "povert*" OR "risk*" OR "neighb*" OR "communit*") *	327,004
#3	#1 AND #2	84,829
#4	AB ('telemed*' OR "virtual medicine" OR 'telemed*' OR 'telecommunication' OR 'telehealth*' OR 'tele-health*' OR "tele health*" OR "telecare" OR 'tele-care' OR "tele care" OR "electronic health*" OR 'ehealth*' OR 'telemonitoring' OR 'm- health*' OR 'e-health*' OR "mobile health*" OR 'mhealth*' OR "digital health*" OR "health* information technology" OR "health* information systems" OR "interactive health* communication" OR "health* app*" OR "internet intervention*") OR TI('telemed*' OR "virtual medicine" OR 'telemed*' OR 'telecommunication' OR 'telehealth*' OR 'tele-health*' OR "tele health*" OR "telecare" OR 'tele-care' OR "tele care" OR "electronic health*" OR 'ehealth*' OR 'telemonitoring' OR 'm-health*' OR 'e-health*' OR "mobile health*" OR 'mhealth*' OR "digital health*" OR "health* information technology" OR "health* information systems" OR "interactive health* communication" OR "health* app*" OR "internet intervention*")*	15,038
#5	#3 AND #4	645
#6	AB("strateg*" OR "reach*" OR "retention*" OR "recruitment*" OR deliver* OR "outreach*" OR "approach*" OR "outreach program*" OR "advert*" OR "social market*" OR "marketing" OR "social	591,633

	service deliver*" OR "health service*" OR "community health service*" OR "welfare service" OR "community service*" OR "health promotion*" OR "delivery channel*" OR "dissemination strateg*" OR "dissemination" OR "deploy*" OR "health education" OR "citizen science*" OR "development strateg*" OR "sustainable development" OR "support" OR "access*") OR TI("strateg*" OR "reach*" OR "retention*" OR "recruitment*" OR deliver* OR "outreach*" OR "approach*" OR "outreach program*" OR "advert*" OR "social market*" OR "marketing" OR "social service deliver*" OR "health service*" OR "community health service*" OR "welfare service" OR "community service*" OR "health promotion*" OR "delivery channel*" OR "dissemination strateg*" OR "dissemination" OR "deploy*" OR "health education" OR "citizen science*" OR "development strateg*" OR "sustainable development" OR "support" OR "access*")*	
#6	#1 AND #4 AND #6*	488
#9	#1 AND #4 AND #6 **	272

* apply equivalent subjects (expanders)

**Published in last ten years 01-01-2024 – 07-06-2024, all methodologies except literature reviews or meta-analysis, apply equivalent subjects (expanders)

Embase.com (07-06-2024)

Embase Basic Search Query

No.	Query	Results
#1	'socioeconomics'/exp	1,575,239
#2	'socioeconomic*':ab,ti OR 'social class*':ab,ti OR 'socio-economic*':ab,ti OR 'social economic*':ab,ti OR 'SES':ab,ti OR 'SEP':ab,ti OR 'socio*':ab,ti OR 'social status':ab,ti	494,246
#3	#1 OR #2	1,904,463
#4	'vulnerable minorit*':ab,ti OR 'vulnerable minority population*':ab,ti OR 'vulnerable people*':ab,ti OR 'vulnerable person*':ab,ti OR 'vulnerable population*':ab,ti OR 'marginal*':ab,ti OR 'disadvantag*':ab,ti OR 'disparity in	5,621,935

	health':ab,ti OR 'health disparit*':ab,ti OR 'health economic disparit*':ab,ti OR 'health inequalit*':ab,ti OR 'health inequit*':ab,ti OR 'inequalit* in health':ab,ti OR 'inequit* in health':ab,ti OR 'underserv*':ab,ti OR 'povert*':ab,ti OR 'risk*':ab,ti OR 'neighb*':ab,ti OR 'communit*':ab,ti	
#5	#3 AND #4	519,537
#6	telemedicine/exp OR "digital health"/exp	77,832
#7	'telemed*':ab,ti OR 'virtual medicine':ab,ti OR 'telecommunication':ab,ti OR 'telehealth*':ab,ti OR 'telehealth*':ab,ti OR 'tele health*':ab,ti OR 'telecare':ab,ti OR 'telecare':ab,ti OR 'tele care':ab,ti OR 'electronic health*':ab,ti OR 'ehealth*':ab,ti OR 'telemonitoring':ab,ti OR 'm-health*':ab,ti OR 'e-health*':ab,ti OR 'mobile health*':ab,ti OR 'mhealth*':ab,ti OR 'digital health*':ab,ti OR 'health* information technology':ab,ti OR 'health* information systems':ab,ti OR 'interactive health* communication':ab,ti OR 'health* app*':ab,ti OR 'internet intervention*':ab,ti	143,163
#8	#6 OR #7	182,473
#9	#5 AND #8	8,582
#10	'health care delivery'/exp	4,565,930
#11	'strateg*':ab,ti OR 'reach*':ab,ti OR 'retention*':ab,ti OR 'recruitment*':ab,ti OR deliver*:ab,ti OR 'outreach*':ab,ti OR 'approach*':ab,ti OR 'outreach program*':ab,ti OR 'advert*':ab,ti OR 'social market*':ab,ti OR 'marketing':ab,ti OR 'social service deliver*':ab,ti OR 'health service*':ab,ti OR 'community health service*':ab,ti OR 'welfare service':ab,ti OR 'community service*':ab,ti OR 'health promotion*':ab,ti OR 'delivery channel*':ab,ti OR 'dissemination strateg*':ab,ti OR 'dissemination':ab,ti OR deploy*:ab,ti OR 'health education':ab,ti OR 'citizen science*':ab,ti OR 'development strateg*':ab,ti OR 'sustainable development':ab,ti OR 'support':ab,ti OR 'access*':ab,ti	8,816,300
#12	#10 OR #11	12,015,171

#13	#5 AND #8 AND #12	9,532
#14	([article]/lim OR [article in press]/lim) AND [embase]/lim AND [2014-2024]/py	
#15	#5 AND #8 AND #12 AND #14*	3,762

*Last 10 years (01-01-2014 07-06-2024), article, article in press , EMBASE (Not MEDLINE)

PubMed (07-06-2024)

No.	Query	Results
#1	(socioeconomic status[MeSH Terms]) AND (social class[MeSH Terms])	46,319
#2	socioeconomic*[Title/Abstract] OR "social class"[Title/Abstract] OR "socio-economic"[Title/Abstract] OR "social economic"[Title/Abstract] OR SES[Title/Abstract] OR SEP[Title/Abstract] OR socio*[Title/Abstract] OR "social status"[Title/Abstract]	395,354
#3	#1 OR #2	411,796
#4	"vulnerable minorit"[Title/Abstract] OR "vulnerable minority population"[Title/Abstract] OR "vulnerable people"[Title/Abstract] OR "vulnerable person"[Title/Abstract] OR "vulnerable population"[Title/Abstract] OR "marginal"[Title/Abstract] OR "disadvantag"[Title/Abstract] OR "disparity in health"[Title/Abstract] OR "health disparit"[Title/Abstract] OR "health inequalit"[Title/Abstract] OR "health inequit"[Title/Abstract] OR "inequalit* in health"[Title/Abstract] OR "inequit* in health"[Title/Abstract] OR "underserv"[Title/Abstract] OR "povert"[Title/Abstract] OR "risk"[Title/Abstract] OR "neighb"[Title/Abstract]	3,504,573
#5	#3 AND #4	180,831
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#8	#4 OR #5	141,733
#9	#5 AND #8	2,943
#10	delivery of health care[MeSH]	1,319,099
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#12	#10 OR #11	7,814,975
#11	#5 AND #8 and #11	2,428
#12	#5 AND #8 and #11 *	1,903

*2014-01-01 until 07-06-2024, full text and excluded publication type: review

Web of Science 07-06-2024

Web of Science Basic

No.	Query	Results
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#2	(TI=("vulnerable minorit*" OR "vulnerable minority population*" OR "vulnerable people*" OR "vulnerable person*" OR "vulnerable population*" OR "marginal*" OR "disadvantag*" OR "disparity in health" OR "health disparit*" OR "health economic disparit*" OR "health inequalit*" OR "health inequit*" OR "inequalit* in health" OR "inequit* in health" OR "underserv*" OR "povert*" OR "risk*" OR "neighb*" OR "communit*")) OR AB=("vulnerable minorit*" OR "vulnerable minority population*" OR "vulnerable people*" OR "vulnerable person*" OR "vulnerable population*" OR "marginal*" OR "disadvantag*" OR "disparity in health" OR "health disparit*" OR "health economic disparit*" OR "health inequalit*" OR "health inequit*" OR "inequalit* in health" OR "inequit* in health" OR "underserv*" OR "povert*" OR "risk*" OR "neighb*" OR "communit*"))	3,355,116
#3	#1 AND #2	161,343
#4	(TI=('telemed*' OR "virtual medicine" OR 'telemed*' OR 'telecommunication' OR 'telehealth*' OR 'tele-health*' OR "tele health*" OR "telecare" OR 'tele-care' OR "tele care" OR "electronic health*" OR 'ehealth*' OR 'telemonitoring' OR 'm-health*' OR 'e-health*' OR "mobile health*" OR 'mhealth*' OR "digital health*" OR "health* information technology" OR "health* information systems" OR "interactive health* communication" OR "health* app*" OR "internet intervention*")) OR AB=('telemed*' OR "virtual medicine" OR 'telemed*' OR 'telecommunication' OR 'telehealth*' OR 'tele-health*' OR "tele health*" OR "telecare" OR 'tele-care' OR "tele care" OR "electronic health*" OR 'ehealth*' OR 'telemonitoring' OR 'm-health*' OR 'e-health*' OR "mobile health*" OR 'mhealth*' OR	106,723

	"digital health*" OR "health* information technology" OR "health* information systems" OR "interactive health* communication" OR "health* app*" OR "internet intervention*")	
#5	#3 AND #4	2,154
#6	(TI=('strateg*' or 'reach*' or 'retention*' or 'recruitment*' or 'deliver*' or 'outreach*' or 'approach*' or "outreach program*" or "advert*" or "social market*" or "marketing" or "social service deliver*" or "health service*" or "community health service*" or "welfare service" or "community service*" or "health promotion*" or "delivery channel*" or "dissemination strateg*" or 'dissemination' or 'deployment' or "health education" or "citizen science*" or "development strategy" or "sustainable development" or "support" or "access*")) OR AB=('strateg*' or 'reach*' or 'retention*' or 'recruitment*' or 'deliver*' or 'outreach*' or 'approach*' or "outreach program*" or "advert*" or "social market*" or "marketing" or "social service deliver*" or "health service*" or "community health service*" or "welfare service" or "community service*" or "health promotion*" or "delivery channel*" or "dissemination strateg*" or 'dissemination' or 'deployment' or "health education" or "citizen science*" or "development strategy" or "sustainable development" or "support" or "access*"))	7,487,778
#7	#3 AND #4 AND #6	1,590
#8	AND 2024 or 2023 or 2022 or 2020 or 2021 or 2019 or 2018 or 2017 or 2016 or 2015 or 2014 (Publication Years) and Review Article (Exclude – Document Types)	
#9	#3 AND #4 AND #6 AND #8	1,392

Search query: <https://www.webofscience.com/wos/woscc/summary/ec6820b0-692a-408e-913f-affe32106712-f22ba250/relevance/1>

Sociological Abstracts (which includes the Social Work Abstracts database) 07-06-2024

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	"socio-economic*" OR "social economic*" OR SES OR SEP OR socio* OR "social status")	
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#3	#1 AND #2	43,632
#4	title('telemed*' OR "virtual medicine" OR 'telemed*' OR 'telecommunication' OR 'telehealth*' OR 'tele-health*' OR "tele health*" OR "telecare" OR 'tele-care' OR "tele care" OR "electronic health*" OR 'ehealth*' OR 'telemonitoring' OR 'm-health*' OR 'e-health*' OR "mobile health*" OR 'mhealth*' OR "digital health*" OR "health* information technology" OR "health* information systems" OR "interactive health* communication" OR "health* app*" OR "internet intervention*") OR abstract('telemed*' OR "virtual medicine" OR 'telemed*' OR 'telecommunication' OR 'telehealth*' OR 'tele-health*' OR "tele health*" OR "telecare" OR 'tele-care' OR "tele care" OR "electronic health*" OR 'ehealth*' OR 'telemonitoring' OR 'm-health*' OR 'e-health*' OR "mobile health*" OR 'mhealth*' OR "digital health*" OR "health* information technology" OR "health* information systems" OR "interactive health* communication" OR "health* app*" OR "internet intervention*")	3,186
#5	#3 AND #4	3,186

