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DIGITAL TECHNOLOGIES TO SUPPORT MENTAL HEALTH AMONG YOUNG PEOPLE

Metsäranta Kiki

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University of Turku

Faculty of Medicine
Department of Nursing Science
Nursing Science
Doctoral programme in Nursing Science

Supervised by

Professor, Maritta Välimäki, PhD, RN
Faculty of Medicine
Department of Nursing Science
University of Turku
Turku, Finland

Adjunct professor, Minna Anttila, PhD
Faculty of Medicine
Department of Nursing Science
University of Turku
Turku, Finland

Reviewed by

Professor, Outi Kanste
Faculty of Medicine
Research Unit of Health Sciences and Technology
University of Oulu
Oulu, Finland

Professor, Pilvikki Absetz
Faculty of Social Sciences
Health Sciences
University of Tampere
Tampere, Finland

Opponent

Professor, Eija Paavilainen
Faculty of Social Sciences
Health Sciences
University of Tampere
Tampere, Finland

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To my family

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KIKI METSÄRANTA: Digital technologies to support mental health among young people
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ABSTRACT

The aim of this study was to describe how digital technologies can support young people in mental health services. An explorative mixed methods study was conducted in three phases. First, a systematic literature review was carried out between 2011 and 2013, followed by a meta-analysis of three studies to examine the effectiveness of a virtual reality intervention used in specialized psychiatric care. Second, the use of an electronic diary (e-diary) was explored among young people (n=89) who were clients of adolescent psychiatric outpatient clinics between 2008 and 2010 due to depressive symptoms. Third, the use of web-based community services aimed at young people (n=2,193) in 2018 was explored. In the second and third stages, quantitative data were analyzed with descriptive analysis and qualitative data with inductive thematic analysis.

No quality evidence for or against virtual reality usage among people with serious mental health problems was found in the systematic review and meta-analysis. The young people's long-term use of the e-diary was low, and nearly half of the participants did not use it at all. Those who did use the e-diary had previous experiences in mental health services and had more severe symptoms of depression than those who did not use it. Most of the young people who used digital technologies during treatment at the adolescent psychiatric outpatient clinics and in the community were females. According to the study results, digital technologies were most often used in the evenings and during the school year. Young people openly discussed their mental health and their personal issues such as relationships, identity, social life, health and illnesses, and self-perception.

Digital technologies have the potential to help young people monitor their behavior, symptoms, and experiences and get support when they need it. When developing and implementing mental health support based on digital technologies, it is important to consider the different mental health and gender-specific needs of young people, as well as their readiness to use digital technologies to support their own mental health and well-being.

KEYWORDS: digitalization, mental health, mental well-being, mixed-method, technology, young people

TURUN YLIOPISTO
Lääketieteellinen tiedekunta
Hoitotieteen laitos
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Hoitotieteen tohtoriohjelma
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TIIVISTELMÄ

Tämän tutkimuksen tavoitteena oli kuvata, miten digitaalisia teknologioita voidaan käyttää nuorten mielenterveyden tukena mielenterveyspalveluissa. Tutkimus toteutettiin kolmessa vaiheessa. Ensimmäisessä vaiheessa systemaattinen kirjallisuuskatsaus tehtiin vuosina 2011–2013, jonka jälkeen tehtiin meta-analyysi kolmesta tutkimuksesta, joissa tutkittiin virtuaalitodellisuusintervention tehokkuutta psykiatrian erityispalveluissa. Toisessa vaiheessa sähköisen päiväkirjan (e-päiväkirjan) käyttöä tutkittiin nuorisopsykiatrian poliklinikoilla masennusoireiden takia vuosina 2008–2010 asiakkaina olleiden nuorten (n=89) keskuudessa. Kolmannessa vaiheessa tutkittiin vuonna 2018 nuorille (n=2,193) suunnattujen verkkopohjaisten palvelujen käyttöä. Toisessa ja kolmannessa vaiheessa kvantitatiivisia tietoja analysoitiin kuvailevalla analyysillä ja kvalitatiivisia tietoja induktiivisella temaattisella analyysillä.

Systemaattisen katsauksen ja meta-analyysin perusteella virtuaalitodellisuus-interventioiden hyödyistä tai haitoista vakavien mielenterveysongelmien hoidossa ei löytynyt laadukasta näyttöä. Nuorten pitkäaikainen e-päiväkirjan käyttö oli vähäistä ja lähes puolet osallistujista eivät käyttäneet sitä lainkaan. E-päiväkirjaa käyttäneillä oli aiempaa kokemusta mielenterveyspalveluista ja heillä oli vakavampia masennusoireita kuin heillä, jotka eivät sitä käyttäneet. Nuoret, jotka käyttivät digitaalisia teknologioita nuorisopsykiatrisen polikliinisen hoidon aikana tai verkkopohjaisissa palveluissa, olivat pääasiassa naispuolisia. Tämän tutkimuksen tulosten mukaan digitaalisia teknologioita käytettiin useimmiten iltaisin ja kouluvuoden aikana. Nuoret keskustelivat avoimesti mielenterveydestään ja henkilökohtaisista asioistaan, kuten ihmissuhteistaan, identiteetistään, sosiaalisesta elämästään, terveydestään ja sairauksistaan sekä miten he näkivät ja kokivat itsensä.

Digitaaliset teknologiat luovat mahdollisuuksia auttaa nuoria seuraamaan käyttäytymistään, oireitaan tai kokemuksiaan sekä saamaan tukea, silloin kun he sitä tarvitsevat. Digitaaliseen teknologiaan perustuvaa tukea kehitettäessä ja toteutettaessa on tärkeää ottaa huomioon nuorten erilaiset mielenterveys- ja sukupuolikohtaiset tarpeet sekä heidän valmiutensa käyttää digitaalista teknologiaa oman mielenterveyden ja hyvinvoinnin tukemiseen.
AVAINSANAT: digitalisaatio, hyvinvointi, mielenterveys, monimenetelmä, nuoret, teknologia

Table of Contents

List of figures and tables

Figures

Tables

Abbreviations

AI	Artificial intelligence
APP	Application
BDI-21	Beck Depression Inventory
BIT	Behavioral Intervention Technology
BIT model	Behavioral Intervention Technology Model
CDRS	Cochrane Database of Systematic Reviews
C-GAS	Children's Global Assessment Scale
CI	Confidence intervals
CINAHL	Cumulative Index to Nursing and Allied Health Literature
CSzG	Cochrane Schizophrenia Group
e-diary	Electronic diary
EU	European Union
FITT	Fit between Individuals, Task and Technology framework
GRADE	The Grading of Recommendations Assessment, Development and Evaluation
GRADEPRO	GRADE profiler
HUS	HUS Helsinki University Hospital
ICR	Inter coder reliability
ID	Personal identifier
ISRCTN	International Standard Randomized Controlled Trial Number
MD	Mean differences
MLL	The Mannerheim League for Child Welfare
NICE	National Institute for Health and Care Excellence (the United Kingdom)
NIH	National Institutes of Health (the United States of America)
NVivo	The qualitative data analysis software
OECD	The Organization for Economic Cooperation and Development
RCT	Randomized controlled trial
RD	Risk difference
RevMan5	Review Manager
SMS	Short message services
SNS	Social network sites

SOSTE	Suomen sosiaali ja terveys ry
TAM	The Technology Acceptance Model
TENK	The Finnish National Board on Research Integrity
UN	United Nations
UTAUT	The Unified Theory of Use and Acceptance of Technology
VR	Virtual reality
WHO	World Health Organization
WMA	The World Medical Association

List of Original Publications

This dissertation is based on the following original publications, which are referred to in the text by their Roman numerals:

I Välimäki M, Hätönen HM, Lahti ME, Kurki M, Hottinen A, Metsäranta K, Riihimäki T, Adams CE. Virtual reality for treatment compliance for people with serious mental illness. *Cochrane Database of Systematic Reviews*, 2014; (10) Art. No.:CD009928.

II Metsäranta K, Kurki M, Välimäki M, Anttila M. How Do Adolescents Use Electronic Diaries? A Mixed-Methods Study Among Adolescents With Depressive Symptoms. *Journal of Medical Internet Research*, 2019; 21(2):e11711.

III Metsäranta, K, Anttila, M, Pajamäki, T, Holappa, H, Välimäki, M. Web messaging among young people in online services: A descriptive mixed-methods study. *Digital Health*, 2022;8.

IV Metsäranta K, Anttila M, Pajamäki, T, Holappa H, Välimäki M. The usage of a chat-based helpline service for young people: a nationwide descriptive study. Manuscript.

1 Introduction

Young people are living in one of the most rapid and formative stages of human development (WHO, 2020). This stage is a time of opportunity and vulnerability in terms of mental health, where experiences can protect future mental health or increase the risk of experiencing mental health problems (Dahl & Suleiman, 2017; Fusar-Poli, 2019; Mcgorry et al., 2022; WHO, 2022). All young people have the potential to improve their mental health and well-being (Lerner et al., 2011; Zava et al., 2022). Distress and struggles are a part of normal development for this age group. This period can be daunting, with possible increased exposure to risk and loss, as well as an increase in feelings of stress and frustration, which can lead to mental health problems. It is important that youth-friendly support is available to young people when they need it, in order to reduce mental health problems and improve well-being (Slade, 2010). Appropriate support and protection during this period can help young people reach healthy adulthood (National Academies of Sciences Engineering and Medicine, 2019). However, the prevailing situation of mental health services for young people in Finland is that the needs of young people seeking help for mental health problems cannot be adequately met (Huikko, 2023; Linnaranta et al., 2023).

Recent guidelines have recommended that promotional and preventive mental health support for young people be implemented close to their own environment, for example, in schools, social and healthcare services, communities, or through digital platforms (Vorma et al., 2020; WHO, 2020). Digital technology can open up new opportunities for mental health services as well as opportunities to improve the overall efficiency of mental health services (Baumgart et al., 2022). Digital technology can also be used to support and facilitate the delivery of services for individuals at different stages of mental health (Doraiswamy et al., 2019; Hennemann et al., 2018; Patel et al., 2018). This could be especially useful to those who would not otherwise seek or receive support (Doraiswamy et al., 2019; Kabacińska et al., 2022; Montagni et al., 2020; Torous et al., 2021) and for those who want to improve their coping strategies for mental health problems (Wies et al., 2021).

Digital technology is an important part of the daily lives of young people, so unsurprisingly, they use it to seek information or help related to mental health (Kendal et al., 2017; Van Meter et al., 2019). For young people with mental health problems, digital technology can be used to improve help-seeking (Johnson et al., 2021; MacDonald et al., 2018), to provide support, and treatment (Rost et al., 2020; Välimäki et al., 2017; Verran et al., 2018). The use of digital technology can facilitate a young person's autonomy and privacy, and increase their sense of control and empowerment (Pretorius et al., 2019; Wies et al., 2021), which can enable them to participate more actively in their own care (Wies et al., 2021).

The aim of this study was to describe digital technologies that support the mental health of young people. The study was conducted in three phases. Phase I involved a systematic literature review and meta-analysis to describe the effectiveness of digital technology used in the treatment of people with serious mental health problems in specialized psychiatric services (Paper I). Phase II and Phase III focused on the usage of digital technologies used to support the mental health and well-being of young people in psychiatric outpatient services (Paper II) and in the community (Papers III and IV). This study is linked to the Depis.Net project (ISRCTN80379583). Data was collected from the Depis.Net web-based support system (Paper II) and from the web-based services of the Mannerheim League for Child Welfare (MLL) that targeted young people (Papers III, IV). The Depis.Net web-based support system was developed at the Department of Nursing Science at the University of Turku (Välimäki et al., 2012), and young people in adolescent outpatient clinics in Finland used this web-based intervention as a supplement to their usual care. The MLL web-based services were aimed at all young people in Finland.