#6	[STRICT] title('strateg*' or 'reach*' or 'retention*' or 'recruitment*' or 'deliver*' or 'outreach*' or 'approach*' or "outreach program*" or "advert*" or "social market*" or "marketing" or "social service deliver*" or "health service*" or "community health service*" or "welfare service" or "community service*" or "health promotion*" or "delivery channel*" or "dissemination strateg*" or 'dissemination' or 'deployment' or "health education" or "citizen science*" or "development strategy" or "sustainable development" or "support" or "access*") or abstract('strateg*' or 'reach*' or 'retention*' or 'recruitment*' or 'deliver*' or 'outreach*' or 'approach*' or "outreach program*" or "advert*" or "social market*" or "marketing" or "social service deliver*" or "health service*" or "community health service*" or "welfare service" or "community service*" or "health promotion*" or "delivery channel*" or "dissemination strateg*" or 'dissemination' or 'deployment' or "health education" or "citizen science*" or "development strategy" or "sustainable development" or "support" or "access*")	536,660
#8	#5 AND #6	70
#9	#5 AND #6 + *	31

*Filters: Peer reviewed only, last 10 years (01-01-2014 – 07-06-2024), literature reviews excluded

Search query:

<https://tilburguniversity.idm.oclc.org/login?url=https://www.proquest.com/search/2638845?accountid=14338>

Appendix 2 – PRISMA 2020 checklist

Section and Topic	Item #	Checklist item	Location (page/appendix) where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	1
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	1

INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	1-2
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	2
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	3 - 4
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	2
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	41 - 46
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	2 -3
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study	2-3

		investigators, and if applicable, details of automation tools used in the process.	
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	4 - 5
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	4 - 5
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	2-3, 6
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	5
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	5

	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	N/A
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	5
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	5
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	N/A
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	N/A
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	N/A
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	6
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies	7

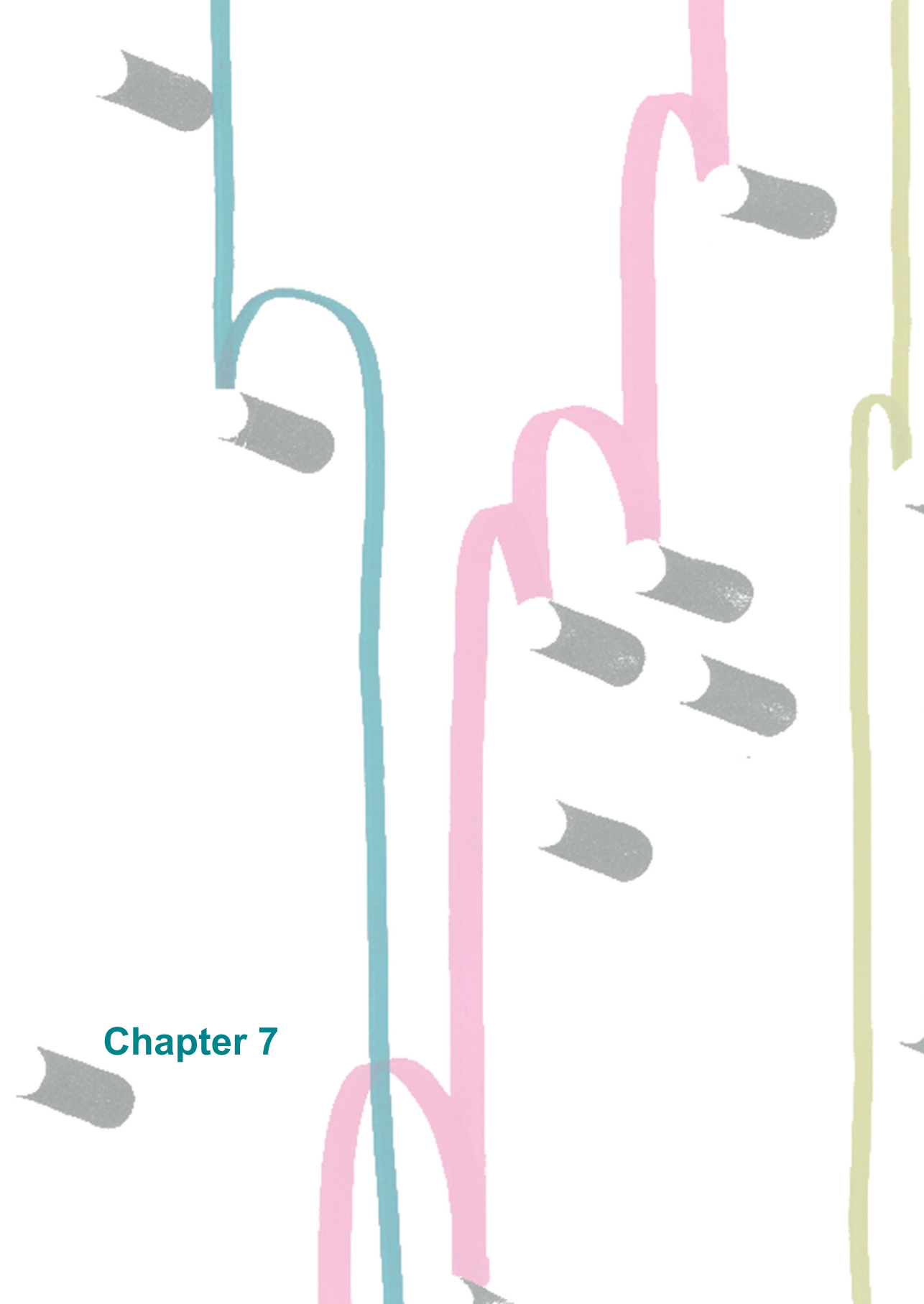
		included in the review, ideally using a flow diagram.	
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	7, Supplementary file 3
Study characteristics	17	Cite each included study and present its characteristics.	7 – 13
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Supplementary file 2
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	14-18, 22- 26, Supplementary file 1
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	6, Supplementary file 2
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	22- 26, Supplementary file 1
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	N/A
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	N/A

Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	N/A
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	6
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	27-28
	23b	Discuss any limitations of the evidence included in the review.	28
	23c	Discuss any limitations of the review processes used.	28
	23d	Discuss implications of the results for practice, policy, and future research.	28-29
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	1
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	1
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	n/a
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	30
Competing interests	26	Declare any competing interests of review authors.	29-30

Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	29
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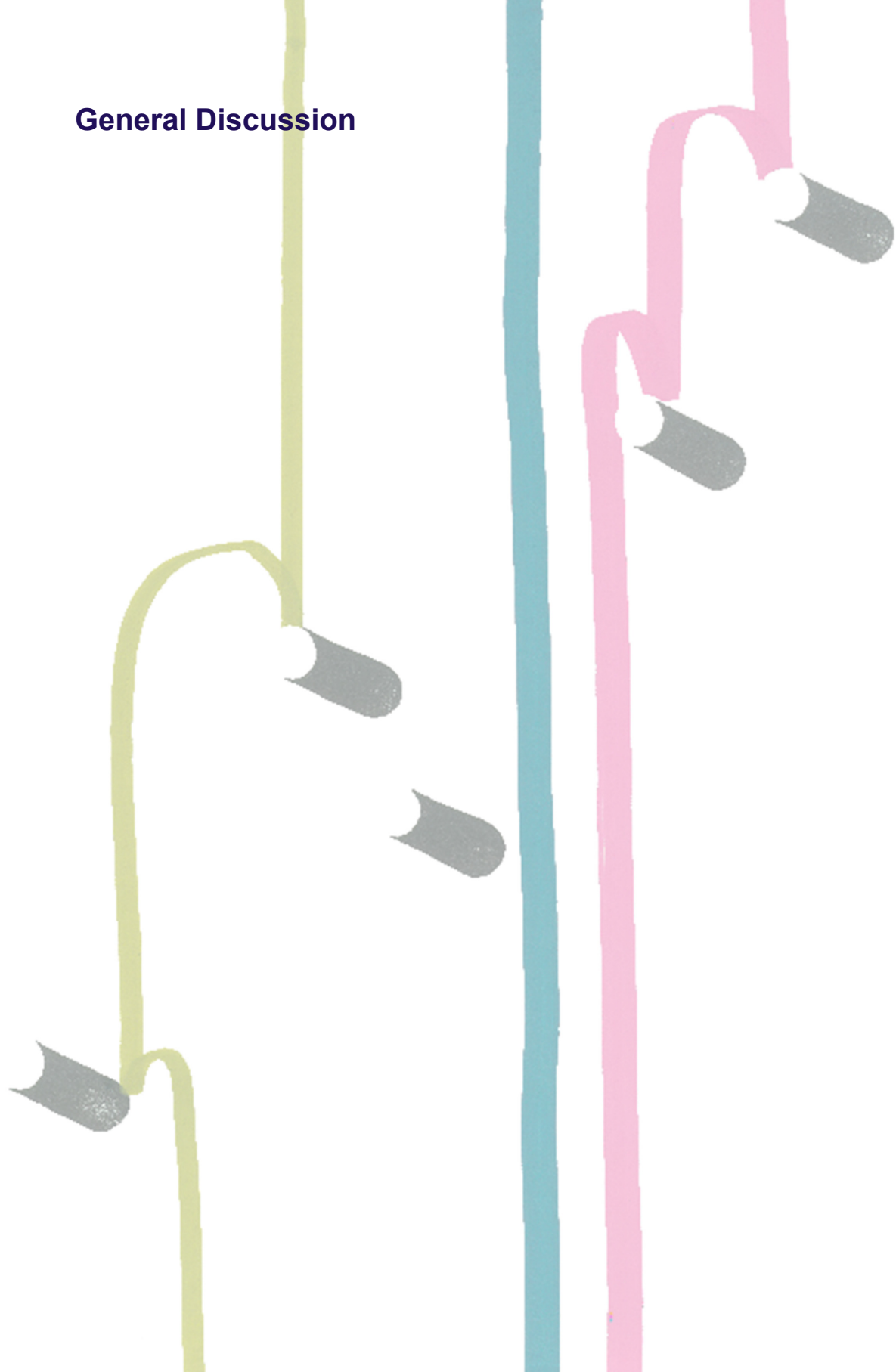
Supplementary material

Supplementary file 1, 2 and 3 of this literature review can be accessed through:
<https://www.researchsquare.com/article/rs-8659>

The background of the page is white, featuring several thick, wavy lines in teal, pink, and olive green that flow vertically. Interspersed among these lines are various grey, brush-stroke-like shapes, some of which are semi-circular or elongated, adding a textured, artistic feel to the design.

Chapter 7

General Discussion



Introduction

This thesis is positioned in the context of two major intertwined challenges facing today's healthcare system. The first is the ongoing issue of health inequity, and the second is the increased demand placed on the healthcare system.

Health inequity is a persistent problem that causes unnecessary morbidity and mortality (1-8). Besides, health inequity poses a great burden on the healthcare system and the economy (1-8). People with social, economic, cultural and geographical disadvantages often have worse health outcomes and have less access to healthcare compared to people with advantaged factors (9). Developments in health inequity research show that the root causes of health inequity mainly lay in societal factors (8, 10-14). Through policy, law, and societies have impact on who, and to what extent someone can achieve good health (8, 10-14).