This dissertation was conducted within the discipline of nursing science. The nursing metaparadigm as described by Fawcett (1984) includes domains of person, health, nursing, and the environment (Fawcett, 1984). Recently, technology has been proposed as the fifth meta-paradigm domain because it is already embedded in healthcare. In addition, technology is and will continue to be, an important and integral part of nursing work (Ahonen et al., 2021; Johnson & Carrington, 2023). In this study, nursing metaparadigm domains are seen as follows: *person* means young people. *Health* means the mental health or well-being of young people. *Nursing* is defined as an integral part of the healthcare system, which encompasses the promotion and prevention of mental health in young people and the care of young people with mental health problems in all healthcare and other community settings (International Council of Nurses, 2023). *Environment* in this study refers to the setting in which young people use digital technology, for example, specialized care, outpatient care, and community. *Technology* in this study is digital technologies used to support the mental health of young people.

2 Review of the Literature

2.1 Mental health in young people and available services

2.1.1 Mental health in young people

Mental health is a fundamental part of good health and good quality of life. It is defined by the broad concepts of well-being and functioning (Patel et al., 2018; WHO, 2022). The World Health Organization (WHO, 2022) has stated that mental health is not just the absence of mental health disorders or problems; it is an integral part of overall health and well-being. It is an asset or resource that enables positive states of well-being and enables people to reach their potential (WHO, 2022). An individual's well-being includes "a subjective satisfaction with their life, a positive affect or mood, and meaningful functioning and human development" (Patel et al., 2018). People who experience well-being often experience positive emotions and function well from both a psychological and a social perspective (Guo et al., 2018). A person's well-being affects their functioning in areas such as independence, work, cognitive functions, finances, relationships, and free time (Palmer et al., 2021) and thus, more generally, promotes the functioning of individuals, families, communities, and society (Barry, 2009).

Young people are in a sensitive transition phase to adulthood (McDonagh et al., 2018; Mcgorry et al., 2022; Sawyer et al., 2018, 2012). Various definitions and names have been used for this transition stage. According to the Convention on the Rights of the Child, people under 18 are considered children (UN, 1989), according to WHO people 10–19 years old are considered adolescents (WHO, 2017), and those under 25 are considered young people (WHO, 2015). For the purposes of this research, the term *young people* refers to individuals between 10 and 25 years old. This phase is typically connected to an interplay of physical, cognitive, social, and emotional development and changes (Dahl & Suleiman, 2017; Hochberg & Konner, 2020; Patel et al., 2018; Sawyer et al., 2012; Worthman & Trang, 2018). During this period, young people define their relationships with others. Their relationship with their parents changes as relationships with friends and intimate relationships tend to become more important to them. (Meeus, 2016) They form their independent identity

and make decisions regarding their education and profession. (Lewis, 2006; Mcgorry et al., 2022; Rickwood et al., 2005). They also may experience distress and struggles, which can be seen as a normal and strong development toward adulthood (Mcgorry et al., 2022). This unique period of transition to adulthood is also a time of mental health vulnerability and opportunity, where experiences can be protective of future mental health or increase the risk of experiencing mental health problems (Dahl & Suleiman, 2017; Fusar-Poli, 2019; Mcgorry et al., 2022; WHO, 2022). Appropriate support and protection during this period can lead to young people forming healthy relationships, developing their identity and self-esteem (National Academies of Sciences Engineering and Medicine, 2019), and thus supporting their mental health.

Mental health is not the same as the absence of mental health problems (Fusar-Poli et al., 2020; Guo et al., 2018; Palumbo and Galderisi, 2020). People with mental health problems can have well-being (Galderisi et al., 2015; WHO, 2022). On the other hand, people who do not have mental health problems may not always have well-being (Fusar-Poli et al., 2020). A fully lived life for a human being often includes feeling sad, unwell, angry, or unhappy, and this can affect a person's actions (Galderisi et al., 2017); however, these feelings and actions are not necessarily signs of mental health problems. Human life is a complex experience, and emotional experiences vary. Having good mental health enables individuals to cope with the normal stresses of life and also gives them the ability and resilience to face and deal with abnormal and potentially destructive stressors (Fusar-Poli et al., 2020). The connection between mental health and mental health problems changes throughout life (WHO, 2022). Also, the boundary between mental health and mental health problems in young people is flexible. It is important to see and understand this flexibility in order to avoid labeling the common experience as abnormal and to recognize the need for help and support in time (Mcgorry et al., 2022).

2.1.2 Mental health problems in young people

Mental health problems among young people are a worldwide problem. Mental health problems account for 45% of the global burden of disease among 0–25-year-olds (Colizzi et al., 2020). It has been estimated that 50% of mental health problems emerge by the age of 14 and 75% by the age of 24 (Jones, 2013; Kessler et al., 2005). The prevalence of mental health problems in young people is estimated to be 10–20% (Kieling et al., 2011). Mental health problems negatively impact their lives, for example, by disrupting the formation of identity and relationships, financial independence, and achievement of autonomy (Fusar-Poli, 2019; Mcgorry et al., 2022). Mental problems can also negatively impact schooling (Currie & Stabile,

2009; Leijdesdorff et al., 2020; Mcgorry et al., 2022; Patel et al., 2007) and employment (Patel et al., 2007).

Compared to their peers, young people with mental health problems are almost twice as likely to not be actively studying, working, or training (O'Dea et al., 2014); this leads to low income and low economic living standards (Gibb et al., 2010). In addition, mental health problems in young people can continue into adulthood as emotional, behavioral, and serious psychiatric problems (Patel et al., 2007). It is clear that mental health problems in young people not only affect the individual and surroundings but also the society (Mcgorry et al., 2022; WHO, 2013). Effective treatments can reduce the burden of mental health problems. However, young people who need mental health support often do not receive it. (UN Children's Fund, 2021.)

The most common mental health disorders among young people are anxiety and depressive disorders. Girls have greater rates of anxiety and depressive disorders than boys (Merikangas et al., 2009). Complex and evolving symptoms of mental health problems among young people often do not meet the criteria for receiving services, despite symptoms that manifest significant distress and impairment (Malla et al., 2016). For example, the impact of stress on the well-being and mental health of young people is significant (Anniko et al., 2019; Dahl & Suleiman, 2017; Moksnes et al., 2016): it can increase worry, which in turn may influence the development of stress-related mental health problems (Anniko et al., 2019). Mental health problems in young people are not always diagnosed as mental health disorders according to the classification system (Malla et al., 2016; Merikangas et al., 2009), which means that young people may not get the services they need.

Mental health problems among young people are multifaceted in nature. The transition from childhood to adulthood can be challenging, and it can trigger mental health problems (Mcgorry et al., 2022). Mental health problems not only include mental disorders but also psychological distress, symptoms, and conditions (OECD/EU, 2018). They can range from temporary and mild conditions to chronic and severely disabling conditions (Patel et al., 2018). Therefore, support for young people must be available when needed to reduce mental health problems and improve mental health (Slade, 2010).

2.1.3 Available services supporting the mental health and well-being of young people

Young people with mental health problems want to be seen and confronted as individuals (NICE, 2021; Persson et al., 2017). In general, communication and interaction with the people who are supporting or helping them are important for young people (Persson et al., 2017; Pitkänen et al., 2022). Young people want these

people to be friendly and trustworthy, and want to be treated with dignity and respect (Lapp, 2019). Young people with mental health problems want the opportunity to communicate openly with a mental health support provider to discuss mental health and wider personal issues (Persson et al., 2017). They want to be treated as individuals who have more than mental health issues in their lives (NICE, 2021; Persson et al., 2017). If young people are seen as passive recipients of support, they will not necessarily be heard and thus may not be understood regarding their problems and their lives in general (NICE, 2021).

In Finland, services that support the mental health of young people are offered in the community (Kalland & Sinkkonen, 2017; Pitkänen et al., 2022), primary healthcare and specialized care (Aalto-Setälä et al., 2020; Kaukonen & Repokari, 2017). In communities, a number of mental health and well-being support services for young people are provided by various third-sector organizations, complementing public-sector services (Kalland and Sinkkonen, 2017). Primary healthcare, school and educational health services, student welfare services, social services, and healthcare centers offer mental health support for young people and their families. Specialized services for young people are offered in child psychiatry, adolescent psychiatry (Aalto-Setälä et al., 2020; Kaukonen & Repokari, 2017), and adult psychiatry. On 1 January 2023, the responsibility of organizing public healthcare and social welfare changed from municipalities to well-being services counties (Finnish government, 2022). The public sector is now responsible for organizing services that support mental health among young people and services related to mental health problems. The provider of mental health support services can, however, be private or third-sector actors who supplement public health and social services (Finnish government, 2022).

In communities, various third-sector organizations offer easily accessible mental health and well-being support services for young people (Pitkänen et al., 2022). In most cases, these services are free and can be accessed anonymously and confidentially. Young people can get help and support from these services when they need it (Kalland & Sinkkonen, 2017). Third-sector organizations are non-profit actors specialized in their target groups (SOSTE, 2023). The funding of these organizations mainly comes from the government, either as a general grant or as project-based funds, according to its own strategic goals (Ruuskanen et al., 2020).

In primary healthcare, the most important services are school and educational health services and student welfare services that support and promote the mental health of young people (Ranta et al., 2018). In these services, the need for support and treatment for young people is assessed, and early support for mental health problems is offered. The service providers include a school health nurse, a doctor, a psychologist, and a school social worker (Health Care Act 1326/2010; Student Wellfare Act 1287/2013). Young people under the age of 13 and their families are

often offered mental health support in child guidance and family counseling centers belonging to social services. The mental health problems of young people are also examined in healthcare centers, where a physician, nurse, and available special workers (e.g., psychologist, occupational therapist, speech therapist) can participate in the examinations of young people (Aalto-Setälä et al., 2020). From these public healthcare services, young people can get a referral to special medical care if necessary.

Specialized mental health services for young people are offered in child psychiatry (<13 years), in adolescent psychiatry (13–17 years) (Aalto-Setälä et al., 2020), and in adult psychiatry (≥18 years). Regarding the time limits for accessing specialized mental healthcare, there are different time limits for adults and young people under the age of 23. For young people, the assessment for the need of treatment must begin within three weeks after the referral is received by the specialized care. Treatment evaluations and specialist assessments must be done within six weeks of the arrival of the referral. When a treatment is found to be necessary, it must be arranged within three months of establishing the need for treatment (Health Care Act 1326/2010). Child and adolescent psychiatry offers treatment in outpatient clinics and wards and gives consultative support to other official organizations (Aalto-Setälä et al., 2020), as does adult psychiatry. In specialized mental health services, multidisciplinary teams (e.g., physician, nurse, psychologist, occupational therapist, mental health nurse, and physiotherapist) offer examinations and support to young people and their families (Kaukonen & Repokari, 2017).

The prevailing situation of mental health services for young people in Finland is that the needs of young people seeking help for mental health problems cannot be adequately met (Huikko, 2023; Linnaranta et al., 2023). Previous reviews have shown that young people's needs for mental health support are largely unmet (Colizzi et al., 2020; Ghafari et al., 2022). It has been shown that a considerable proportion of young people with mental health problems go untreated (Ghafari et al., 2022), and their first contact and support are delayed (Fusar-Poli, 2019; Malla et al., 2016; Mcgorry et al., 2022), or they do not get appropriate care in a timely, effective manner (Costello et al., 2014; Wang, P. S. et al., 2007). In addition, the path for young people to receive mental health support is often complex and involves various formal and informal agents (MacDonald et al., 2018). Protecting and promoting mental health is not only a matter of health or social services; it requires the involvement of a wide range of sectors, and stakeholders (WHO, 2005) such as education, workplaces, social welfare, and child and youth services (Patel et al., 2018). In Finland, there is a need to improve the adequacy of low-threshold services that support the mental health of young people (Linnaranta et al., 2023).

2.2 Digital technologies in support for the mental health of young people

Digital technology provides new ways of offering mental health services to young people. Digital technology is a crucial part of young people's everyday lives, and they seek information and help from various web-based mental health resources according to their needs (Kendal et al., 2017; Van Meter et al., 2019). With digital technology, it is possible to improve help-seeking (Johnson et al., 2021; MacDonald et al., 2018), support, and treatment related to mental health problems in young people (Rost et al., 2020; Välimäki et al., 2017; Verran et al., 2018). The use of digital technology can facilitate autonomy and privacy among young people and increase their sense of control and empowerment (Pretorius et al., 2019; Wies et al., 2021), which can, in turn, enable them to participate more actively in their care (Wies et al., 2021).