Healthcare systems are bending under the pressure of significant challenges such as the increasing prevalence of chronic and non-communicable diseases, ageing populations, and a shrinking healthcare workforce (3-8, 15-20). Governments and healthcare organizations need to adapt and aim to improve healthcare systems' efficiency. The digitalisation of the healthcare system is seen as one of the solutions to accommodate to these challenges (23, 24). However, there is a growing concern that digital health contributes to the already existing health inequities (25-28). There has been increasing research showing that people with a low socioeconomic position (SEP) have less access and use of digital healthcare services (25, 28-33). To ensure access to care for those who need it most and to reduce the burden on the healthcare system, it is of utmost importance to overcome digital health inequity.

Digital health inequity research predominantly describes the associations between social, economic and cultural inequities and digital health access in specific populations and research settings (34-38). There is a knowledge gap in how digital health is accessed in daily life and among the general public. Furthermore, research focuses on individual and technological aspects, even though health inequity research shows that organizational and societal factors are at least equally important (8, 10-14, 34-39). However, research into how and why digital health inequities come to exist is minimal, presenting a second knowledge gap. This dissertation explores these two knowledge gaps. First, an exploration of the status-quo of digital health inequity among the general public. Second, the exploration of how digital health inequities come to exist, with emphasis on the role of organizational and societal factors.

The following research questions were answered:

What are the challenges in access to digital health for low socioeconomic positioned groups?

- 1. How does digital health inequity manifest at the population level?*
- 2. What factors influence engagement with and support for digital health use among people with a low socioeconomic position?*

The research practices in this dissertation adhere to a population level and real-world context perspective. Research into digital health inequities from these perspectives can broaden our understanding of how digital health is viewed and approached by people and organizations in daily life. The digital health inequity was studied from a population perspective. Furthermore, digital health inequity was studied through the lens of peoples' daily experience with digital health, allowing for exploration of relevant individual, organizational and societal factors in digital health inequity.

In this general discussion, the main findings of this dissertation are summarized and the research questions answered. Followed by reflections on the main findings, methodological reflections, implications for policy and practice, and future research recommendations.

Summary of findings

How does digital health inequity manifest at the population level?

To address the first research question, two secondary analysis questionnaire studies were conducted: one in a sample of the Dutch general population (Chapter 2) and one in a sample of Dutch adults with a chronic disease (Chapter 3). The questionnaires assessed participants' experiences with access to and use of digital health. Both studies focused on motivation to use digital health and the use of digital health applications. In Chapter 2, participants were additionally asked about their perceived benefits from digital health use. The process of digital health access was interpreted through the perspective of the Digital Divide model from van Dijk (2020) as summarized in Box 1.

The study among the Dutch general population was done to provide insights on a population level to what extent the digital divide exists. The second study in a population of people with a chronic disease was done to assess to what extent the digital divide is present among people who are more likely to be exposed to e-health and have a cause for use.

Box 1. Summary of the Digital Divide Model theory

The digital divide model describes a casual process that theorizes that people with less advantaged personal or positional categories have less resources and, therefore, less opportunities to access and use digital media to their benefit. Personal categories are biological and fixed personal characteristics such as intelligence and health. Positional categories are social and economic characteristics, such as employment and education. People who benefit from digital media use will improve their access to resources leading to a vicious circle, exacerbating digital inequities.

Next to individuals' personal and positional categories, the technical design and properties of information and communication technology (ICT) also have influence on the access of digital media. According to van Dijk, these categories influence the availability of resources which are necessary to access digital media. Access to digital media is described via three causal digital divide levels: 1) access, 2) use and 3) benefit. The first two levels of digital divide encompass four sequential types of access (21, 22).

In **Chapter 2**, the socioeconomic differences in digital health access were examined in a study sample of the Dutch general population. The association between SEP and digital health access, use and benefit were studied through three operationalizations of SEP: education, standardized income and socioeconomic status of the neighbourhood. The associations were studied for digital health in general and for a cluster of specific applications: websites, mobile apps, and wearables. Significant differences in motivation to use e-health in general were found for all three operationalizations of SEP. Analysis of the cluster websites, apps and wearables showed that education was associated with differences in motivation and frequency of use, while high standardized income was associated with digital skills and frequency of use. Education emerged as the most indicative SEP measure, showing the strongest associations with disparities in digital health access and use.

In **Chapter 3**, socioeconomic differences in motivation and use of digital health were examined in a population of Dutch adults with one or more chronic diseases, using education as a proxy for SEP. Participants with low education used websites, apps, wearables and patient portals less frequently. Differences in use for the web-based applications, namely websites and patient portals, were most pronounced across education levels. Significant differences were also found in motivation to use digital health: participants with higher

educational attainment were more likely to be inclined to use digital health, while participants with lower education were more likely to report uncertainty about its use. There were no significant associations between educational attainment and 'not being inclined' to use e-health; approximately 30% of the participants from each educational attainment level were not inclined to use e-health.

Overall, these findings demonstrate that digital health inequity manifests at a population level in the Netherlands. Socio-economic differences in digital health access and use exist both in the general population and among adults with one or more chronic diseases. Education appears to be the most indicative factor underlying these differences. Importantly, we find that health inequities persist even among patients that participate in a highly digitized healthcare system. Furthermore, uncertainty about digital health use emerges as a relevant barrier, particularly for patients with low SEP and a chronic disease. Our findings suggest a high probability that digital healthcare leads to health inequity, predominantly affecting people with lower education. Unequal access to and use of e-health leads to unequal access to, for example, health information, online treatment and patient portals, that may otherwise support better health outcomes. Additionally, the findings indicate that the Dutch digital healthcare system does not engage patients with a chronic disease equitably.

What factors influence engagement with and support for digital health use among people with a low socioeconomic position?

To answer the second research question, two qualitative studies (Chapter 4 and Chapter 5) and a literature review study (Chapter 6) were conducted. The two qualitative studies were carried out in the context of the digital health skills course DigiVitaler. DigiVitaler is a free-of-charge digital health skills course offered in public libraries across the Netherlands. The course DigiVitaler is an example of an intervention offered by a national institution, in this case the public library, to address digital health inequity. The studies explored experiences of digital health access from the perspectives of course participants (Chapter 4) and course trainers (Chapter 5). Chapter 6 reviewed the literature to examine how people with a low SEP were introduced to digital health in real-world contexts.

In **Chapter 4**, a qualitative study explored the motivations of participants of the course DigiVitaler to learn digital health skills and to use a differing range of digital health applications such as health websites, patient portals and video consultations. By interviewing this specific population, we had the opportunity to study the motivations of people who experience significant barriers in digital health use, a population we assumed normally to be less inclined to use digital

health. The study enabled retrospective reflection on participants' experiences and motivations for seeking support.

Overall, our interviews showed that participants felt excluded from the digital society and struggled to keep up with technological developments. Their main motivation to use digital health came from a sense of urgency, rooted in fear of losing access to care, being or becoming a patient or caregiver, or losing independence in organizing their health and healthcare. Some participants were also encouraged by their general practitioner or another healthcare professional to use e-health. The main barrier to the use of digital health, and their reason for seeking support, was their own lack of digital skills needed to use e-health applications successfully. Participants also indicated that they lacked adequate informal support from family and friends and felt comfortable seeking support at the public library.

Furthermore, the people who attended the course DigiVitaler were homogenous in terms of personal characteristics and experienced similar motivations and barriers for e-health use and seeking support. The participants were mainly older females with limited digital skills who had access to digital devices, time, and were fluent in Dutch. These findings imply that the DigiVitaler course provided by the public library reaches and supports a specific target group.

Chapter 5 examined the perspectives of trainers of the course DigiVitaler. The study investigated trainers' experience in providing support for digital health skills development, the reach and content of the DigiVitaler course, and potential opportunities for course improvement. Trainers showed insight in the diversity of target groups, the target groups' barriers and needs in digital health access, the trainers' experienced barriers in providing support in digital health skills, and the importance of collaborations for the improvement of the public libraries' offered support in digital health skills development.

Target populations are elderly, youth, people with limited language skills, people with limited digital skills, people with immigration background, people who work non-digital jobs, and people who are unemployed. Various populations need support in gaining access to digital healthcare and different target groups face different individual, organizational, and societal challenges in accessing digital health. The barriers in digital health use that were mentioned were: lack of digital skills, lack of language skills, lack of knowledge about the digital healthcare system, and lack of access to digital devices. These barriers manifested differently across groups.

Although public libraries aim to reduce digital health inequity, trainers experienced barriers related to course reach and engagement, institutional

accessibility, and clients' personal barriers. DigiVitaler primarily reached older adults, and trainers often adapted course content to participants' immediate needs. Some potential participants were unable to engage due to language, logistical, financial, time, or skill-related barriers. Trainers also noted that not all populations feel comfortable visiting public libraries.

Finally, trainers assumed or experienced clients' personal barriers for seeking support in e-health use: lack of awareness of e-health, lack of awareness of the existence of support, lack of time to learn skills, unfamiliar or uncomfortable with taking initiative in patient-doctor relationship, and lack of access to up-to-date digital devices. The trainers also pointed to potential societal barriers, such as lack of general digital inclusion by peers and professionals and stigma around having limited digital skills.

Regarding improvements, trainers highlighted the importance of collaboration with health, social, and governmental parties. Such collaborations could increase the reach of DigiVitaler, promote exchange of skills and information, and create opportunities to provide support in locations familiar to target groups. While trainers recognized the potential benefits of collaboration, they identified few concrete actions. Some trainers noted that healthcare organizations and public library organizations need time to familiarize themselves with one another before collaborations can be effective, and that national-level efforts may be required.

In **Chapter 6**, a literature review aimed to identify delivery strategies used to deliver e-health and reach people with a low SEP in real-world contexts. It also examined whether these delivery strategies were effective and whether their design drew on scientific or experiential underpinnings. Using the marketing mix model from McCarthy (1964) strategies were categorized into place, point-of-contact, promotion, facilitation and incentive. The review identified 35 papers describing 33 studies on methods used to introduce people with a low SEP to e-health or e-health enabling services. Most strategies focused on place and point-of-contact. Some evidence suggested that digital health delivery in familiar areas, using offline promotion, and recruiting via authorities were more effective.

Overall, the evidence on the effectiveness of delivery strategies is insufficient and too scattered to draw solid conclusions. The predominance of randomized controlled trials restricted insight into real-world implementation. Furthermore, the sparse reporting on the underpinnings of delivery strategy design highlights the need for more systematic scientific reporting practices to improve future knowledge synthesis.

In summary, Chapters 4, 5 and 6 find multiple individual, organizational and societal factors that influence the engagement and support for digital health use among people with a low SEP. Chapter 4 and 5 finds that individual factors, the reach of support, the type of support and the organization that provides the support are important. Chapter 6 shows that the type of delivery strategy, the implementation context and the responsible organizations are relevant. Importantly, our findings indicate that the aforementioned factors differ per target group, reflecting varying needs and capacities. Overall, our findings reveal that societal and organizational factors play a role in the engagement and support in digital health use.

To conclude, our findings provide a three-parted answer for the second research question. First, support and implementation strategies need to be tailored to diverse target groups with differing needs, capacities and daily lives. Second, barriers to e-health use are not limited to digital health interventions and individual factors alone and include the organization and implementation of digital health interventions and support for digital health use. Third, organizations and societies play a role in the engagement and support for digital health use for people with a low SEP. This implies that digital health access is a target-group specific and multi-layered process that involves the individual, organizations and societal factors.

Reflections upon main findings

1. Digital health as a newly acknowledged determinant of health

At the beginning of this PhD trajectory, there was still uncertainty about what the impact of digital health would be on health inequity (25, 40). In 2020, however, the COVID-19 pandemic shocked the world and forced a rapid transition to digital healthcare delivery. This global digital healthcare transition catalysed research on digital health and digital health inequity, including population-level research (37, 41, 42). Our findings (Chapter 2 and 3) show that individual SEP characteristics are associated with differences in digital health access and use in the Netherlands. In line with these findings, current literature widely acknowledges the existence of digital health inequity (42). Given this shared understanding that digital health affects health equity, the following question emerged: *“Digital health inequity exists, now what?”*. It is imperative to understand the nature of this health challenge, as such understanding is vital to addressing digital health inequity effectively.

Further reflection on the two quantitative studies (Chapter 2 and 3) led to two additional conclusions. First, different interpretations of SEP, namely education, standardized income and socioeconomic status level from the neighbourhood,

were related to different types of access from the digital divide model. This suggests that digital health exclusion is likely to have different underlying causes dependent on the type of SEP vulnerability. Second, we found people with a low SEP are not effectively involved in the digital health transformation, even when they are patients in a highly digitized healthcare system. In this dissertation, these conclusions led to further exploration how people with low SEP experience digital health access and use and what societal, organizational and individual factors are relevant in this context.

In line with the thought process in this dissertation, research has increasingly focused not only on *if* but also on *how* the digital health transformation shapes health and healthcare (43). Prior to the COVID-19 pandemic, digital health was not considered as a determinant for health (44-46); however, the finding that digital health impacts health through individual, organizational and societal factors (43, 47-49) led to a conceptual shift. Digital health is increasingly viewed as a determinant of health within the social determinants of health model (SDOH) (12, 43, 47, 48, 50-52). The SDOH model holds an ecological perspective on health and acknowledges multiple domains of determinants of health, including social, political, economic and environmental determinants of health (14, 53). This model and the ecological model of health are described in the introduction of this dissertation (p.4).

Consequently, multiple scholars and institutions, including an extensive report by *The Lancet* argue for the acknowledgement of a new domain within the SDOH that are referred to as the digital determinants of health (DDOH) (12, 43, 47, 48, 50-52). The World Health Organization (WHO) (2024) provided a first overview and expert evaluation of DDOH factors and provided one of the first definitions of DDOH: *“Any factor rooted in, contingent on or inextricably linked to the digital world that can directly or indirectly influence health or well-being.”* (Kessel, 2024) (43). The acknowledgement of the DDOH provides clarity on which causes of health are intrinsically rooted in technology and provides a helpful distinction from other SDOH domains (43, 47, 48). The following example illustrates the need for the acknowledgement of DDOH: *“A person at a lower income level may only be able to afford a version of a symptom checker with fewer functions and capabilities. While the ability to purchase an advanced version is a social determinant, the existence of different tiers of technology is a digital determinant.”* (Chidambaram, 2024) (47). Furthermore, the DDOH consider individual, technological, policy, political, economic, societal and cultural factors (43, 47, 48, 51, 54). These factors include engagement with, implementation of and support for digital health and the role of organizations and society in that matter (43), as was also identified in Chapter 4, 5 and 6. The

DDOH could broaden the perspective of science, politics and the general public on the impact of digitalisation on health and the diversity of stakeholders and systems involved (43, 47-49, 51, 54). Establishing the DDOH concept would create opportunities for research to identify key determinants, support the development of targeted policies, and guide agenda setting and coordinated action by all stakeholders to address digital health inequities.

2. Digital health access and use is a multilayered process

This dissertation demonstrates that digital health access and use constitute a multilayered process. Our findings show that different populations have distinct needs, facilitators, and barriers related to digital health access and use (Chapters 2 and 5). Moreover, the accessibility of the content, context, and outreach strategies of support initiatives shapes both their reach and the diversity of the target groups they engage (Chapters 4 and 5). Choudhary (2022) acknowledges the influence of design and community infrastructure upon the accessibility of support initiatives (55). Furthermore, there is some evidence that the type of implementation strategy is relevant for engaging people with a low SEP (Chapter 6).

In addition, broader societal and organizational factors, such as lack of knowledge about effective implementation strategies to reach low SEP groups, limited public awareness of digital health, stigma, inequitable digital inclusion, and lack of cross-sector collaborations that expand support in digital health access, play a role in individuals' barriers and opportunities for accessing digital health (Chapters 3, 4, 5, and 6).

While most literature and policies link barriers in digital health access and use primarily to individual factors (42, 56, 57), our findings challenge this assumption. This raises a central question: "What is the role of societal and organizational factors upon individual access and use of digital health?". Our findings lead us to conclude that individual barriers in digital health access and use do not necessarily stem from individual causes. The aforementioned societal and organizational factors considering digital health awareness, implementation and support are mechanisms that involve both the obstacles people face in digital health access and use, and the possibilities for overcoming them.

Several other scholars theorize or argue that organizational and societal factors are highly important in shaping digital health inequity (38, 43, 48, 49, 52, 57-59). Richardson (2022) argues that improvement of upstream factors, such as tech policy, healthcare and community infrastructure, often benefit disadvantaged populations more than down-stream, individually targeted

improvements (52). Some evidence is provided by Asmar (2022), her analysis to digital media inequities provide evidence that political resources, such as the public service infrastructure, are important in both social and digital exclusion (60). Yet, individuals and healthcare workers are often framed as most responsible for overcoming barriers (57). Even though, most proposed solutions are often system related, such as adequate digital interventions, infrastructures and policies (57). There is a tendency to downplay the effect of contextual factors which impacts our understanding and decision making in digital health inequity research and policy (52, 61-63). To counter this tendency, new evidence is needed to understand and estimate the effects of society and organization-related factors that cause digital health inequity (63, 64). Stronks (2025) developed a complex systems model that provides the opportunity to generate evidence to understand and tackle complex health problems (62). The model addresses mechanisms, dynamics and patterns in complex health problems through individual, organizational and societal perspectives (62). New research methodologies and frameworks, such as complex systems models, can guide research and practice to determine new holistic courses of action to reduce digital health inequities (61, 62).

3. The knowledge gap: role of reach, implementation and support in realizing digital health for all

This dissertation reveals the need for a new area of research: inclusive implementation and support strategies in digital health. We need to be curious to what digital inclusion for people with low SEP should look like. While other findings often relate lack of access and use of e-health to individual and intervention factors, our findings relate digital health inequities to individual factors, technological factors, implementation and support. It is telling that digital health inequities are observed among patients that are interacting with a highly digitized healthcare system (Chapter 3). Although, perhaps, this is not surprising, as there is a scientific and practical knowledge gap in what support and implementation methods serve people with a low SEP best (Chapter 5 and 6). There is little evidence that informs us on how to create contexts that enable people with a low SEP to access and use e-health more easily.

Inequity in digital health access and use is a signal that people with a low SEP more often are unaware of the existence of e-health, do not see the value of e-health, do not have the opportunity to use e-health, or actively do not want to use e-health (Chapter 2, 3, 4, 5, 6). There is great diversity in the people who experience exclusion to digital health. Moreover, the underlying reasons for barriers to arise and peoples' needs in support and implementation are just as diverse. The course DigiVitaler can be interpreted as a case for how one target

population, namely: elderly, were introduced to e-health and how they acquired digital health use through support in the public library. The case is illustrative for how individual, organizational and societal factors together shape individuals' opportunities for access and use of digital health (Chapter 4 and 5). Smit (2025) and Goedhart (2019) and Asmar (2020) find that groups that are vulnerable to digital exclusion, such as people with low literacy, mothers with immigration backgrounds, have specific barriers, resources, support and support-seeking behavior patterns (65-67). Were, Sinha & Catalani (2019) show that people have different needs in support to access mobile personal health records based upon their level of digital inclusion (68).

Successful implementation strategies are vital for successful adoption of digital health (69). Yet, there is lack of evidence and practical knowledge for efficient e-health delivery strategies that reach people with a low SEP (Chapter 5 and 6) (59, 70). Although, there is some evidence for delivery strategies of e-health, the majority of these findings are derived from specific clinical trial settings (Chapter 6). Few researchers dedicate research specifically to the equitable implementation strategies (71, 72). Bodell (2025) finds that digital health intervention research actively involve stakeholders in the design process, but fail to broaden this involvement to the implementation and evaluation of digital health interventions in real life (73). These insights indicate that research to inclusive implementation and support strategies should be held in real-life contexts, to best attune to peoples' daily lives.

Methodological reflections

By studying digital health inequity through the lens of the digital divide model, we uncovered that digital health inequities arise during the first and second digital divide level. Second, the sequential nature of the model provided explanation to why people do not use digital health even though they have access and use of digital devices and digital skills (Chapter 2, 3 and 5). As motivational access is essential and the first step for gaining access and use of digital media, the access to devices and digital skills alone are not enough.

In the general introduction of this dissertation the three models of health were introduced: the biomedical, biopsychosocial and ecological model. Building forward on that introduction, the first reflection in this section discusses the digital divide model through the lens of the ecological model of health. The second reflection concerns the application of the digital divide model in the health context. At the end of the reflections, an updated version of the digital divide model (Figure 1) is presented that takes these reflections into account.

The digital divide model in context of the biomedical, biopsychosocial and ecological models of health

The digital divide model is a positivistic and individual focused model, that takes into account individuals' social circles. This leads to the interpretation that the digital divide model has similarities to the biomedical and the biopsychosocial models on health. Several researchers, including van Dijk himself, argue for a diversification of research and, thus, evidence to understand how and why digital divides come to exist (21, 60, 64, 74, 75). This dissertation studied digital health inequity with eye for the ecological perspective, which is contrary to the biomedical model. Research to the digital divide model within a real world context reveal that organizational and societal factors play a role in digital health access and use.

In the digital divide model, the factor 'nation' is categorized as positional characteristic. The factor nation captures the level of digitalisation of the region the individual lives in. The nations' level of digitalisation is often interpreted through dichotomous variables, such as rural/urban or developed/not developed. In the case of digitized and well-connected countries, we argue that this is an unjustified simplification of the role of nations and their governments upon individuals' digital health access and use. The design of policies and their focus on equitable digital health access, including implementation and support, are influential to equitable digital health access (76). Furthermore, we argue that the factor 'nation' is a contextual factor that should not be interpreted on the same level as individual positional factors. When following the line of argumentation of the ecological model of health, societal and organizational factors, or the structural determinants of health, are the factors that shape individual factors, such as income and employment (10, 14, 77). This dissertation shows that access and use of digital health are shaped by societal, organizational and individual factors (Chapter 4, 5, and 6), underlining the ecological perspective. By placing the societal and organizational factors in the same category as individual factors, this warrants the perspective that organizational and societal factors are passive and that individuals are responsible for how they manage these societal conditions. Whereas governments and organizations do have influence on individual opportunities and should carry responsibility and accountability for their role in providing equitable digital health systems (57, 58, 75, 76). Moreover, we argue that the interpretation of 'ICT properties of digital media' should be broadened as well. We find that, apart from digital infrastructure, devices and applications, the implementation of digital health is just as important (Chapter 5 and 6). Several researchers and theoretical models argue that the implementation of ICT should be viewed as a part of the intervention (69, 73).

The second reflection discusses the digital divide model within the context of health and the healthcare sector. As the model conceptualizes digital media access in general terms, it does not explicitly account for the specific conditions of health and healthcare. Applying the model in this context therefore invites reflection on how health- and healthcare-specific characteristics influence its interpretation.

First, good health and healthcare is interpreted, according to Maslow (1943), as an essential physiological and safety need (78). Access to digital health is, therefore, not a 'nice to have', it is a must-have, which is different to other types of digital media, that fulfil other, higher, levels of needs (Chapter 4) (78). Consequently, as health and healthcare are essential needs, most governments take responsibility in organizing healthcare through health policy and healthcare organizations (79). As a result, these parties have substantial influence over the access to healthcare (79, 80). In the access to care model by Levesque, the role of the healthcare professionals and organizations are described in every aspect of access to care (81, 82). Both our findings and other scholars underline the role of healthcare professionals and the organization of health in promoting equitable digital health access (79, 82-84).

Despite this, little research is done on the role of healthcare provision models, financing models, laws and regulations upon digital health inequity (42, 85, 86), even though these structures are important in health inequity (80). Many countries' financial models were quickly designed during the COVID-19 pandemic to allow e-health access and require revisions to ensure long-term sustainability and equity (85, 86). Therefore, evaluations of these policies are limited (85, 86). Germany is an exception, here the "Digitale Gesundheitsanwendungen" (DiGA) policy was issued in 2019 (87). Through this policy, state approved digital health applications are reimbursed through statutory health insurance. However, scholars concluded that the current evidence is too limited to support robust conclusions about the financial, patient-centred structural and procedural outcomes of these applications (87-89).

All in all, the role of healthcare professionals and healthcare organizations are evident in access to care models. Moreover, although evidence remains limited, it is likely that legal frameworks, financial mechanisms and healthcare provision models influence access to digital healthcare. These structural factors should be considered when applying the digital divide model in health contexts.