In Finland, mental health support for young people based on digital technology is offered by both public healthcare and third-sector organizations. The website mentalhub.fi is run by the public healthcare sector, and includes information, psychoeducation, self-help programs, and a list of places where young people can get help (European Commission, 2023; HUS, 2023; Korhonen & Korhonen, 2018). Numerous third-sector organizations have developed telephone and internet-based support services aimed at children and young people (A-klinikkasäätiö, 2023; European Commission, 2023; Kalland & Sinkkonen, 2017; Pitkänen et al., 2022). Among these services, digital technology-based self-help and counseling services are aimed at supporting the mental health of young people (Aalto-Setälä et al., 2020). Counseling often includes concrete help and support or guidance in the service system. Counselors can be healthcare or social care professionals or trained volunteers (Kalland and Sinkkonen, 2017), services are free of charge, and most of them are open several days a week (A-klinikkasäätiö, 2023; European Commission, 2023). Young people can find information on the opening times of these services through, for example, Nuortenlinkki (A-klinikkasäätiö, 2023) or Netari.fi (Save the Children, 2023).

2.2.1 Digital technologies for mental health

Variety of digital technologies open up new opportunities for mental health services as well as opportunities to improve the overall efficiency of mental health services (Baumgart et al., 2022). By utilizing digital technologies, it is possible to provide support and facilitate the delivery of services and care to individuals at different stages of the mental health (Doraiswamy et al., 2019; Hennemann et al., 2018; Patel et al., 2018). With digital technologies, it is possible to reach those who otherwise would not apply or would not receive support, and it can be used as an adjunct or

augment to existing treatment (Doraiswamy et al., 2019; Kabacińska et al., 2022; Montagni et al., 2020; Torous et al., 2021) as well as for those who want to refine their coping strategies for mental health problems (Wies et al., 2021).

The terms and concepts used to describe digital technologies supporting mental health are not conceptually clear and consistent, and the terms used for interventions and technologies vary (De Witte et al., 2021; Halldorsson et al., 2021; Hollis et al., 2017; Von Huben et al., 2021). Mohr et al. (2013) classified behavioral intervention technologies (BITs) used to support physical, behavioral and mental health as follows: technologies connecting users and service providers, web-based interventions, mobile technologies, social media, virtual reality and chatbots, and gaming (Mohr et al., 2013). BITs are behavioral and psychological interventions that incorporate digital technology to address behavioral, cognitive, and emotional changes related to health, mental health, and well-being. These interventions use digital technologies designed to help users manage or change their behaviors, cognitions, and emotional states (Hermes et al., 2019; Mohr et al., 2015, 2013). Electronic medical records and clinical decision support programs are not included in BITs because they are not designed for intervention. However, BITs can be integrated into such systems. BITs not only provide technologies to deliver existing mental health treatments, they also offer the potential for entirely new interventions (Mohr et al., 2013).

Technologies connecting users and service providers

Digital technologies connecting users and service providers are used to facilitate, support, or replace traditional methods of contact for providing both support and treatment (Doraiswamy et al., 2019; McCashin et al., 2019; Philippe et al., 2022; Reay et al., 2020; Varker et al., 2019). For example, text-based technologies are used for symptom reporting, lifestyle, and behavioral modification (Voruganti et al., 2017), and videoconferencing or telephone calls are used for short-term symptom management (Philippe et al., 2022). The use of digital communication can enhance the autonomy, empowerment, and activation of service users (Griffiths et al., 2017).

Various digital technologies, such as telephones, videoconferencing, instant messaging, and email, are used to connect mental health service users and service providers (Berger, 2017; Gega et al., 2022; Parish et al., 2017). These technologies enable synchronous (real-time), or asynchronous (delayed) connections. With a synchronous connection, the service user and the service provider are connected to each other at the same time (Philippe et al., 2022) via voice (phone calls, voice over internet protocol), with text (chat, chat rooms), or with video (videoconferencing) (Griffiths et al., 2017, 2018). In an asynchronous connection, there is a time delay between the responses of the service user and the service provider (Philippe et al.,

2022). An asynchronous connection typically uses text-based messaging (direct messages, emails) (Caldwell et al., 2017; Di Tosto et al., 2020; Fujioka et al., 2021; Lancaster et al., 2018; Parish et al., 2017). Some technologies, such as SMS and instant messaging, can provide both synchronous and asynchronous connections (Goumi et al., 2011; Piwek & Joinson, 2016), and instant messaging can offer not only text but also online voice and video transmission (Piwek & Joinson, 2016).

Web-based mental health interventions

Web-based interventions are defined as interventions that are delivered online and have been developed to provide therapeutic activities. The aim of these activities is to prevent and improve mental health-related symptoms and increase mental health. (Gega et al., 2022; Hollis et al., 2020, 2017). Web-based interventions are based on digital technology components and intervention (De Witte et al., 2021). Web-based interventions can be complex and may include different combinations of digital technologies and multiple intervention components (Hollis et al., 2017). Interventions can contain various therapeutic components (e.g., acceptance and commitment therapy, motivational interviewing, psychoeducation, cognitive or behavioral techniques, and positive psychological interventions,) and activities (Borghouts et al., 2021; Gega et al., 2022). To support mental health improvement, interventions may include symptom assessment, education, self-care strategies (Sin et al., 2020) or medication reminders (Philippe et al., 2022).

Web-based interventions are accessed using devices—either mobile or desktop—that have a web browser (Sin et al., 2020; Von Huben et al., 2021). Web-based interventions are often standardized, automated, user-directed programs that the user accesses to get help with performing therapeutic activities; help can be accessed independently (stand-alone), with some guidance and support from the provider, or with a blended individual treatment approach (De Witte et al., 2021; Fairburn & Patel, 2017; Gega et al., 2022). The user can access stand-alone interventions as much or as often as necessary or desired according to their own preferences. In supported interventions, users are guided through core content in a specific order or over a period of time (Sin et al., 2020). The guidance can be linear, leading users step-by-step through the intervention, or more flexible, using a variety of modules with partial or total flexibility (Fairburn and Patel, 2017).

Mobile- and remote technologies supporting mental health

Digital mobile- and remote technologies serve multiple purposes in supporting mental health. With these technologies it is possible to support mental health monitoring and assessment, for example, identifying behavioral patterns and

associations, classifying them and predicting future mental health conditions/disorders (Baumgart et al., 2022; Torous et al., 2020). These technologies also provide support in a timely manner. Mobile technologies enable an exploration of within-person behavioral differences by collecting intensive individual-level data. Further, it makes possible to gather data in real time about an individual's situation, behavior, and location at a specific moment (Naslund et al., 2017). Mobile technologies also include automatically delivered short message services (SMS or text messages) or e-mails, which can be used to support the use of the intervention, for example, with reminders, information transmission, or automated text message dialogue (Mohr et al., 2013; Renfrew et al., 2020).

Mobile technologies include mobile telephones, smartphones, digital devices for measuring human performance and behavior, such as sensors (Caulfield et al., 2019), and mobile applications (apps) (Lecomte et al., 2020; Mcmillan et al., 2016; Von Huben et al., 2021). Sensors are able to collect clinical data related to physiological and behavioral parameters such as physical activity, sleep quality, heart rate, and body temperature (Baumgart et al., 2022; Moura et al., 2022). Sensors can be present in mobile devices (e.g., smartphone) as well as wearable devices (e.g., smartwatches, smart bands) (Mohr et al., 2013; Moura et al., 2022). Mobile apps are interventions designed to be used directly on the mobile devices (Kabacińska et al., 2022). Like web-based interventions, apps can also be used independently (stand-alone) in self-management, with guidance, or adjunctive to treatment (Lecomte et al., 2020; Weisel et al., 2019).

Social media intended to support mental health

Support groups and interventions can be delivered through or integrated into online forums and social network sites (Hunter et al., 2019; Zhou & Cheng, 2022). Social media can provide mental health support to both clinical and nonclinical populations (Ridout and Campbell, 2018; Rost et al., 2020). People use social media for peer contact and social network activating (De Witte et al., 2021) as well as for seeking out information and support related to their mental health problems before receiving professional care (Birnbaum et al., 2017). Social media can offer platforms where user can interact, learn, communicate, and share information (Birnbaum et al., 2017) anonymously with other people (Hanley et al., 2019). Informational and emotional support can be offered by peers, professionals, or a combination of both (Hanley et al., 2019; Prescott et al., 2017). The use of social media can be combined with supportive interventions (De Witte et al., 2021), and peer influence can be used to change behavior (Valente & Pumpuang, 2007). Social media groups or multimedia platforms (e.g., chat rooms or web-based discussion forums) in interventions can be used to encourage people to connect with others in similar situations (Rost et al.,

2020). It can also be used to complement face-to-face work with professionals in an informal setting (Hanley et al., 2019).

Social media sites are bounded systems in which users create a profile and establish and display connections with other users (Ridout and Campbell, 2018). These networks are available 24/7 (Prescott et al., 2017), and they facilitate interaction and exchanges of user-created content, verbally and visually, between people (De Witte et al., 2021; Mohr et al., 2013; Rost et al., 2020).

Virtual reality (VR) and conversational agents

Virtual reality (VR) is defined as a simulated environment that enables a digital immersion experience without the physical world (Reynard et al., 2022). Conversational agents—chatbots, virtual agents, and dialog systems—are digital technologies that can converse in natural language (Vaidyam et al., 2021). VR and conversational agents can be used to promote well-being and to improve access to mental health (Abd-Alrazaq et al., 2021; Riva & Serino, 2020). These technologies can be used for the assessment and treatment of mental health problems (Abd-Alrazaq et al., 2019; Philippe et al., 2022). VR allows individuals to learn strategies for regulating their emotions (Riva and Serino, 2020) and makes it possible to develop skills for managing mental health difficulties (Dellazizzo et al., 2020; Rus-Calafell et al., 2018; Torous et al., 2021). Chatbots, as automated systems, can detect and respond to immediate mental health needs (Torous et al., 2021). They are used to provide therapy, train, screening (Abd-Alrazaq et al., 2019), psychoeducation, coping skills (Beilharz et al., 2021), to teach behavioral activation, and to change negative thoughts (Dosovitsky and Bunge, 2023).

VR is used to create realistic environments that allow people to communicate, be present, and act in a computer-generated life-like environment (Lawes-Wickwar et al., 2018; Montana et al., 2020; Riva and Serino, 2020). In these virtual environments, users, represented as personal avatars, interact with other users in real time (Torous et al., 2021). Avatars are individualized graphic representations that are directly influenced by the actions of the participants in real time (Riva and Serino, 2020). There are two types of chatbots: rule-based chatbots have predefined rules or decision trees that manage their responses and dialogues, and intelligent chatbots involve artificial intelligence (AI)-generated dialogue (Abd-Alrazaq et al., 2020). Chatbots are systems capable of conversing and interacting with humans through spoken, written, and visual communication (Abd-Alrazaq et al., 2020; Vaidyam et al., 2019).

Serious games

Serious games are interventions in which gaming is used for serious purposes (Fleming et al., 2014). Serious games can be stand-alone interventions or game elements can be added as extensions to other interventions (Cheng and Ebrahimi, 2023). Digital technology-based games are used to prevent, promote, and educate mental health as well as to treat mental health problems (Ferrari et al., 2022). Serious games and gamification-based interventions are used to help reduce mental health complaints and improve mental health (Fleming et al., 2014; Lau et al., 2017). In serious games, playing is the central and primary medium (Fleming et al., 2014), while a gamified intervention can include game elements without being a full game experience (Fleming et al., 2017). In serious games and gamified interventions, games or game elements are used to educate, change patterns of experience or behavior, and relieve symptoms (Fleming et al., 2017; Read & Shortell, 2011). Gamified interventions involve different levels of severity, and they can be used for a wide range of mental health problems (Ferrari et al., 2022; Granic et al., 2014; Roberts et al., 2021). Typically, the duration of a serious game intervention is several weeks (Townsend et al., 2022; Xie, 2022).