Implications for policy and practice

1. E-health access and use is a multi-stage and multi-stakeholder process

Governments struggle to keep up with technological developments, and so does research aiming to understand their impact on health and health inequity (48, 90). As discussed in the main reflections, policy is one of the keys to steering the effects of digital health on health inequity (48). Clarity regarding regulations (what e-health should do and deliver, the quality of products and systems), purpose (for whom and with what goal), and organization (how to organize an equitable digital health system) at every level is essential (62, 69, 81, 91). This dissertation provides direction to which policy areas are critical for digital health inequity. Next to this, it encourages involvement and collaboration with vulnerable populations and the organizations that tend to these populations to realize equitable digital health policy and practice.

According to Kickbusch (2023), governments, digital agents and other stakeholders can achieve equitable digital health systems through the following actions: building healthy public policy, creating supportive digital environments, strengthening community actions, developing personal skills and reorienting health services (90). Furthermore, youth and marginalized populations should be at the centre of the development of each of these actions to regulate and organize digital health in an equitable manner (90). Significant efforts have been made to create supportive digital environments. Two examples are the European Health Data Space (EHDS) (92, 93) and the ISO/TS 82304-2:2021, a global quality and reliability standard for health and wellness apps (94). Such regulations offer guidelines and structure for commercial, government and healthcare organization parties, which should translate into equitable, high-quality and reliable digital health interventions, digital infrastructures and health data management. However, there are other areas in digital health policy that deserve attention.

In line with Kickbusch's argumentation, our findings show that equitable digital health systems require equitable technology infrastructures, interventions, implementation strategies, and support strategies. Furthermore, this dissertation reveals the complexity of how individual, organizational and societal factors shape the opportunities for digital health access. In order for policy and practice to be effective and appropriate, decisions should be made *with*, rather than *about*, people with low SEP and other vulnerable groups. On top of that, our findings reveal that individuals, social circles, including caregivers, local health-, public service- and leisure organizations, local and

national public libraries, community centres, local and national healthcare organizations, and municipalities can play a role in the design and execution of digital health policies and strengthen community actions.

2. The organization of support in digital health access

The lack of access and reach of support for people who are vulnerable to digital health exclusion reduces peoples' opportunities to organize their digital healthcare access (Chapter 4 and 5). In the Netherlands, the Aanvullend Zorg en Welzijnsakkoord (AZWA) policy was agreed upon in 2025 and will be effective in 2027 (95). This policy aims, among other things, to reduce health inequities through digital health (95). One of the aspects of this policy is to install a nation-wide digital health helpdesk, that will be available online, by telephone and via physical helpdesks that will be installed throughout the Netherlands (95).

According to our findings, people have different needs and sources in terms of support (60, 67, 96, 97). Other scholars show that people who are digitally excluded often rely on social support (66, 67, 96, 98). However, Courtois (2016) and Smit (2025) find that social support is often not enough to overcome all barriers in digital media access (66, 98). Additionally, our findings indicate that not everybody has access or wants to rely on social support (Chapter 4) (67). Furthermore, Asmar (2022) shows that political resources, such as public services, are vital for digital inclusion and argues for the mobilisation of community groups to foster digital inclusion of those most extremely deprived (60). These findings make a case for publicly organized helpdesks to improve digital health access for vulnerable populations.

The results of this dissertation heavily encourage policy makers and practice to assess the needs of the target groups that are ought to be reached by this policy and organize support efforts accordingly. Additionally, policy makers should organize support through different civil and public service organizations to engage diverse populations that are likely in need of support in digital health access. False assumptions about peoples' capacities and needs are easily made and would hinder the potential equitable effect of such digital health policies (99).

Our findings show that populations experience a diversity of barriers to digital health access. Barriers do not only concern e-health literacy, but also lack of awareness, access to devices, general knowledge about the healthcare system, language skills, stigma, and lack of general digital inclusion. A helpdesk can help overcome some of these barriers, such as lack of digital skills, knowledge of the healthcare system, and access to digital devices. However, I

assume that helpdesks are less likely to reach people who experience a lack of awareness, uncertainty about e-health, stigma or general digital exclusion. People who experience these types of barriers first need to be introduced to e-health in a, for them, meaningful way, before they can receive support. Van Deursen (2021) proposes a similar line of thought to improve the general digital inclusion (100). Van Deursen finds that each stage of digital inclusion has specific barriers and determinants that shape inequities in digital inclusion and thus require attention (100). Therefore, policies should stimulate positive attitudes towards the digital world, provide material access and facilitate support in acquiring digital skills simultaneously (100).

3. The great unknowns: the effect of digitalisation of healthcare upon health inequity and the measures to overcome digital health inequities

The existence of digital health inequity has been demonstrated in numerous studies including our own (42), indicating that disadvantaged populations are disproportionately affected. However, the majority of these findings have primarily focused on clinical health outcomes. There is limited evidence regarding how societal-level political, economic, and social factors influence digital health inequity (49). We find that the reach and content of support and implementation methods are important factors in digital health inequity.

This dissertation offers limited qualitative insight into the effectiveness of measures such as the DigiVitaler course, as well as scattered evidence on the effectiveness of e-health delivery strategies. There remains a lack of real-world evaluations, monitoring, and long-term assessments of interventions, implementation, and support strategies aimed at addressing digital health inequity. Healthcare organizations, organizations that provide support, and policy makers should regard this as an opportunity to strengthen their policies and practices. Systematic evaluations of the effects of their implementation and support policies would yield more robust insights for both policy and practice.

From a scientific perspective, such insights could uncover the degree to which societal and organizational-level measures reduce digital health inequities. Moreover, these evaluations would create opportunities to develop evidence-based digital health equity policies. They would also clarify what the government and society can reasonably expect from citizens, as well as from the people and organizations that provide support in digital health access. Our findings in regard to the DigiVitaler course (Chapter 4 and 5) reveal that the improvement of digital health literacy requires quite some effort. However, these findings should be interpreted as an observation and an invitation for future research, and not a robust fact.

In the absence of evaluations, there is a risk that measures become merely performative and fail to produce meaningful improvements in digital health inequities. Given the limited evidence currently available, it is imperative that we experiment and learn how to design our society in ways that reduce digital health inequities as effectively as possible.

Future research

1. A sense of urgency is key in people's motivation for e-health adoption, but will it lead to digital health access and use?

A sense of urgency was key in the participants of the course DigiVitaler. Participants felt that they needed to be able to use e-health to maintain access to care. This sense of urgency was driven by (the expectation of) being a patient or caregiver, the health care professional, or the desire to stay independent in managing their health (Chapter 4). However, the interviews with trainers indicate that people who are attending the DigiVitaler course underestimate the effort needed to reach independence in e-health use and show limited willingness or opportunities to make this effort (Chapter 5). The participants of the course DigiVitaler can be considered as the pro-active group with resources at hand to access this type of support and use e-health. Furthermore, quantitative results show that people with a chronic disease and low educational attainment are more often uncertain about e-health use. Additionally, a substantial percentage was not inclined to use e-health in all educational attainment groups (Chapter 3).

Currently, at the time of writing this dissertation, the use of digital healthcare is not (yet) an obligation. It is not unlikely that digital health will become an obligation, perhaps not by law, but by lack of opportunity to continue traditional care in the future (39). Parallels can be drawn from the financial sector; the digitalisation of the financial sector led to the closing of automated teller machines (ATM) and bank offices, which excludes those with no access to digital financing services and those who lack the opportunity to access bank offices and ATMs that are farther away (101). Consequently, this increases the risk of financial exclusion for vulnerable groups, such as those with low education, limited digital skills, elderly and people with a disability (101). It is our expectation that if e-health use becomes obligatory, this will reveal a group of people who were not reached by implementation strategies and, therefore, have no access to e-health (Chapter 6). This will affect people with low SEP most, who are simultaneously the most vulnerable for ill-health (Chapter 2 and 3). There is a high risk for exclusion of these groups which poses a serious threat to accessible healthcare for all. Future research needs to focus on the following

topics that address foreseeable risks for digital health inequity: 1) the response of people when e-health access becomes essential for access to healthcare, 2) inclusive engagement and support for people with no access to e-health, and 3) the prevention of exclusion to digital healthcare and traditional healthcare in the digital age.

2. Real world evaluations in e-health delivery and implementation strategies

Our findings show that there is some, scattered, evidence for the effectivity of e-health delivery strategies. Other scholars find that researchers often fail to evaluate the effect of implementation of digital health interventions on digital health inequity in real life (49, 73). Future research should provide efforts to explore and evaluate implementation strategies that aim to reach people with a low SEP and other vulnerable populations. This is crucial to prevent digital health exclusion of vulnerable populations. Furthermore, the perspective of the healthcare professional and the structure of healthcare organizations need to be taken into account, as these are the people and organizations that often need to carry out these implementation strategies. The field of digital health inequity research would seriously benefit from systemic research practices and theory building, as it would be a promising start to understand and assess the effect on how these measures impact digital health inequities.

3. Research to the reach, methods, organization, and effectivity of support initiatives

Further research to support initiatives are needed from two perspectives. From a health and public service perspective, it is vital to understand what populations need in terms of support, what barriers they experience and how to overcome them. From the public administration perspective, is it imperative that there are insights to what organizations that provide support need to effectively organize this support. Additionally, governments and organizations need to know what they can expect from support initiatives in terms of effectivity. Moreover, as described in implications for policy and practice, monitoring and real-world evaluations are key in the further exploration of what measures in support practices are effective to reduce digital health inequity.

4. Exploration of other societal and organizational factors in digital health inequity

This dissertation's exploration led to the identification of several organizational and societal factors that are related to digital health inequity. Our first reflection on the main findings, methodological reflection, and other scholars suggest that the role of healthcare system related factors on digital health inequity are

severely under researched (38, 42, 80, 81). Future research that adheres to an ecological perspective has a high probability of identifying new factors. Scholars such as Stronks (2025) and Kunst (2017) argue for broader evaluation and exploration of societal and organizational mechanisms for complex health problems (61, 62). This dissertation and the earlier described newly developed complex system model by Stronks (2025) is an invitation for researchers to further explore mechanisms that drive digital health inequity through an ecological perspective.

5. Opportunities for the expansion of the digital divide model

Research on the digital causes of health inequity has taken a flight since 2020 (Chapter 6) (102), highlighting the need to understand digital health inequity from diverse perspectives. Our findings identified factors that influence digital health access that go beyond the individual. Societal and organizational factors are not passive conditions; rather, they shape digital health access. Moreover, the methodological reflections reveal how the healthcare sector itself influences access to digital healthcare and thus the interpretation of the digital divide model. Current research on the impact of digitalisation of health, including our findings, invites the exploration to a potential expansion of the digital divide model (21). Additionally, these insights should stimulate further research and reflection into how the digital divide model can be interpreted and applied across healthcare and other contexts.

Strengths and limitations

This dissertation has several strengths. First, it employed multiple research methods, including quantitative, qualitative, and literature review studies, which enhances the robustness and credibility of the findings. Second, the dissertation focusses on both population-level and real-world insights into how people experience digital health access and use. The quantitative studies drew on nationally representative and large-scale populations; participants were selected randomly and did not participate in clinical trial settings, thereby increasing the generalizability of the findings. Additionally, the quantitative studies examined two populations, the general population and patients with a chronic disease, which strengthened our findings on the population-level manifestation of digital health inequity in the Netherlands. Second, through the DigiVitaler course, we were able to reach individuals who experienced digital exclusion and faced difficulties using digital health. This offered rare insight into a population often considered hard to reach and is positioned at the centre of this dissertation. In addition, the interviews with DigiVitaler trainers enabled us to explore professionals' experiences of their roles in digital health inequity.

Their perspectives allowed for identification of individual (professional) and organizational factors that shape support for digital health access. Third, our quantitative and qualitative studies addressed peoples' experience with digital health in a real-world context, which provides insights that are free of clinical trial or other research related biases. Finally, this dissertation used several conceptual models which enhances the scientific robustness of the findings. Our findings even provide new theoretical insights that may lead to the adjustment of the Digital Divide model (21). Together, these perspectives strengthen the evidence that digital health inequity exists and clarify several underlying societal and organizational factors contributing to it.

Alongside these strengths, this dissertation also has several limitations. First, its overall approach is exploratory. While this enabled the identification of new factors that may explain digital health inequities, it does not provide evidence regarding the magnitude or relative contribution of these factors. Second, the context and population of the DigiVitaler case are specific, and the findings are not intended to be generalized. Instead, they should be interpreted as an illustrative case demonstrating how individual, organizational, and societal factors collectively shape opportunities for digital health access and use. Other contexts are likely to yield different observations.

Finally, there were strengths and limitations to how socioeconomic position (SEP) was addressed in this dissertation. It is considered a strength that SEP was studied through three operationalizations instead of one. This provided insights in how different aspects of SEP are associated to digital health access. On the other hand, SEP is a multifaceted construct, and the use of single indicators as direct proxies has been critiqued upon. Scholars have argued that composite indicators are preferable for capturing SEP (103-105), although their design and use require caution due to challenges in interpretation and construction (103, 106). It was not possible to perform a clear assessment on the SEP level of the participants of the DigiVitaler course (Chapter 4). Prior to the study, it was assumed that a more diverse population in terms of age and SEP would attend the course. As most participants were female and of older age, the variable education was a less suitable indicator for SEP. Women in that age category often had less opportunities to pursue higher education and were financially dependent on their partner. Although these women often did not have high levels of educational attainment, they did have access to digital devices and the opportunities to attend the course, which can be interpreted as certain types of wealth. Therefore the results of this study provide very limited and non-generalizable insights on if people from different educational backgrounds have different motivations to seek support in e-health use.

Conclusion

This dissertation shows that digital health inequity is a persistent and multifaceted problem that reflects and amplifies broader social inequities in health. Across both quantitative and qualitative studies, digital health access and use were consistently related to socioeconomic position, confirming that the digital health divide manifests at the population level despite the expanding digitalisation of healthcare.

The findings demonstrate that digital health inequities cannot be explained by individual factors such as motivation or digital skills alone. Instead, they emerge from the combined influence of individual, organizational, and societal factors. The reach and content of support, the implementation of e-health, and the delivery strategies used to introduce people to digital health are important in establishing equitable digital health access and use. The DigiVitaler case illustrates how these factors operate in everyday contexts and highlights the limitations of current support infrastructures. The literature review further shows that evidence on effective, real-world delivery strategies is scattered and insufficient to guide equitable implementation.

Taken together, the findings call for a shift from an individualised understanding of digital health inequity toward an ecological perspective that acknowledges the roles of political choices, public services, digital infrastructures, and health governance. Achieving equitable digital health systems requires not only high-quality technologies but also inclusive implementation processes, patient and citizen involvement, sustained and diverse support structures, cross-sector collaboration, and systematic evaluation.

Current policies and practices insufficiently address these broader determinants, and support remains unevenly accessible. Without rigorous real-world evaluation, there is a risk that initiatives become performative rather than effective. Future research should therefore prioritise evaluations of implementation and delivery strategies, examine the influence of healthcare systems and organizations, and explore how populations respond as digital health becomes increasingly integral to accessing care.

Despite its exploratory nature, this dissertation provides a multi-layered understanding of how digital health inequity arises and identifies factors that shape unequal access to and use of digital health. Healthcare systems undergoing digital transformation to respond to increasing patient demands and ageing populations must be aware that this transformation entails substantial risks of digital health inequity. This dissertation demonstrates that there is limited evidence and knowledge on how to implement digital health

transformations in an equitable manner. By addressing this gap, the dissertation contributes to the emerging evidence base needed to design context-sensitive, inclusive, and equitable digital health systems, and underscores the urgency of ensuring that digital transformations in healthcare benefit all populations.

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Appendix



Summary

Nederlandse Samenvatting [Dutch Summary]

Acknowledgements

About the Author

List of Publications



Summary

Healthcare systems across Western societies are facing two major intertwined challenges. The first is the persistent problem of health inequity. The second is the increasing pressure on healthcare systems caused by ageing populations, the rising prevalence of chronic and non-communicable diseases (CNDs), and shortages in the healthcare workforce. These challenges threaten health outcomes, healthcare accessibility, and the sustainability of healthcare systems.

Health inequity refers to avoidable and unfair differences in health outcomes between socially advantaged and disadvantaged groups. Across Europe and other Western societies, people with a low socioeconomic position (SEP) experience worse health outcomes, higher disease burdens, and shorter life expectancies than people with a high SEP. Research increasingly demonstrates that these inequities are largely driven by the social determinants of health (SDOH): the social, economic, political, and environmental conditions in which people are born, grow, live, work, and age. Although healthcare systems continue to invest heavily in medical care and treatment, substantial health inequities persist, indicating that broader societal factors play a crucial role in shaping health outcomes.

At the same time, healthcare systems are under increasing strain. Improved living conditions and medical advances have contributed to longer life expectancy, but also to a growing prevalence of chronic diseases that require long-term care. Combined with ageing populations and workforce shortages, this has created an urgent need for healthcare systems to become more efficient and sustainable. In response, governments, healthcare organizations, and industry increasingly promote digital health as a solution to these challenges.

Digital health refers to the use of information and communication technologies in support of health and healthcare. Through websites, patient portals, mobile applications, telemedicine, wearable devices, and other digital tools, healthcare systems aim to improve access to care, support self-management, facilitate communication between patients and healthcare professionals, and increase the efficiency of healthcare delivery. Digital health therefore holds considerable promise for patients, healthcare organizations, and public health.

However, alongside this promise, concerns have emerged regarding the impact of digital health on health inequity. Growing evidence suggests that people with a low SEP are less likely to access, use, and benefit from digital health services.

As healthcare systems become increasingly dependent on digital technologies, unequal access to digital healthcare may result in unequal access to healthcare itself. Understanding the causes and consequences of digital health inequity is therefore essential to ensure that digital transformation contributes to, rather than undermines, equitable healthcare.

The study of digital health inequity can be understood through the lens of the Digital Divide model. This model describes digital participation as a sequential process consisting of access, use, and benefit. Successful digital participation depends not only on having physical access to digital technologies but also on motivation, digital skills, opportunities for meaningful use, and the ability to translate digital engagement into beneficial outcomes. Previous research has shown that people with fewer social, economic, and cultural resources experience barriers throughout this process. Within digital health research, these barriers are commonly associated with lower e-health literacy, lower confidence in using digital technologies, lower awareness of digital health services, and digital health interventions that insufficiently accommodate the needs of vulnerable populations.

Despite increasing recognition of digital health inequity, important knowledge gaps remain. Most research focuses on specific digital health interventions, clinical trial settings, or individual-level determinants. Consequently, limited insight exists into how digital health inequity manifests at the population level and how it is experienced in everyday life. Furthermore, research often emphasizes individual characteristics and technological design, while health inequity research consistently demonstrates that organizational and societal factors are equally important in shaping opportunities for health. This dissertation addresses these gaps by studying digital health inequity from a population-level, and an ecological perspective.

The central research question of this dissertation was:

"What are the challenges in access to digital health for low socioeconomic positioned groups?"

To answer this question, two sub-questions were addressed:

1. *How does digital health inequity manifest at the population level?*
2. *What factors influence engagement with and support for digital health use among people with a low socioeconomic position?*

The quantitative studies demonstrated that digital health inequity manifests at the population level in the Netherlands. Socioeconomic differences in digital

health access and use were observed both among the Dutch general population and among adults with chronic diseases. Educational attainment emerged as the most consistent indicator of digital health inequity. Individuals with lower educational attainment reported lower motivation to use digital health, lower use of digital health applications, greater uncertainty about digital health use, and lower levels of digital engagement overall. Importantly, these disparities remained visible among people living with chronic diseases, despite their greater need for healthcare services and more frequent interactions with the healthcare system. These findings suggest that participation in a highly digitized healthcare system does not automatically result in equitable access to digital healthcare.

The qualitative studies and literature review broadened understanding of how digital health inequities arise. Participants who attended the DigiVitaler digital health skills course often described feeling excluded from an increasingly digital society and struggling to keep up with technological developments. Their motivation to engage with digital health was primarily driven by a sense of urgency, such as fear of losing access to healthcare, losing independence, or becoming unable to support family members as caregivers. Lack of digital skills was the most important barrier to digital health use, but participants also described limited informal support and uncertainty regarding digital technologies.

The perspectives of DigiVitaler trainers highlighted that different population groups experience different barriers to digital health access. Older adults, people with limited literacy, people with migration backgrounds, individuals with limited language skills, and people working in non-digital occupations all faced distinct challenges. Trainers also identified organizational and societal barriers, including limited awareness of available support, stigma surrounding limited digital skills, lack of digital inclusion, and insufficient collaboration between healthcare organizations, public services, and community organizations. The literature review similarly revealed that evidence regarding effective delivery and implementation strategies remains fragmented and that little is known about how digital health can be introduced equitably in real-world settings.

Taken together, these findings demonstrate that digital health access and use constitute a multilayered process. Digital health inequity cannot be explained by individual characteristics such as motivation or digital skills alone. Instead, access to digital health emerges through interactions between individual, technological, organizational, and societal factors. The reach of support initiatives, the implementation of digital health interventions, the availability of

support structures, and the broader organization of healthcare all shape opportunities for digital health access and use.

One of the central reflections emerging from this dissertation is that digital health should increasingly be understood as a determinant of health. While digital health was initially viewed primarily as a technological innovation, recent developments increasingly position it within broader discussions on health inequity. Scholars have therefore proposed the concept of the Digital Determinants of Health (DDOH), referring to factors rooted in the digital world that directly or indirectly influence health and wellbeing. The findings of this dissertation support this perspective. Digital health affects health outcomes not only through individual behaviour but also through technologies, organizations, infrastructures, policies, and societal conditions. Understanding digital health as a determinant of health broadens responsibility for addressing digital health inequity and highlights the need for action beyond the individual level.

This dissertation further identifies an important knowledge gap concerning the implementation and support of digital health. While substantial attention has been devoted to the design and effectiveness of digital health interventions, much less is known about how digital health can be implemented, delivered, and supported in ways that are accessible to vulnerable populations. The findings suggest that equitable digital health systems require more than accessible technologies alone. They require equitable implementation strategies, inclusive support structures, effective outreach efforts, and collaboration between healthcare organizations, public services, community organizations, and policy makers.

The findings therefore support a shift from an individualized understanding of digital health inequity toward an ecological perspective. Similar to broader health inequities, digital health inequities emerge through interactions between individual circumstances and the wider social, organizational, and political context. Consequently, reducing digital health inequity requires attention not only to digital skills and technology design, but also to healthcare policies, public services, implementation practices, support infrastructures, and societal inclusion.

In conclusion, this dissertation demonstrates that digital health inequity is a persistent and multifaceted problem that reflects and amplifies broader social inequities in health. Socioeconomic differences in digital health access and use are visible at the population level and remain present even among people who frequently interact with healthcare systems. The findings show that digital health access is shaped by a combination of individual, organizational, and societal

factors and that current knowledge regarding equitable implementation and support remains limited. As healthcare systems increasingly rely on digital technologies to address rising healthcare demands, there is an urgent need to develop evidence-based approaches that ensure digital transformation benefits all populations. By identifying key mechanisms underlying digital health inequity and highlighting the importance of implementation and support, this dissertation contributes to the growing evidence base required to build inclusive and equitable digital health systems.

A summary of the key implications for policy, practice and future research

Implications for policy and practice

Digital health access is a multi-stage and multi-stakeholder process

- Equitable digital health requires more than accessible technologies; it also depends on equitable implementation, support structures, and outreach strategies.
- Policy should provide clarity on the purpose, quality, regulation, and organization of digital health systems.
- People with low socioeconomic position (SEP) and other vulnerable populations should be actively involved in the design, implementation, and evaluation of digital health policies and services.
- Multiple stakeholders have a role in creating equitable digital health systems, including but not limited to: healthcare organizations, municipalities, public libraries, community organizations, caregivers, and public services.