Digital technology-based serious games can be delivered via various digital platforms and devices (Philippe et al., 2022). They are voluntary, include competitive and cooperative goals, and allow for a sense of control (Fleming et al., 2017; Granic et al., 2014). In addition, players can take on a role in virtual world narratives or storylines and immerse themselves in fantasy worlds (Granic et al., 2014; Xie, 2022). These worlds provide safe contexts in which negative emotions can be processed (Granic et al., 2014). Gamified interventions can use minigames (Fleming et al., 2017; Gega et al., 2022) or certain gaming elements instead of a full game experience, such as storylines, setting rules, goals, scoring of points, and in-game rewards (Fleming et al., 2017, 2014). In games, as players level up, or progress, they learn real-life knowledge and skills that can be used to manage the symptoms of their mental health conditions (Xie, 2022), and behavior changes are supported (Read & Shortell, 2011).

2.2.2 A summary of studies related to digital technologies aimed at the mental health of young people

A systematic literature searches was carried out to present the use of digital technologies in supporting the mental health of young people, and the effectiveness of these technologies. In April 2023, the PubMed (Medline), PsycInfo, and CINAHL databases were searched for studies on the use of such digital technologies. The search focused on systematic reviews, meta-analyses, and literature reviews

published in English within the 10 last years. Studies were included if they involved young people aged 12–24, digital technology according to the Mohr et al. (2013) classification of the BIT, and mental health outcomes. The search was complemented by a manual search using the reference lists of the review articles. The search strategies are presented in Appendix 1, and the flowcharts presented in Appendices 2–7 provide details of the study selection process. The included articles (N=33) are presented in Appendix 8.

Technologies connecting young people and service providers are employed in mental health support services and interaction between young people and mental health professionals (Mathieu et al., 2021; Orsolini et al., 2021; Zhou et al., 2021). Young people can easily get support for their mental health problems through mental health support services such as counseling helplines (also known as helplines, hotlines, crisis lines, etc.) (Mathieu et al., 2021). Various digital technologies are also used in the communication between mental health professionals and the young people (Orsolini et al., 2021; Zhou et al., 2021). Synchronous communication between mental health professionals and young people has been shown to be comparable to face-to-face communication (Davidson et al., 2022). The role of mental health support services for young people has been shown to be positive, but the effectiveness of these services is unclear (Mathieu et al., 2021; Verran et al., 2018) and research on the effectiveness of digital technologies connecting young people and mental health professionals is limited (Davidson et al., 2022; Verran et al., 2018).

Web-based interventions have been developed for the promotion of mental health and prevention and treatment of mental health problems among young people (Lehtimaki et al., 2021; van Doorn et al., 2021). These interventions are used for both supplementing and supplanting traditional mental health treatment (Lehtimaki et al., 2021). Preventive and promotive web-based interventions have been shown to have positive impacts on the mental health and well-being of young people (Clarke et al., 2015; van Doorn et al., 2021; Wright et al., 2023). Web-based interventions for treatment of mental health problems are effective in decreasing depressive and anxiety symptoms (Lehtimaki et al., 2021; Välimäki et al., 2017). Stand-alone interventions are effective in managing anxiety, depression, psychological stress levels, and psychological distress, and in improving mental health well-being (Babbage et al., 2022; Zhou et al., 2021). However, guided and supported web-based interventions with contact between young people and service providers are more effective than stand-alone interventions (Bennett et al., 2019; Lehtimaki et al., 2021; Välimäki et al., 2017). In general, the in-person element (professional, peer, or parent) (Lehtimaki et al., 2021; Välimäki et al., 2017) is an important part of a web-based intervention (Garrido et al., 2019; Lehtimaki et al., 2021). However, there is a

lack of information about the effects of the format and the amount of guidance and support (Bennett et al., 2019; Grist et al., 2019).

Mobile applications (apps) are integrated into the clinical environment and used in connection with treatment, allowing the professional to monitor the progress of the treatment, and offer additional support (Temkin et al., 2020). Young people who have used mobile sensor technology for tracking mood, sleep, or medication have been able to strengthen their relationship with their mental health care providers and have been encouraged to talk more openly about mental health care (Sequeira et al., 2019). There is mixed evidence on the effectiveness of mobile apps in managing mental health problems in young people (Grist et al., 2017; Leech et al., 2021; Lehtimaki et al., 2021; Punukollu & Marques, 2019; Zhou et al., 2021). Stand-alone mobile apps have potential as a gateway or supplement to current mental health support (Leech et al., 2021). It is unclear to what extent gains of treatment may be attributable to mobile apps versus to standard treatment (Temkin et al., 2020). Mobile technology research has focused on evaluating functionality, acceptability, usability, engagement, or adoption rather than effectiveness (Stewart et al., 2022; Williams & Pykett, 2022).

Social media intended to support mental health, such as online forums and social network sites (SNS), are important to young people (Zhou & Cheng, 2022) and social connection is an important component of supporting young people with mental health problems (Dewa et al., 2021). Social media can be used for therapeutic purposes. Moderated social networks are especially suitable as interventions for young people with various mental health needs (Ali et al., 2015; Dewa et al., 2021; Ridout & Campbell, 2018). There is some evidence that peer support groups can have a positive impact on quality of life and reduce depression and emotional distress (Rice et al., 2014; Ridout and Campbell, 2018) when used alone or as an adjunct to other treatment (Ali et al., 2015). However, evidence of the efficacy of peer support groups and SNS in reducing mental health symptoms is limited (Lehtimaki et al., 2021; Rice et al., 2014; Ridout & Campbell, 2018; Verran et al., 2018).

VR interventions target the mental health problems of young people such as specific phobias, symptoms of social anxiety (Farrer et al., 2013; Halldorsson et al., 2021), and psychological distress (Kelson et al., 2021). It has been shown that in a psychologically stressful situation, VR interventions can reduce negative symptoms, and improve self-efficacy and emotion regulation strategies (Kelson et al., 2021). Conversational agents have been used among young people with mental health challenges, with conflicting results on the effectiveness in managing anxiety and depression (Zhou et al., 2021). Research on VR interventions and conversational agents for supporting mental health among young people is limited, and therefore it is difficult to draw conclusions about their effectiveness (Halldorsson et al., 2021; Kelson et al., 2021; Martinez et al., 2021).

Serious games have been developed to support young people's mental health, and they can be used as alternative or adjunct form of support for mental health in young people (Martinez et al., 2021; Zayeni et al., 2020). Games and gaming interventions aimed at supporting mental health in young people are delivered via various digital platforms and devices, and young people have access to the games and interventions in their own time (Martinez et al., 2021; Xie, 2022). Some games have built-in messaging platforms that allow interaction between the service user and a service provider, as well as between players (Xie, 2022). The interactive and social components of serious games have been discussed as being some of the key factors in their effectiveness (Townsend et al., 2022). There is limited evidence on serious games that aim to promote well-being and prevent and treat mental health problems among young people (Barnes & Prescott, 2018; Choi et al., 2022; David et al., 2020; Lehtimaki et al., 2021; Martinez et al., 2021; Zayeni et al., 2020). There is some evidence that digital game interventions are effective in the treatment of depressive and anxiety symptoms (Choi et al., 2022; Halldorsson et al., 2021; Townsend et al., 2022). However, in game intervention studies, the severity and chronicity of depression symptoms have often not been considered (Townsend et al., 2022). Comparing the effectiveness of serious games has also been found to be difficult because the games are different (Martinez et al., 2021).

Digital technologies are generally used for the promotion of mental health and the prevention and treatment of mental health problems among young people. Although it is uncertain, based on the reviews, whether all digital technologies are effective in supporting young people's mental health. An exception to this are, web-based interventions at least have been shown to be effective in reducing symptoms of depression and anxiety (Bennett et al., 2019; Clarke et al., 2015; Garrido et al.,2019; Grist et al., 2019; Lehtimaki et al., 2021; Välimäki et al.,2017), especially when they include guidance and support between young people and service providers (Garrido et al., 2019; Grist et al., 2019; Hollis et al., 2017; Lehtimaki et al., 2021). However, web-based interventions are complex and consist of different components and characteristics (Clarke et al, 2015; Grist et al, 2019; Hollis et al, 2017; Välimäki et al., 2017), and it is unclear which ones make interventions more effective (Clarke et al, 2015; Hollis et al., 2017; Välimäki et al., 2017).

Overall, there are more technical possibilities than research on various digital technologies used to promote mental health, prevent or treat mental health problems of young people (De Witte et al., 2021). Therefore, it is important to study different digital technologies and intervention components and how young people use them to support their mental health (Pretorius & Coyle, 2021). This study evaluates the effectiveness of digital technology in supporting treatment compliance and describes how and for what purposes young people have used digital technologies.

2.3 Theoretical approaches to supporting usage of digital technology

There are a number of theoretical models related to the usage of digital technology (Dwivedi et al., 2019; Harst et al., 2019). Theoretical models have been developed to understand people's acceptance, behavioral intentions, and usage related to digital technology (Dwivedi et al., 2019; Oinas-Kukkonen, 2013). In this section, I describe three theoretical models related to the usage of digital technology in healthcare: the Technology Acceptance Model (TAM) (Davis, 1989; Davis et al., 1989), the Unified Theory of Use and Acceptance of Technology (UTAUT) (Venkatesh et al., 2003), and Fit between Individuals, Task and Technology framework (FITT framework) (Ammenwerth et al., 2006; Nilsson et al., 2020). In addition, I describe the Behavioral Intervention Technology Model (BIT model), which is related to developing and designing digital technologies for supporting behavior changes.

The Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) was developed by Fred Davis in the late of 1980s (Davis, 1989). TAM was developed not only to predict but also to explain technology acceptance (Davis et al., 1989). The hypothesis of TAM is that perceived usefulness (U) and perceived ease of use (EOU) are key determinants for technology acceptance (Davis, 1989; Davis et al., 1989). According to TAM, both usefulness and perceived ease of use influence individuals' attitudes towards using (A) the technology (Davis et al., 1989). Further, usefulness and attitudes towards using determine the Behavioral Intention to Use (BI) (Davis et al., 1989), which can be interpreted as technology acceptance (Holden & Karsh, 2010). This, in turn, determines the actual use of the system (Davis et al., 1989; Holden & Karsh, 2010). External variables, for example variables related to the individual, development and implementation of the technology, may impact the perceived ease of use and perceived usefulness (Davis, 1989; Davis et al., 1989).

TAM, with its extensions and modifications, is widely used in healthcare (Alqudah et al., 2021; Prgomet et al., 2019; Rahimi et al., 2018). According to systematic reviews of technology acceptance in healthcare by Rahimi et al. (2018) and Alqudah et al. (2021), TAM research has been focused mainly on three areas in health services: telemedicine, electronic health records, and mobile application. Further, TAM research has mostly involved healthcare workers (i.e., physicians, nurses, and healthcare professionals) and, to a lesser extent, patients (Alqudah et al., 2021; Harst et al., 2019; Rahimi et al., 2018).

The Unified Theory of Use and Acceptance of Technology (UTAUT)

The Unified Theory of Use and Acceptance of Technology (UTAUT) was developed in the early years of the 21st century by Venkatesh et al. (2003). The development of the UTAUT was based on an analysis and comparison of eight technology acceptance models. It was developed to predict intention and behavior of usage of technology (Venkatesh et al., 2003). The UTAUT includes four key factors: performance expectancy, effort expectancy, social influence, and facilitating conditions. The first three factors directly determine behavioral intention to use technology, while the fourth factor and behavioral intention determine technology use. In addition, the UTAUT contains four moderators that are integral features: age, gender, experience, and voluntariness, which influence all four of the key factors (Venkatesh et al., 2016, 2003).

The UTAUT and its extensions are widely used in healthcare (Alqudah et al., 2021). They have been used to explain the user's acceptance of technology in healthcare from the perspective of the patient more often than that of the healthcare provider (Harst et al., 2019).

Fit between Individuals, Task and Technology framework (FITT framework)

The Fit between Individuals, Task and Technology framework (FITT) was developed by Ammenwerth et al. in the mid-2000s (Ammenwerth et al., 2006). The development of the FITT framework was based on analysis of other technology adoption frameworks (Ammenwerth et al., 2006). It was developed specifically for the healthcare domain to identify, understand, and explain the reasons for failed or successful technology adoption (Ammenwerth et al., 2006; Prgomet et al., 2019; Tsiknakis and Kouroubali, 2009). The FITT framework is based on the idea that technology adoption in a clinical environment depends on the interaction (i.e., fit) between three main factors: individual users (e.g., technology competence, motivation and interest in the task to be performed, openness to new ways of working), tasks or work processes (e.g., activities and their interdependence, complexity of tasks), and technology (e.g., usability, functionality that supports a certain task, availability in certain situations) (Ammenwerth et al., 2006).

The FITT framework has been used in healthcare research to understand technology adoption and implementation (Kujala et al., 2020; Tsiknakis and Kouroubali, 2009), to identify factors that influence technology adoption (De Leeuw et al., 2020; Koivunen et al., 2008; Schnall et al., 2012), and to understand optimal use (Prgomet et al., 2019). The framework has been used to evaluate the use of technology by healthcare professionals (Honekamp & Ostermann, 2011; Prgomet et al., 2019) as well as patients' experiences with using technologies that support their

self-management (Ali et al., 2018; Cho et al., 2019; Nilsson et al., 2020; Zulman et al., 2015).

The Behavioral Intervention Technology Model (BIT model)

The Behavioral Intervention Technology model (BIT model) was developed in the mid-2010s by Mohr and colleagues (2014) and is based on a combination of existing theories of human behavior and conceptual and technical aspects of technology (Mohr et al., 2015, 2014). The BIT model has two broad levels: the theoretical action level and the instantiation action level in relation to which the model asks the five questions of "why", "how" theoretically, "what", "how" technically, and "when" (Mohr et al., 2015, 2014).

The theoretical action level has two components: intervention aims and behavioral strategies. These components reflect the intentions of the developers or researchers by asking the questions of "why" the BIT exists and "how" the aims can be achieved with a behavior change strategy (Mohr et al., 2015). Further, intervention aims are classified into two classes: clinical aims and usage aims. Clinical aims are defined as desired changes in behavior, cognition, or motivation that refer to the clinical goals of an intervention or treatment. Usage aims refer to maintaining user engagement with the BIT model (Mohr et al., 2014).

The instantiation action level has three components: 1) elements, 2) characteristics, and 3) workflow. These components reflect the technological instantiation by asking 1) "what" is delivered, 2) "how" the technical elements are delivered, and 3) "when" they are delivered (Mohr et al., 2015, 2014). First, BIT elements ("what") such as user interfaces, notifications, and logging are intended to implement behavior change strategies that support the user in achieving clinical and usage aims. Second, characteristics refer to "how" the elements are deployed, which includes the medium through which they are deployed (e.g., text, video, audio), complexity (e.g., tasks in simulated environment can be simple or complex depending on the target tasks and population, and users), form and esthetic, and personalization (i.e., changing the characteristics of the BIT to be more relevant for individual users) (Mohr et al., 2015, 2014). Third, workflow determines when and under which conditions the BIT model is delivered to individuals over time (Mohr et al., 2014). The workflow determines the delivery time, order, and duration of certain element sets (Mohr et al., 2015, 2014). For example, a user-defined workflow allows users to decide when and in what order BITs are used (Mohr et al., 2015).

The BIT Model has been used in systematic reviews to organize the results (Stiles-Shields et al., 2019, 2016) and development of applications (Anderson & Wallace, 2015; Yen, 2021; Zingg et al., 2021).

In this dissertation, the Behavioral Intervention Technology model (BIT model) (Mohr et al., 2014) was used as a theoretical framework for reviewing previous research and structuring and reviewing empirical results. Within digital technology, there are many technical possibilities that can be used to support the mental health and well-being of young people (De Witte et al., 2021). It is important to explore different digital technologies and to identify the components that make digital technologies effective and useful for supporting the mental health of young people (Clarke et al., 2015; Halldorsson et al., 2021; Leech et al., 2021; Välimäki et al., 2017). The BIT model was selected because it is grounded in a combination of human behavior theories and conceptual and technical aspects; therefore, it provides a theoretical framework for both studying and describing digital technologies (Mohr et al., 2015, 2014, 2013). An illustration of the BIT model with examples is presented in Figure 1.

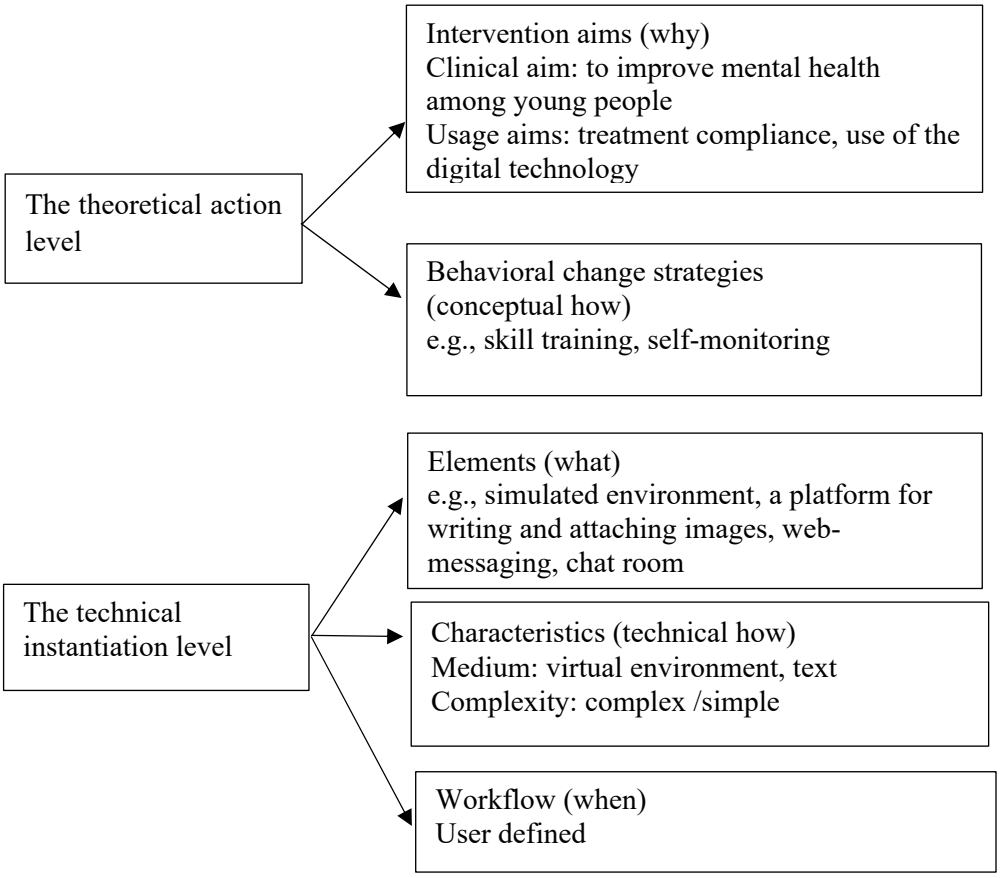

Figure 1. Theoretical action level and technical instantiation level of the Behavioral Intervention Technology model (BIT model) based on Mohr et al. 2014 with examples

3 Aims

The aim of this study was to describe how digital technology can support young people in mental health services.

The study consists of three phases, which are described below. The research questions of the phases are as follows:

Phase I: Digital technology to support mental health among people with serious mental illness in specialized psychiatric services.

Is the digital technology used in specialized psychiatric services effective in supporting compliance with treatment for people with serious mental health problems? (Paper I)

Phase II: Digital technology to support mental health among young people in psychiatric outpatient services.

How do young people use digital technology that supports mental well-being in psychiatric outpatient services? (Paper II)

Phase III: Digital technology to support mental health among young people in the community.

How do young people use digital technology that support mental well-being in the community? (Papers III and IV)

4 Materials and Methods

4.1 Methodological approach of the study

Phase I consisted of conducting a systematic review and meta-analysis. A systematic review was chosen because it provides a comprehensive process of searching for and selecting relevant research, appraising study quality, and summarizing findings (Smith et al. 2011). It utilizes systematic methods to minimize bias and provide reliable findings and evidence (Cook et al., 1997). A meta-analysis was conducted to synthesize the results of the selected studies by pooling evidence using statistical methods to determine the magnitude of overall effects and effect size (Glass, 1976).

In **Phases II** and **III**, an explorative mixed methods approach was used. The approach was chosen to gain a deeper insight into the use of digital technologies to support young people's mental health (Creswell & Plano Clark, 2018). A quantitative or qualitative approach alone would not have been sufficient for a comprehensive understanding of the use of digital technologies (Creswell & Plano Clark, 2018; NIH Office of Behavioral and Social Sciences Research, 2018). The mixed methods integration approaches used in this study were implemented in the design, the application of methods, and the interpretation and reporting of the findings (Fetters et al., 2013). First, the convergent approach was used in the research design stage. Quantitative and qualitative data were collected parallelly and analyzed separately (Creswell & Plano Clark, 2018; Fetters et al., 2013). Second, as a method of integration, a merging approach was used and data were collected from different sources (Fetters et al., 2013). Merging was done after the quantitative and qualitative data were analyzed with quantitative and qualitative analysis methods (Creswell & Plano Clark, 2018; Fetters et al., 2013). Third, for the interpretation and reporting, a contiguous approach to integration was used. According to the contiguous approach, the results were presented within a single report (Fetters et al., 2013). In the report, the results were discussed and combined to describe the use of digital technologies (Creswell & Plano Clark, 2018).

4.2 Study design

In **Phase I**, a systematic review and meta-analysis was conducted to evaluate the effectiveness (Higgins & Green, 2011) of digital technology used to support treatment compliance in the treatment of people with severe mental health problems. There is limited research on the effectiveness of digital technologies for young people with severe mental health problems, so age-related exclusion was not used (Grist et al., 2017; Verran et al., 2018). Therefore, a systematic review and meta-analysis was used to examine evidence of virtual reality that may increase treatment options for people with severe mental health problems. The systematic review was based on Cochrane review methods (Higgins & Green, 2011). (Paper I.)

Phase II was a sub-study of a randomized controlled trial (RCT), the Depis.Net study, of the effectiveness of a web-based intervention for young people with depressive symptoms (ISRCTN80379583). The mixed methods study design (Creswell & Plano Clark, 2018) was used to explore the usage of an e-diary for a web-based intervention targeting young people with symptoms of depression. Quantitative data were used to describe the background information of the participants and their use of the e-diary. Qualitative methods were used to analyze the content of the written text. The purpose of identifying the contents of e-diaries written by young people was to study how the participants used the e-diary. (Paper II.)

In **Phase III,** a population-based descriptive study design (Grove et al., 2012) with mixed-methods was used (Creswell & Plano Clark, 2018) to explore the usage of web-based services targeting young people. Quantitative methods were used to describe the users' background information and their use of the web-based services. Qualitative methods were used to explore the topics of the written texts. The purpose of identifying the content was to study why the web-based service was being used. The characteristics associated with usage were analyzed with statistical methods. (Papers III and IV.)

4.3 Study setting

In **Phase I**, the study setting included the settings of the studies selected for the meta-analysis. Those studies had been conducted in various types of research environments, from institutional hospitals to long-term care, in China, Korea, and Hong Kong in 2010–2013. In these studies, the digital technology was virtual reality (VR) programs used for skill training. (Paper I.)