Support for digital health access should be organized strategically and tailored to target populations

- People experience diverse barriers to digital health, including limited digital skills, lack of awareness, language barriers, limited access to devices, stigma, and broader digital exclusion.
- Publicly organized support structures, such as the planned Dutch national digital health helpdesk, may improve access for vulnerable groups.
- Support initiatives should be tailored to the needs of different populations and offered through multiple organizations and trusted community settings.
- Policies should simultaneously promote positive attitudes toward digital technologies, provide material access, and facilitate skill development.

Evidence on how to reduce digital health inequities remains limited

- There is insufficient evidence on the effectiveness of implementation strategies, delivery approaches, and support initiatives in real-world settings.
- Policymakers, healthcare organizations, and support providers should systematically monitor and evaluate their initiatives.
- Without rigorous evaluation, there is a risk that policies become symbolic rather than producing meaningful reductions in digital health inequities.

Future research priorities

Understand how people respond when digital healthcare becomes essential

- Investigate whether motivation and a sense of urgency translate into sustainable digital health use.
- Explore how people with limited access to digital health respond when digital services become necessary for accessing healthcare.
- Develop strategies to prevent exclusion from both digital and traditional healthcare.

Evaluate implementation and delivery strategies in real-world settings

- Assess which approaches effectively reach and engage people with low SEP and other vulnerable populations.
- Examine how healthcare professionals and healthcare organizations influence implementation success.
- Strengthen theory-building and systematic research on equitable digital health implementation.

Study support initiatives more systematically

- Identify what types of support different populations need and which barriers support initiatives can effectively address.
- Examine how support organizations can best organize and deliver services.
- Evaluate the effectiveness, reach, and sustainability of support initiatives in practice.

Explore broader organizational and societal determinants of digital health inequity

- Investigate how healthcare systems, policies, financing structures, and public services shape digital health access and use.
- Apply ecological and systems-based approaches to better understand the complex mechanisms underlying digital health inequities

Further develop and expand the Digital Divide model

- Explore how organizational, societal, and healthcare system factors can be incorporated into existing digital divide frameworks.
- Investigate how the model can be adapted for healthcare and other contexts where access to digital services is increasingly essential.

Nederlandse Samenvatting [Dutch Summary]

De zorgsystemen in Westerse landen staan voor twee grote, met elkaar samenhangende uitdagingen. De eerste uitdaging is het aanhoudende probleem van gezondheidsverschillen. De tweede uitdaging is de toenemende druk op de zorg als gevolg van vergrijzing, de groei van het aantal mensen met chronische aandoeningen en tekorten aan zorgpersoneel. Deze ontwikkelingen zetten de toegankelijkheid, kwaliteit en betaalbaarheid van de zorg onder druk.

Gezondheidsverschillen verwijzen naar verschillen in gezondheid tussen groepen mensen die samenhangen met hun maatschappelijke positie. Mensen met een lage sociaaleconomische positie (SEP) hebben gemiddeld een slechtere gezondheid, leven minder lang en krijgen vaker te maken met ziekte dan mensen met een hogere sociaaleconomische positie. Onderzoek laat zien dat deze verschillen niet alleen worden veroorzaakt door individuele keuzes of medische factoren, maar vooral door de omstandigheden waarin mensen geboren worden, opgroeien, wonen, werken en ouder worden. Deze zogenoemde sociale determinanten van gezondheid omvatten onder meer inkomen, opleiding, werk, huisvesting en sociale omstandigheden. Ondanks grote investeringen in de gezondheidszorg blijven gezondheidsverschillen bestaan, wat laat zien dat maatschappelijke factoren een belangrijke rol spelen bij gezondheid.

Tegelijkertijd neemt de druk op de zorg toe. Mensen leven langer en hebben daardoor vaker langdurige zorg nodig voor chronische aandoeningen. In combinatie met de vergrijzing en personeelstekorten zorgt dit voor een groeiende zorgvraag. Om de zorg toegankelijk en betaalbaar te houden, zetten overheden, zorgorganisaties en bedrijven steeds meer in op het digitaliseren van de zorg.

Digitale zorg omvat het gebruik van digitale technologieën ter ondersteuning van gezondheid en zorgverlening. Voorbeelden zijn gezondheidswebsites, patiënt portalen, mobiele apps, beeldbellen met zorgverleners, draagbare meetapparatuur (wearables) en andere digitale toepassingen. Deze technologieën moeten de zorg toegankelijker en efficiënter maken, mensen ondersteunen bij het zelf beheren van hun gezondheid en de communicatie tussen patiënten en zorgverleners verbeteren. Digitale zorg biedt daardoor belangrijke kansen voor patiënten, zorgorganisaties en de samenleving als geheel.

Tegelijkertijd bestaan er zorgen dat de digitalisering van de zorg bestaande gezondheidsverschillen kan vergroten. Steeds meer onderzoek laat zien dat

mensen met een lage sociaaleconomische positie minder vaak gebruikmaken van digitale zorg en er minder voordeel uit halen. Naarmate zorg steeds afhankelijker wordt van digitale technologieën, kan ongelijke toegang tot digitale zorg leiden tot ongelijke toegang tot zorg in het algemeen. Daarom is het belangrijk om te begrijpen hoe gezondheidsverschillen die gedreven worden door de digitalisering van de zorg, ofwel digitale gezondheidsverschillen, ontstaan en hoe deze kunnen worden verminderd.

Sociaaleconomische verschillen in het gebruik van digitale zorg kunnen worden verklaard aan de hand van het Digital Divide model. Dit model beschrijft het gebruik van digitale technologieën als een proces dat bestaat uit toegang, gebruik en voordelen naderhand van het gebruik van de technologie. Om succesvol gebruik te kunnen maken van digitale technologieën zijn niet alleen een apparaat en internetverbinding nodig, maar ook motivatie, digitale vaardigheden, mogelijkheden om technologie te gebruiken en het vermogen om daar voordeel uit te halen. Mensen met minder sociale, economische en culturele hulpbronnen ervaren vaak belemmeringen in dit proces. Binnen de digitale zorg hangen deze belemmeringen onder meer samen met beperkte digitale vaardigheden, minder vertrouwen in technologie, onbekendheid met digitale zorgtoepassingen en toepassingen die onvoldoende aansluiten bij de behoeften van kwetsbare groepen.

Ondanks de groeiende aandacht voor gezondheidsverschillen die worden veroorzaakt door de digitalisering van de zorg bestaan er nog belangrijke kennishiaten. Veel onderzoek richt zich op specifieke digitale toepassingen of op individuele kenmerken van gebruikers. Daardoor is nog onvoldoende bekend hoe digitale gezondheidsverschillen zich voordoen in de algemene bevolking en hoe mensen deze in hun dagelijks leven ervaren. Ook is er relatief weinig aandacht voor de rol van organisatorische en maatschappelijke factoren, terwijl onderzoek naar gezondheidsverschillen in het algemeen laat zien dat deze factoren van groot belang zijn. Dit proefschrift draagt bij aan het opvullen van deze kennislacunes door digitale gezondheidsverschillen te onderzoeken vanuit een populatie- en ecologisch perspectief.

De centrale onderzoeksvraag van dit proefschrift luidde:

"Welke uitdagingen bestaan er bij de toegang tot digitale zorg voor mensen met een lage sociaaleconomische positie?"

Daarbij werden twee deelvragen onderzocht:

1. *Hoe komt digitale gezondheidsverschillen tot uiting op bevolkingsniveau?*
2. *Welke factoren beïnvloeden het gebruik van en de ondersteuning bij digitale zorg onder mensen met een lage sociaaleconomische positie?*

De kwantitatieve studies laten zien dat digitale gezondheidsverschillen daadwerkelijk voorkomt in Nederland. Zowel in de algemene bevolking als onder mensen met een chronische aandoening werden verschillen gevonden in toegang tot en gebruik van digitale zorg. Opleidingsniveau bleek hierbij de belangrijkste indicator. Mensen met een lager opleidingsniveau waren minder gemotiveerd om digitale zorg te gebruiken, maakten minder gebruik van digitale toepassingen en waren vaker onzeker over het gebruik ervan. Opvallend was dat deze verschillen ook zichtbaar waren onder mensen met een chronische aandoening, ondanks hun grotere behoefte aan zorg en hun frequentere contact met zorgverleners. Dit laat zien dat deelname aan een sterk gedigitaliseerd zorgsysteem niet automatisch leidt tot gelijke toegang tot digitale zorg.

De kwalitatieve studies en de literatuurstudie gaven meer inzicht in hoe deze verschillen ontstaan. Deelnemers aan de cursus DigiVitaler vertelden dat zij moeite hadden om mee te komen met de toenemende digitalisering van de samenleving. Hun motivatie om digitale zorg te gebruiken kwam vooral voort uit een gevoel van noodzaak. Zij waren bang om in de toekomst minder toegang tot zorg te hebben, hun zelfstandigheid te verliezen of familieleden niet meer goed te kunnen ondersteunen als mantelzorger. Een gebrek aan digitale vaardigheden vormde de belangrijkste belemmering, maar ook beperkte steun vanuit familie en vrienden en onzekerheid over technologie speelden een rol.

De trainers van DigiVitaler benadrukten dat verschillende groepen verschillende problemen ervaren bij het gebruik van digitale zorg. Ouderen, mensen met beperkte taal- of leesvaardigheden, mensen met een migratieachtergrond en mensen die weinig met digitale technologie werken, lopen tegen andere belemmeringen aan. Daarnaast wezen trainers op organisatorische en maatschappelijke factoren, zoals onbekendheid met beschikbare ondersteuning, schaamte over beperkte digitale vaardigheden, onvoldoende digitale inclusie en gebrekkige samenwerking tussen zorgorganisaties, publieke diensten en maatschappelijke organisaties. De literatuurstudie liet zien dat er weinig kennis beschikbaar is over effectieve manieren om digitale zorg op een toegankelijke en inclusieve manier aan te bieden.

Gezamenlijk laten deze bevindingen zien dat toegang tot en gebruik van digitale zorg een complex en gelaagd proces is. Digitale gezondheidsverschillen kan niet uitsluitend worden verklaard door individuele factoren zoals motivatie of digitale vaardigheden. Ze ontstaan door een samenspel van individuele, technologische, organisatorische en maatschappelijke factoren. De manier waarop digitale zorg wordt geïmplementeerd, hoe de ondersteuning in toegang en gebruik wordt georganiseerd, welke doelgroepen worden bereikt en hoe de zorg als geheel is ingericht, beïnvloeden allemaal de mogelijkheden van mensen om digitale zorg te gebruiken.

Een belangrijke conclusie van dit proefschrift is dat digitale zorg steeds meer moet worden gezien als een factor die gezondheid beïnvloedt. Waar digitale zorg aanvankelijk vooral werd beschouwd als een technologische vernieuwing, wordt zij tegenwoordig steeds vaker gezien als een determinant van gezondheid. Hierbij wordt gesproken over de zogenoemde digitale determinanten van gezondheid: factoren uit de digitale wereld die direct of indirect invloed hebben op gezondheid en welzijn. De bevindingen van dit proefschrift ondersteunen deze gedachte. Digitale zorg beïnvloedt gezondheid niet alleen via het gedrag van individuele gebruikers, maar ook via technologie, organisaties, infrastructuur, beleid en maatschappelijke omstandigheden. Hierdoor ligt de verantwoordelijkheid voor het verminderen van digitale gezondheidsverschillen niet alleen bij individuele burgers, maar ook bij organisaties, beleidsmakers en de samenleving als geheel.

Daarnaast laat dit proefschrift zien dat er nog veel onbekend is over hoe digitale zorg op een inclusieve manier kan worden geïmplementeerd en mensen kunnen worden ondersteund in toegang en gebruik. Hoewel veel onderzoek zich richt op de ontwikkeling van digitale toepassingen, is veel minder bekend over hoe deze toepassingen mensen daadwerkelijk bereiken en hoe zij daarbij ondersteund kunnen worden. De resultaten laten zien dat toegankelijke technologie alleen niet voldoende is. Ook de manier waarop digitale zorg wordt aangeboden, de beschikbaarheid van ondersteuning en de samenwerking tussen verschillende organisaties zijn essentieel om de digitale gezondheidsverschillen te verkleinen.

De bevindingen ondersteunen daarom een bredere, maatschappelijke benadering van digitale gezondheidsverschillen. Net als andere gezondheidsverschillen ontstaan zij uit de wisselwerking tussen persoonlijke omstandigheden en de sociale, organisatorische en politieke omgeving. Het verkleinen van digitale gezondheidsverschillen vraagt daarom niet alleen om aandacht voor digitale vaardigheden en gebruiksvriendelijke technologie, maar

ook om passend beleid, goede ondersteuning, toegankelijke dienstverlening en een inclusieve samenleving.

Concluderend laat dit proefschrift zien dat digitale gezondheidsverschillen een hardnekkig en veelzijdig probleem vormen dat bestaande gezondheidsverschillen weerspiegelt en kan versterken. Sociaaleconomische verschillen in toegang tot en gebruik van digitale zorg zijn zichtbaar in de Nederlandse bevolking en zijn zelfs aanwezig onder mensen die veel contact hebben met de zorg. De resultaten laten zien dat digitale zorg wordt beïnvloed door een combinatie van individuele, organisatorische en maatschappelijke factoren, terwijl kennis over effectieve en inclusieve manieren van implementatie en ondersteuning nog beperkt is. Nu de zorg steeds verder digitaliseert om de groeiende zorgvraag op te vangen, is het van groot belang om te investeren in kennis over hoe digitale zorg voor iedereen toegankelijk kan blijven. Dit proefschrift draagt daaraan bij door inzicht te geven in de mechanismen achter digitale gezondheidsverschillen en door het belang van ondersteuning, implementatie en maatschappelijke context te benadrukken.

Samenvatting van de belangrijkste implicaties voor beleid, praktijk en toekomstig onderzoek

Implicaties voor het beleid en de praktijk

Het realiseren van een inclusief digitaal zorgsysteem is een gelaagd en multi-sectoraal proces

- Een inclusief digitaal zorgsysteem vraagt om meer dan alleen toegankelijke technologie; het hangt ook af van inclusieve implementatie, ondersteuningsstructuren en outreach-strategieën.
- Beleid moet duidelijkheid bieden over het doel, de kwaliteit, regulering en organisatie van digitale zorgsystemen
- Mensen met een lage sociaaleconomische positie (SEP) en andere kwetsbare groepen moeten actief worden betrokken bij het ontwerp, de implementatie en de evaluatie van beleid en diensten rond digitale zorg.
- Verschillende stakeholders spelen een rol in het realiseren van rechtvaardige digitale zorgsystemen, waaronder zorgorganisaties, gemeenten, openbare bibliotheken, maatschappelijke organisaties, mantelzorgers en publieke diensten.

Ondersteuning voor toegang tot digitale zorg moet strategisch worden georganiseerd en afgestemd op doelgroepen

- Mensen ervaren uiteenlopende barrières bij digitale zorg, waaronder beperkte digitale vaardigheden, gebrek aan bewustzijn, taalbarrières, beperkte toegang tot apparaten, stigma en bredere digitale uitsluiting.
- Publiek georganiseerde ondersteuningsstructuren, zoals de geplande landelijke digitale zorg-hulplijn, kunnen de toegang voor kwetsbare groepen verbeteren.
- Ondersteuningsinitiatieven moeten worden afgestemd op de behoeften van verschillende groepen en worden aangeboden via meerdere organisaties en vertrouwde community contexten.
- Beleid moet tegelijkertijd inzetten op het bevorderen van een positieve houding ten opzichte van digitale technologie, het bieden van materiële toegang en het versterken van digitale vaardigheden.

Bewijs voor aanpakken die digitale gezondheidsverschillen verminderen moet worden gehaald uit de praktijk

- Er is onvoldoende bewijs over de effectiviteit van implementatiestrategieën, uitvoeringsvormen en ondersteuningsinitiatieven in de praktijk.
- Beleidsmakers, zorgorganisaties en aanbieders van ondersteuning zouden hun initiatieven systematisch moeten monitoren en evalueren.
- Zonder grondige evaluatie bestaat het risico dat beleid vooral symbolisch blijft en het geen daadwerkelijke vermindering van digitale gezondheidsverschillen oplevert.

Implicaties voor toekomstig onderzoek

Onderzoeken en begrijpen hoe mensen zullen reageren wanneer de digitale zorg noodzakelijk wordt

- Onderzoeken of motivatie en een gevoel van urgentie leiden tot duurzaam gebruik van digitale zorg.
- Verkennen hoe mensen met beperkte toegang tot digitale zorg reageren wanneer digitale diensten noodzakelijk worden voor toegang tot zorg.
- Strategieën ontwikkelen om uitsluiting van zowel digitale als traditionele zorg te voorkomen.

Implementatie- en uitvoeringsstrategieën evalueren in de praktijk

- Onderzoeken welke aanpakken effectief zijn in het bereiken en betrekken van mensen met een lage SEP en andere kwetsbare groepen.
- Bestuderen hoe zorgprofessionals en zorgorganisaties het succes van implementatie beïnvloeden.

- Theorieontwikkeling en systematisch onderzoek naar inclusieve implementatie strategieën van digitale zorg versterken.

Ondersteuningsinitiatieven systematischer bestuderen

- In kaart brengen welke vormen van ondersteuning verschillende groepen nodig hebben en welke barrières tot toegang en gebruik van digitale zorg daarmee kunnen worden weggenomen.
- Onderzoeken hoe organisaties die ondersteuning bieden dit het best kunnen organiseren en uitvoeren.
- De effectiviteit, reikwijdte en duurzaamheid van ondersteuningsinitiatieven in de praktijk evalueren.

Breder onderzoek naar organisatorische en maatschappelijke determinanten van digitale gezondheidsverschillen

- Onderzoeken hoe zorgsystemen, beleid, financieringsstructuren en publieke diensten digitale toegang en gebruik beïnvloeden.
- Ecologische en systeemgerichte benaderingen toepassen om de complexe mechanismen achter digitale gezondheidsverschillen beter te begrijpen.

Verdere ontwikkeling en uitbreiding van het Digital Divide model

- Onderzoeken hoe organisatorische, maatschappelijke en zorgsysteemfactoren kunnen worden geïntegreerd in het bestaande Digital Divide model
- Bestuderen hoe het model kan worden aangepast aan de zorgcontext en andere domeinen waarin toegang tot digitale diensten steeds essentiëler wordt.

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About the Author



Lucille Standaar was born on May 10, 1994, in Rotterdam, the Netherlands. She obtained a bachelor Biomedical Sciences from Utrecht University in 2017. During her bachelor's degree, Lucille was a full-time board member of the study association M.B.V. Mebiose. Additionally, she was a student member of the Bachelor Advisory Council. These extracurricular activities expanded her interest into policy and governance and led her to follow a minor in political sciences at the Australian National University in Canberra, Australia followed by attending the advanced research master Global Health at the Vrije Universiteit Amsterdam.

The minor and the master program forced Lucille to expand her beta-focused brain and learn about new ways of conducting science. This led to a greater and different understanding of the world and showed her how important context is for people to achieve and remain in good health.

In 2021, she started the PhD program from Tilburg University at the Rijksinstituut voor Milieu en Volksgezondheid (RIVM) and Nivel. Lucille's PhD program was supervised by Prof. dr. Roland Friele (Nivel and Tilburg University), dr. Lilian van Tuyl (Nivel) and dr. Roos van der Vaart (de Haagse Hogeschool). Lucille was a project member from the E-healthmonitor (currently, Monitor Digitale Zorg), while conducting her PhD. This set-up provided the opportunity to conduct research and participate in monitoring and evaluation projects in a semi-governmental context. The PhD program had no research outline at the start, however, Lucille and the team quickly decided on the accessibility of e-health for people with a low socio-economic position (SEP) to be the main topic. In this trajectory, Lucille had the opportunity to conduct quantitative and explorative qualitative research in collaboration with the Erasmus MC and Stichting DigiSterker.

Since February 2026, Lucille is working as a consultant Care, Consumer and Society [Zorg, Consument en Maatschappij] at the Royal Netherlands Standardization Institute [Stichting Koninklijk Nederlands Normalisatie

Instituut]. In this role, she guides the development and implementation of international, European and Dutch standards. It is her role to facilitate the development of standards that foster international trade, innovation, safety, efficiency, and sustainability of products and services. Standards shape the requirements for how the world operates and provide guidance for stakeholders to improve societal issues such as access to healthcare. A representation of all relevant stakeholders, including commercial, governmental, societal partners, and end-users is key to acceptable and effective standards. In this sense, digital health systems and standards are not too different from one another. The skills, experience and insights Lucille has gathered through her PhD program will support her to contribute to her personal goal: to contribute to a world where societies are designed to support and provide enough for all.

List of publications

Scientific publications

Lucille M.B. Standaar, Lilian H.D. van Tuyl L, Anita Suijkerbuijk, Anne Brabers, Roland D. Friele. Differences in eHealth Access, Use, and Perceived Benefit Between Different Socioeconomic Groups in the Dutch Context: Secondary Cross-Sectional Study. *JMIR Form Res.* 2025 Jan 7;9:e49585. doi: 10.2196/49585.

Lucille M.B. Standaar, Rosalie van der Vaart, Juliane Menting, Karlijn Leenaars, Roland D. Friele, Lilian H.D. van Tuyl. Digital Health Use Across Socioeconomic Groups in Patients with a Chronic Disease. *Submitted*

Lucille M.B. Standaar, Adriana M.C. Israel, Rosalie van der Vaart, Brigitta Keij, Frank J. van Lenthe, Roland D. Friele, Mariëlle A. Beenackers, Lilian H.D. van Tuyl. The Motivations of Citizens to Attend an eHealth Course in the Public Library: Qualitative Interview Study. *JMIR Form Res.* 2025 Apr 28;9:e60612. doi: 10.2196/60612.

Lucille M.B. Standaar, Adriana M.C. Israel, Rosalie van der Vaart, Brigitta Keij, Roland D. Friele, Mariëlle A. Beenackers, Lilian H.D. van Tuyl. Support in digital health skill development for vulnerable groups in a public library setting: perspectives of trainers. *Front. Digit. Health* 2025 Jan 6:1519964. doi: 10.3389/fdgth.2024.1519964

Lucille M.B. Standaar, Rosalie van der Vaart, Karlijn Leenaars, Ronald D. Friele, Lilian H.D. van Tuyl. A systematic literature review to identify delivery strategies of digital health for low SEP populations. *Submitted*

Scientific publications not included in this thesis

Liza van Deursen, Anke Versluis, Rosalie van der Vaart, Lucille Standaar, Jeroen Struijs, Niels Chavannes, Jiska Aardoom. eHealth Interventions for Dutch Cancer Care: Systematic Review Using the Triple Aim Lens. *JMIR Cancer* 2022;8(2):e37093. doi: 10.2196/37093

Lilian H.D. van Tuyl, Jelle Keuper, Lucille M.B. Standaar, Eva Alblas, Brigitta Keij. Toegankelijkheid van digitale zorg: signalen uit de e-healthmonitor 2023. *TSG Tijdschr Gezondheidswet* 103 (Suppl 1), 3–7 (2025). <https://doi.org/10.1007/s12508-025-00451-7>

Policy reports

E-healthmonitor 2022: hulp bij digitale zorg uit de bibliotheek als onderdeel van het sociale domein.

<https://www.rivm.nl/publicaties/e-healthmonitor-2022-hulp-bij-digitale-zorg-vanuitbibliotheek-als-onderdeel-van>

E-gezondheidsmonitor 2022. Stand van zaken digitale zorg.

<https://www.rivm.nl/publicaties/ehealthmonitor-2022-stand-van-zaken-digitale-zorg>

E-healthmonitor 2021 Stand van zaken digitale zorg.

<https://www.rivm.nl/publicaties/indicatorene-healthmonitor-2021-2023-en-doelstellingen-voor-e-health>

Indicatoren E-healthmonitor 2021-2023 en doelstellingen voor e-health.

<https://www.rivm.nl/documenten/e-healthmonitor-2021-stand-van-zaken-digitale-zorg>