In **Phase II**, six adolescent psychiatric outpatient clinics at two university central hospitals in southern Finland formed the study setting of the Depis.Net study. In 2016, over 3 million inhabitants lived in this area, which was over 55% of the Finnish

population (Kuntaliitto, 2018). There were over 300,000 young people aged 10 to 19 years old (State treasury, 2022). In these two university central hospitals, adolescent outpatient clinics provided specialized outpatient care for young people aged 13 to 17 years. A physician referral was required to access treatment. The treatment usually included a period of examination, diagnostic evaluation and a period of treatment. (Anttila et al., 2015, 2017). (Paper II.)

The Depis.Net program developed by the Department of Nursing Science at the University of Turku was the digital technology used (Välimäki et al., 2012). The Depis.Net program consisted of a six-week program with a total of five weekly themes (adolescent depression, and treatment of adolescents' depression, well-being, adolescents' rights and responsibilities, home and family) (Anttila et al., 2015, 2017; Välimäki et al., 2012). Health information, self-monitoring, and an e-diary use were also part of the program. The program was used in addition to outpatient care for young people. (Paper II.)

In **Phase III**, The Mannerheim League for Child Welfare (MLL) web-based services targeting young people formed the study setting. MLL offers support for young people free of charge via telephone and through the internet, and the services are targeted at all Finnish-speaking young people (MLL, 2012). Through the website, young people have access to the Child and Youth Helpline, which are web-based counseling services. These services offer an anonymous text-based contact channel with web messaging (asynchronous) or a chat room (synchronous) where volunteer counselors provided young people with supportive counseling in response to their needs. The volunteer counselors are adults who had been trained by professional instructors at MLL (MLL, 2012). The counselors' responses are not included in this study. (Papers III and IV.)

A web-messaging service (Paper III) and a chat room service (Paper IV) were the digital technologies used. The web messaging service was established in 2002, with two-way communication being possible since 2018. Multiple two-way communication allows for the establishing of a long-term relationship between a young person and a counselor. The messages sent by the young person and the counselor formed a single thread (Paper III). The chat room service was established in 2010. A young person and a counselor can use instant messaging in the chat room to have a single discussion without needing passwords or using a pseudonym. (Paper IV.) The study design, methods and settings in each phase are described in Table 1.

Table 1. Summary of research design, methods, and setting.

RESEARCH PHASE	DESIGN	METHODS	SETTING
PHASE I	Systematic review	Cochrane review method	Electronic databases
PHASE II	RCT sub-study	Mixed methods	Six adolescent outpatient clinics
PHASE III	Population-based descriptive study	Mixed methods	Nationwide web-based service targeted young people

4.4 Study population, sampling, and participants

In **Phase I**, the population was formed from the papers that reported on randomized controlled trial (RCT) studies about VR used to support the mental health of people with severe mental health problems. All relevant RCTs were included in the review. Altogether, 87 records were identified and, after removing duplicates, 86 records were left and screened for eligibility. Based on the inclusion and exclusion criteria, 3 studies were included for the purpose of investigating the effects of VR. In eligible studies, the study participants were people diagnosed with schizophrenia or related disorders. The studies consisted of N=156 participants. VR was used in addition to normal professional care. Details of the inclusion and exclusion criteria are described in Paper I.

In **Phase II**, the population was young people who had been referred to a youth psychiatric unit and randomized into the Depis.Net RCT intervention group. The inclusion criteria were 15–17 years of age (at the time of recruitment), symptoms of depression or anxiety, and ability to speak Finnish. Young people were excluded if they had a serious mental disorder, such as bipolar disorder, psychotic depression, a primary eating disorder, or substance abuse, or if they had been admitted to a psychiatric hospital ward or been involved in a brief intervention at an outpatient clinic (≤3 appointments) (Anttila et al., 2015, 2017). A total of 89 young people were randomized into the intervention group. They used the web-based intervention in addition to their treatment as usual. Out of 89 young people, 47 used the e-diary. (Paper II.)

In **Phase III**, the population was formed from all young people who had contacted MLL's Child and Youth Helpline via web messaging (asynchronous) or chat room (synchronous). Web messages and chats were included if they were written in Finnish by a young person. Duplicates and those with no written content were excluded, as were those with only one-word comments or content created for testing or training purposes. The data were excluded if a young person had written

to prohibit the use of their texts for research purposes. A total of 3,160 web-messages and chats were sent to the web-based services. After the inclusion and exclusion criteria were applied, 2,780 web-messages and chats from 2,193 young people were included. (Papers III and IV.)

4.5 Instruments

In **Phase I,** a standard, simple form for data collection and extraction was created for collecting the characteristics of the studies. The characteristics collected from the studies were: authors, publication years, methods (blindness, allocation, design, location, and duration of follow up), participants (N, age, sex, diagnosis, history, excluded, and setting), interventions, outcomes, and risk of bias. The GRADE approach was used for evaluating the quality of evidence for the outcomes reported in the review (Higgins & Green, 2011). Risk of bias was assessed using the criteria described in the Cochrane Handbook for Systematic Reviews of Interventions (Higgins & Green, 2011) for assessing trial quality. (Paper I.)

In **Phase II,** instruments were used to assess the severity of disturbance and depressive symptoms in young people. In addition, instructions were provided for the Depis.Net intervention that guided users through the themes and exercises, including the e-diary. Severity of disturbance was assessed using the Children's Global Assessment Scale (C-GAS) (Shaffer et al., 1983) and depressive symptoms were identified through self-assessment using the Beck Depression Inventory (BDI-21) (Beck et al., 1961). (Paper II.)

4.6 Data collection

In **Phase I**, data were collected from the Cochrane Schizophrenia Group Trials Register (May 2011, November 2011, July 2012, September 2013), the PubMed database (November 2011), and relevant reference lists. The search was performed mainly through the Cochrane Schizophrenia Group Trials Register (Shokraneh & Adams, 2020) and once through the PubMed database. The major focus of the Cochrane Schizophrenia Group (CSzG) is the treatment of people with schizophrenia. It also focuses on the care of individuals with unspecified "chronic" or "severe" mental illnesses and non-organic, schizophrenia-like conditions. Only an information expert can search the Cochrane Schizophrenia Group Trials Register on behalf of the CSzG authors. Therefore, the systematic search was conducted with an information expert (The Cochrane Collaboration, 2022). The Cochrane Collaborations' typical study selection process was applied to choose studies that met the predetermined criteria for inclusion and exclusion (Higgins & Green, 2011). The researchers performed the selection independently. Disagreements were resolved through discussion and the

decisions were documented, and when needed the authors of studies were contacted for clarification. (Paper I.)

In **Phase II**, the data were collected during 2008–2010 using the Depis.Net program. The young people were introduced to the program by a research assistant at the outpatient clinic. The young people also got personal identifiers (IDs) for access to Depis.Net program. They were able to access the program from any computer with an internet connection. After activation, the weeks remained open throughout the six-week intervention, and during this time the young people could access the materials of all weeks and the e-diary at any time. SMS text messages were sent on Mondays to support young people's use of the e-diary, and those who had not used it were sent an extra text message on Thursdays. A trained tutor provided feedback through the program to the e-diary users during the week. (Paper II.)

The data consisted of the content of e-diaries and a timestamp automatically made by the e-diary program when the young person logged in. The background information of the participants' baseline characteristics—age, gender, previous use of mental health services, and previous depression—were collected from medical records by nurses at the outpatient clinics. (Paper II.)

In **Phase III**, the data were collected between 1 January and 31 December 2018 from the regular MLL Child and Youth Helpline data, and they were transferred from MLL in Excel format. The data comprised automatically collected information and unclassified texts sent by young people via the helpline with web-messaging (Paper III) and chat (Paper IV) to MLL.

The web messaging service was open 24 hours a day, every day. The service used restricted access and used password-protected pseudonyms. A counselor responded to the message within two weeks via an online mailbox. (Paper III.) In 2018, chat room service was open from Monday to Wednesday, from 5 PM to 8 PM, and occasionally on other days and times. There were no special time limits for chatting, but young people could expect to chat with a counselor during the service time only. (Paper IV.)

Automatically collected data were extracted from background information of participants: age (≤11, 12–14, 15–17, ≥18) and gender (girl, boy, other) (Papers III and IV). Also, the season (month), weekday (Papers III and IV), and time (hour) that the messages were sent (Paper III) and the chat began and ended (Paper IV) were extracted from the automatically collected data. The use of the web-based services was recorded in terms of the number of messages sent and words used (Papers III and IV), the length of the messaging period in days (starting and ending day, month) (Paper III), and the duration of the chat (hours and minutes) (Paper IV). Unclassified texts sent by young people were gathered from the data (Papers III and IV).

4.7 Data analysis

In **Phase I,** a systematic review was conducted in accordance with the Cochrane Handbook for Systematic Reviews of Interventions, and the GRADE approach was used to interpret the findings (Higgins & Green, 2011). The risk difference (RD) and 95% confidence intervals (CI) were calculated for the homogeneous dichotomous data based on intention-to-treat. Mean differences (MD) were calculated for continuous data. Risk of bias was assessed, and the "Summary of findings" table was created using the GRADE approach. The main outcomes used in the table were compliance, mental state, quality of life, functioning (cognitive and social), satisfaction, and acceptability of intervention. Data from RevMan5 (Review Manager) was imported with GRADE profiler (GRADEPRO) to generate "Summary of findings" table. (Paper I.)

In Phase II, the quantitative data were analyzed using descriptive statistics (frequencies, averages, percentages) (Grove et al., 2012) to describe participants' background information (age, gender, previous depression, and previous use of mental health services) and usage activity (number of words, logins) of the web-based intervention. Detailed information from each week was gathered into an Excel table, which also gave an overview of the six-week period. The time of logging in and automatic timestamps were computed. Background information of the baseline characteristics of the young people, BDI-21 and C-GAS were analyzed. The qualitative data were analyzed using inductive analysis with manifest content. All text data were read, and sentences that corresponded to the research question were categorized by relevant phrases, and coded (Graneheim & Lundman, 2004). The coding was done by two researchers. The codes and their content were compared to identify differences and similarities to form sub-categories. Then, the sub-categories were abstracted and organized into categories and themes based on the similarity of their content (Graneheim & Lundman, 2004). (Paper II.)

In **Phase III**, the quantitative data was analyzed using descriptive statistics (frequencies, percentages, means with SD, medians with ranges for variables) (Grove et al., 2012) to describe the participants' the background information (age, gender), and the usage activity (number of messages and words) of the web-based services. To explore the young people's web-based services usage, the times that services were used (season, weekday, and time of day) were analyzed (Papers III and IV). Qualitative data was analyzed using inductive thematic analysis with manifest content. After reading all text data, initial codes were generated independently by two researchers. The researchers coded everything relevant from the first ten messages (Paper III) and chats (Paper IV), which were used to create the coding frame (Gale et al., 2013; O'Connor & Joffe, 2020). Coding frames were formed as analytical tools for reducing, categorizing, and synthesizing raw qualitative data (O'Connor & Joffe, 2020). The Framework method was used because it is useful in

categorizing, organizing, and developing an analytical framework (Gale et al., 2013). The codes and the coding results were compared by the researchers to identify differences and similarities (Gale et al., 2013; Graneheim & Lundman, 2004). The process was performed with the following messages (Paper III) and chats (Paper IV) until the coding frame was saturated and no new codes were identified (Gale et al., 2013; O'Connor & Joffe, 2020). The codes were grouped into categories based on their similarities.

The reliability of coding with coding frames was assessed using the intercoder reliability (ICR) (O'Connor & Joffe, 2020) to gain information about the consistency between the researchers (Kurasaki, 2000; MacPhail et al., 2016). The agreement between the researchers was calculated for the categories (Paper III) and codes (Paper IV) (Kurasaki, 2000) using Cohen's kappa (Cohen, 1960; MacPhail et al., 2016). The Cohen's kappa coefficient was 0.80 (Paper III) and 0.88 (Paper IV) out of -1.00–1.00 (Cohen, 1960), while the simple proportion agreement was 0.73 (Paper III) and 0.91 (Paper IV). Based on these results, ICR was acceptable (Paper III) and good (Artstein & Poesio, 2008) (Paper IV), and the coding frames could therefore be used for data analysis.

The rest of the text data were coded by one researcher according to the coding frame (O'Connor & Joffe, 2020). After coding all the text data, themes were formed from all the phrases or paragraphs that corresponded to each content area of the coding frame. (Papers III and IV.)

The population, where the data were collected, instrument used to collect and manage the data, and analysis of the data is described in Table 2.

Table 2. Summary of the population, where the data was collected, instruments used to collect and manage the data, and the data analysis.

RESEARCH PHASE	POPULATION	DATA COLLECTED	INSTRUMENTS	ANALYSIS
PHASE I	People diagnosed with schizophrenia or related disorders	The Cochrane Schizophrenia Group Trials Register and the PubMed database	Standard, simple form for data collection and extraction	Systematic review
PHASE II	Young people with depressive symptoms	Web-based program	Children's Global Assessment Scale (C-GAS) Beck Depression Inventory (BDI-21) C-GAS	Quantitative descriptive analysis, Inductive thematic analysis.
PHASE III	Young people	Web-based services targeted young people	Coding frames for reducing, categorizing, and synthesizing raw qualitative data.	Quantitative descriptive analysis, Inductive thematic analysis.

4.8 Ethical considerations

The guidelines of the Finnish Advisory Board of Research Integrity and The European Code of Conduct for Research Integrity were followed to responsible conduct throughout the study (All European Academies, 2017; TENK, 2023). In all stages, research ethical principles respecting the autonomy of subjects, avoiding harm, and protecting privacy and data protection were followed (TENK, 2019; WMA, 2013).

Phase I, the purpose of the literature review was to obtain information that could be used to improve the treatment and well-being of people with serious mental health problems (WMA, 2013). The review was conducted according to the Cochrane Handbook for Systematic Reviews of Interventions (Higgins & Green, 2011) to ensure that procedures were in accordance with the scientifically valid guidelines for the selection of studies, data collection and analysis, assessment of study quality, and presentation and interpretation of results (All European Academies, 2017; TENK, 2023).

In **Phase II**, ethical approval was granted by the hospital ethics committee (#R08075H). Permission to conduct the study was obtained from hospital administrators. As the participants were 15–17 years, both the young people and their parents received oral and written information about the study from the research assistant and the staff of the adolescent outpatient clinic. Participants received verbal and written information from the research assistants about the purpose and process

of the study. Participation in the trial was voluntary, and participants provided written informed consent. Participants could withdraw from the study without reason and without consequences for treatment (TENK, 2019). Trained tutors read participants' e-diary entries daily. For serious concerns, such as suicidal thoughts, the research assistant notified the nurse or physician to ensure safety of the participant. Participants had personal usernames and passwords to access the web-based support system. Unidentifiable codes (IDs) were used, and only the research assistants had access to the program. Anonymity was guaranteed in all phases of the study and in the reporting of the results. (Paper II.)

In **Phase III**, ethical approval was granted by the HUS Helsinki University Hospital Ethics Committee (Diary code 1759/2019). A research permit was obtained from MLL (Date 20.06.2019). (Papers III and IV.) The data was in an anonymous form, so individual participants could not be identified. This ensured the privacy and data protection of individual participants in accordance with ethical principles (TENK, 2019). The login page of the Child and Youth Helpline informed that the texts could be used for research purposes. The MLL online counseling system complied with "The ethical guidelines regarding voluntary telephone and online help", which dictates that confidential discussion is offered to a person who takes contact (Puhelin- ja verkkoauttamisen eettisten periaatteiden neuvottelukunta, 2016). (Papers III and IV.)

The young people in Phases II and III were considered to be a vulnerable group with a higher risk of mental health disorder than their peers (Arora et al., 2015). There are many risk factors that influence vulnerability in the lives of young people, for example, a lack of money or access to healthcare, a lack of care and support, poor self-esteem, poor emotional, social or coping skills, or a lack of a supportive peer group (Arora et al., 2015; Walker & Donaldson, 2010). Vulnerable young people can benefit from early, personalized intervention and support (Walker & Donaldson, 2010). Studying and developing interventions for young people used in community and in psychiatric outpatient and specialized mental health services can be seen as a way to reduce vulnerability (Raphael et al., 2006).

5 Results

5.1 Characteristics of the study participants

In **Phase I**, 87 records were identified for the systematic review, and after removing duplicates, 86 records remained. After the selection, three articles met the inclusion criteria. The study settings were specialized psychiatric services, and VR was used for skill training in addition to normal professional care. The total number of participants from the three articles that met the inclusion criteria was n=156. Participants were quite equally male n=86 and female n=81. The participants' ages ranged from 18 to over 60. More details of characteristics of the study participants are described in Paper I.

In **Phase II**, the participants were young people aged 15–17 (N=89) who had depressive symptoms and were referred to an adolescent psychiatric unit, and then randomized to the Depis.Net RCT intervention group. Participants were mostly female (N66/89.75%). Slightly more than half of the participants had previously experienced depression (n=55/89, 66%) and used mental health services (n=58/89, 67%). More than half of the participants had previously had depression. The characteristics of the participants are described in Table 3.

Table 3. Characteristics of the study participants in Phase II.

PARTICIPANTS CHARACTERISTICS		N (%)
GENDER		
	Female	66 (75)
	Male	22 (25)
AGE		
	15	25 (29)
	16	38 (43)
	17	24 (27)
	18	1 (1)
PREVIOUS DEPRESSION		
	Yes	55 (66)
	No	28 (34)
PREVIOUS USE OF MENTAL HEALTH SERVICES		
	Yes	58 (67)
	No	28 (33)

In **Phase III**, the participants (N=2193) were young people who had contacted MLL's Child and Youth Helpline web-based counseling with web messaging (n=1,354) (Paper III) or in a chat room (n=839) (Paper IV). They were mostly females (n=1,775/2,193, 81%). The gender and age of the participants in Phase III are described in Table 4.

Table 4. Characteristics of study participants in Phase III.

PARTICIPANTS CHARACTERISTICS		**Web-messaging** N=1354 (%)	**Chat room** N=839 (%)
GENDER			
	Female	1,178 (87.0)	597 (71.2)
	Male	119 (8.8)	190 (22.6)
	Other	57 (4.2)	51 (6.1)
	n/a		1 (0.1)
AGE			
	≤11	64 (4.7)	57 (6.8)
	12–14	440 (32.5)	418 (49.8)
	15–17	642 (47.4)	248 (29.6)
	≥ 18	208 (15.4)	111 (13.2)
	n/a		5 (0.6)

n/a information was not available

5.2 Effectiveness of digital technology in specialized psychiatric services

In the systematic review and meta-analysis, the investigation of the effectiveness of the VR intervention to support treatment compliance included three RCT studies. Each of these studies included its own VR intervention to deliver skills training sessions. Virtual technology was used to create environments where participants could train through different tasks such as VR role-playing for social skill, virtual ball catching, virtual soccer goalie playing, and virtual boutique scenario for vocational skills. VR participants used gloves or a head-mounted display to interact with the technology. The VR interventions were experimental, and VR programs were used as a supplement to treatment to deliver skill training sessions (Paper I).

Effects regarding compliance (3 RCTs, n = 156, RD loss to follow-up 0.02 CI -0.08 to 0.12) and acceptability of intervention (2 RCTs, n = 92, RD 0.05 CI -0.09 to 0.19) were small. The evidence from the studies was of low quality, and there was no clear evidence for or against using a VR intervention to support the mental health of people with severe symptoms. (Paper I.)

5.3 The usage of digital technology in psychiatric outpatient services for young people

Out of the 89 participants, 53% (n=47/89) used the e-diary during the data collection period. Almost all e-diary users were females (45/47, 96%). More moderate or severe depressive symptoms and more previous episodes of depression were found among e-diary users than among non-users. Further, e-diary users had used medications and mental health services more often than non-users. However, e-diary users had less serious functioning problems than non-users. (Paper II.)

During the five theme weeks, more than half (27/47, 57%) of the young people logged into the e-diary during the first two weeks, and a fifth (10/47, 21%) logged in at least once every week. The length of the e-diary entries based on word count ranged from 8 to 1,442 words per log. The range of times logged into the program was 1–13 times per participant. (Paper II.)

The young people generally used the electronic diary from Sunday to Tuesday, and evening was the most common time that they used the e-diary. The number of e-diary logged in days and hours are described in Table 5.

Table 5. Description of the number of e-diary logins in days and hours.

VARIABLES		N (%)
DAY		
	Sunday	30 (23.4)
	Monday	27 (21.1)
	Tuesday	21 (16.4)
	Wednesday	13 (10.2)
	Thursday	12 (9.4)
	Friday	10 (7.8)
	Saturday	15 (11.7)
TIME		
	00-03	6 (4.7)
	04-07	0 (0)
	08-11	12 (9.4)
	12-15	25 (19.5)
	16-19	41 (32.0)
	20-23	44 (34.4)

A thematic analysis revealed that writing in the e-diary had three focuses: the young people wanted to discuss and describe their mental health, their relationships,

and their identity. Regarding their mental health, the young people wrote about their symptoms, treatment, and recovery. Relationships were discussed from the perspective of how supportive and non-supportive they were. The young people described their identity through their ego development and future expectations. Details of the content of the young people's e-diaries are described in Paper II.

5.4 The usage of digital technology by young people in the community

MLL Web services were used by N=2,193 young people. Web messaging was used by n=1,354 young people with N=1,941 web messages (Paper III), and the chat room was used by n=839 young people (Paper IV). Web messaging allowed multiple two-way communication, and 17.7% (n=239/1,354) of participants used this opportunity by sending at least two messages and a maximum of 31 messages (Paper III). The chat room allowed one-to-one communication between a young person and a counselor. One-fourth of the chat conversations (303/1,179, 26%) consisted of a young person logging into the chat room but not chatting. The number of words used in the web service ranged from 2 to 4,097 words (Median 168) (Paper III) and from 2 to 2,103 words (Median 195) (Paper IV). The usage time of the online service varied from 1 to 294 days for web messaging (Paper III) and from 18 seconds to 188 minutes for chatting (Paper IV).

The use of the web services had some variations in seasons. The web services were used the least in the summer (July–September): 18.0% (349/1,941) of messages (Paper III) and 19.5% (164/839) of chats (Paper IV). Web services were used in the same way regardless of the day of the week (Paper III) or opening days (Paper IV). Regarding the time of day, more than half of the messages were sent during the evening via a web-based service that was available 24 hours a day, 7 days a week (Paper IV). The use of the web service with messages and chats by season, day, and time is described in Table 6.

Table 6. Description of the use of the web service with messages (N=1,941) and chats (N=839) by season, day, and time.

VARIABLES		WEB- MESSAGING N (%)	CHAT ROOM N (%)
SEASON			
	Winter (January–March)	556 (28.6)	265 (31.6)
	Spring (April–June)	567 (29.2)	211 (25.1)
	Summer (July–September)	349 (18.0)	164 (19.6)
	Autumn (October–December)	469 (24.2)	199 (23.7)
DAY			
	Sunday	279 (14.4)	n/a
	Monday	295 (15.2)	277 (33.0)
	Tuesday	281 (14.5)	329 (39.2)
	Wednesday	292 (15.0)	223 (26.6)
	Thursday	309 (15.9)	n/a
	Friday	252 (13.0)	n/a
	Saturday	233 (12.0)	n/a
	Not known		10 (1.2)
TIME OF THE DAY			
	Night 23–07	107 (5.5)	n/a
	Day 07–15	591 (30.5)	n/a
	Evening 15–23	1,243 (64.0)	n/a
	17–18		458 (54.6)
	18–19		191 (22.8)
	19–20		167 (19.9)
	Not known	1941	23 (2.7)

n/a = the service was not available

A thematic analysis revealed that the reasons young people contacted the text-based web service were related to three areas of life: aspects of social life, health and illnesses, and views of themselves. Aspects of social life involved young people's relationships with other people and the environment in which they lived and spent their time. In the content related to health and illness, young people brought up their health problems and illnesses as well as managing them. They also discussed the professional support they had received or tried to receive. The young people

described and discussed their views of themselves, how they perceived themselves from positive and negative perspectives. Details of the content of the young people's web service contacts are described in Papers III and IV.

5.5 Summary of results based on the Behavioral Intervention Technology Model (BIT Model)

The aim of the Behavioral Intervention Technology model (BIT model) is to characterize behavioral intervention technology (Mohr et al., 2014). The BIT model has two broad levels, the theoretical action level and the instantiation action level, in relation to which the model asks the five questions of "why", "how" theoretically, "what", "how" technically, and "when" (Mohr et al., 2015, 2014). In this study, the BIT model was used as a theoretical framework for reviewing previous research and structuring and reviewing empirical results (Mohr et al., 2015, 2014, 2013).

The theoretical action level questions "why" and "how" were answered in all phases of this study. The clinical aim of digital technologies was to improve the mental health of young people in specialized psychiatric services (Phase I), psychiatric outpatient services (Phase II), and their community (Phase III). Usage aims were explored, focusing on treatment compliance (Phase I) and use of digital technologies (Phases II and III). Behavioral change strategies included skill training (Phase I), self-monitoring, and supportive discussion (Phases II and III). The technical instantiation level questions "how" and "what" were answered in all phases, and "when" was addressed in Phases II and III. User logins, and time of usage (Phases II and III) reflected the workflow of using digital technologies. Figure 2 depicts a summary of the BIT model in the study context.

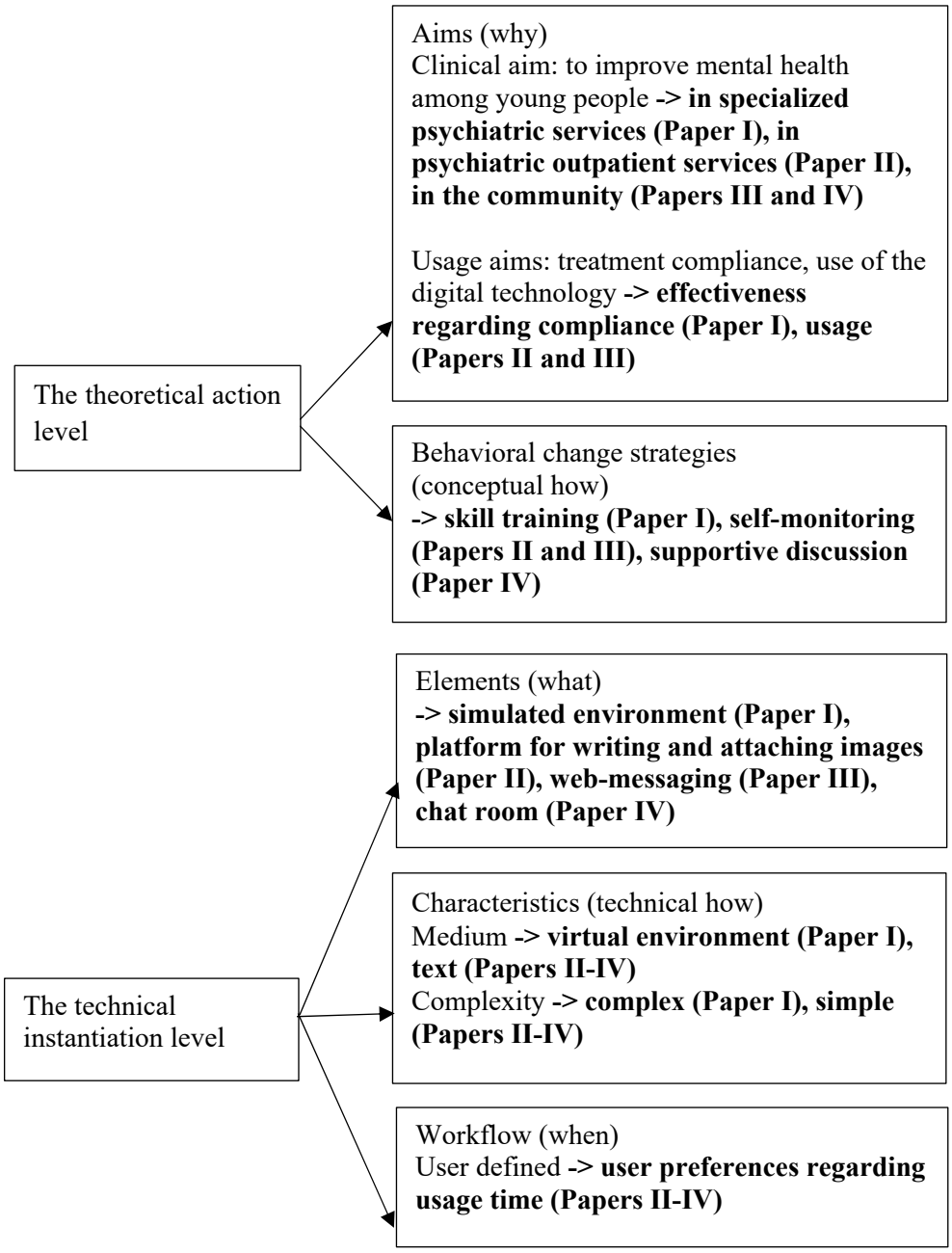

Figure 2. Theoretical functional level and technical instantiation level of the Behavioral Intervention technology model (BIT model) based on Mohr et al. 2014 in the study context.

A systematic literature review and meta-analysis revealed that there was no quality evidence for or against the use of virtual reality among people with serious mental health problems (Phase I). The young people's long-term use of digital technologies was low, both for the use of the e-diaries in psychiatric outpatient clinics and the multiple two-way communication in the community (Phases II and III). Young people who used digital technology in psychiatric outpatient clinics had more severe symptoms of depression and, based on previous mental health service experience, had longer-lasting mental health problems than non-users. (Phase II). Out of the young people who used digital technologies in psychiatric outpatient clinics and in the community, most were females (Phases II and III). Digital technologies were most commonly used in the evenings and during the school year. Young people used elements of digital technologies to reflect and discuss personal issues such as mental health, relationships, identity, social life, health and illness, and self-perception. (Phases II and III.)

6 Discussion

6.1 Discussion of main results

The overall aim of this study was to describe how digital technologies can support young people in mental health services. The research was conducted in three phases where digital technologies were examined: in psychiatric special services (Phase I), psychiatric outpatient services (Phase II), and the community (Phases III and IV).

The systematic review was conducted to evaluate the effectiveness of digital technology in the treatment of people with serious mental health problems in specialized psychiatric services (Phase I). In this study, VR was selected as a digital technology because, in a virtual environment, it is possible to develop skills to manage mental health difficulties (Dellazizzo et al., 2020; Rus-Calafell et al., 2018; Torous et al., 2021), and thus it might be beneficial for people with serious mental health problems receiving treatment in specialized psychiatric services. For the review, a limited number of RCT studies was found, and their quality was low (Phase I). Although the research on VR interventions for the treatment of people with serious mental health problems has increased since the review, the quality of studies still have low evidence levels (Rus-Calafell et al., 2018; Wiebe et al., 2022) and these interventions have not been shown to be significantly more effective than usual evidence-based treatments (Dellazizzo et al., 2020; Torous et al., 2021).

Although the effectiveness of VR interventions is low, there is potential to develop them for complex and treatment-resistant symptoms that are challenging to address with traditional treatments (Dellazizzo et al., 2020). Further, young people have experienced their VR experience positively, and there is a low dropout rate in VR intervention studies (Kelson et al., 2021). The symptoms of people with serious mental health problems can cause limitations in everyday functioning. VR can be used to create realistic environments that allow people to communicate, be present, and act in a computer-generated life-like environment (Lawes-Wickwar et al., 2018; Montana et al., 2020; Riva & Serino, 2020). The user can learn complex emotion regulation strategies and experience a sense of environmental control and a feeling of autonomy (Montana et al., 2020).

The usage of an e-diary was examined as a digital technology for psychiatric outpatient services supporting the well-being of young people. Nearly half of

participants did not use the e-diary at all, and e-diary usage decreased after the first week (Phase II). Based on the systematic reviews, the dropout rate of web-based interventions is high (Clarke et al., 2015; Lehtimaki et al., 2021; Välimäki et al., 2017). In other words, young people do not fully participate in web-based interventions, as was the case in this study.

There is some evidence that human support can be beneficial for adherence and effectiveness (Hollis et al., 2017). To support the usage of the e-diary, SMS text messages were sent weekly, and those who had not used the e-diary were sent an extra text message. SMS text messages may not have been very valuable in supporting young peoples' participation (Phase II). There is no clear information about in what form and how much human support is needed to benefit young people's adherence to web-based interventions (Hollis et al., 2017). Although many web-based interventions include human support, its effect on treatment adherence is still unclear (van Doorn et al., 2021).

The results of Phases II and III show that the majority of digital technology users were females. This is in line with previous studies that have shown that females have been the majority of users of digital technologies that connect users and service providers (Mathieu et al., 2021; Orsolini et al., 2021), digital interventions (Clarke et al. 2015; Garrido et al., 2019, van Doorn e al., 2021), mobile applications (Leech et al., 2021; Punukollu & Marques 2019), and VR interventions (Kelson et al., 2021).

The higher proportion of females may be due to the fact that females are at a higher risk of developing depression and anxiety disorders at an earlier age and have more depression than males (Sloan & Sandt, 2006). According to the Finnish School Health Promotion study, females have more depressive symptoms and anxiety symptoms than males. In addition, females' positive mental health has weakened more than males', and loneliness has increased more for females than for males (Aalto-Setälä et al., 2023). It is possible that, for these reasons, females are seeking support for themselves more than males. Males had indicated that web-based services are easier for them to use to get support for their mental health problems, rather than having a talk face-to-face conversation (Best et al., 2016; Bradford & Rickwood, 2014). However, some studies have shown that they seem to prefer telephone (Callahan and Inckle, 2012) or face-to-face contact (Rickwood et al., 2016) when seeking support for themselves. It is possible digital technologies are lacking elements important to males such as male-sensitive language, imagery, and settings in which they would feel comfortable expressing their concerns (Ellis et al., 2013; Robertson et al., 2015). It has been discussed that, to get young men to use digital mental health services, the services should be action-oriented and focused on shifting behavior and stigma. Furthermore, these services should be user-driven and relevant (i.e., related to everyday life and interests) and should facilitate contact with peers (Ellis et al., 2013).

Web services had the lowest use in the summer season (Phase III), which is in line with a previous study which reported that young people used a health information website the least in the summertime (Santor et al., 2007). In other words, young people used web services during the school year, which is typically a period of higher stress. Further, digital technologies were mostly used in the evenings (Phases II and III), which is the most common time for young people to use web services, as reported by previous studies (Abbott et al., 2016; Lekić et al., 2014; Santor et al., 2007). Digital technology services seem to offer support to young people when they are stressed, and when other services may not be available. In Phases II and III, young people used digital technologies to discuss and describe their personal issues such as their mental health, relationships, identity, social life, health and illness, and self-perception. These results confirmed that young people in general want to discuss their own issues (Lapp, 2019) and that young people with mental health problems want to openly discuss mental health and wider personal issues (Persson et al., 2017). It can be assumed that digital technologies have the potential to help young people monitor their behavior, symptoms, and experiences and get support when they need it.

The Behavioral Intervention Technology model (BIT model) (Mohr et al., 2014) was used as a theoretical framework for reviewing previous research and structuring and reviewing empirical results. The terms and concepts describing digital technologies supporting mental health are not conceptually clear and consistent, and the terms used for interventions and technologies vary (De Witte et al., 2021; Halldorsson et al., 2021; Hollis et al., 2017; Von Huben et al., 2021). Therefore, the BIT model was necessary to review digital technologies supporting young people in mental health services. The BIT model also helped structure and review the empirical results of this study. The framework served as a good structure for the study. However, fitting the theoretical and technical components into the framework was challenging, as the study used various existing digital technologies with different interventions. Despite this, the use of the BIT model structure was encouraging. The BIT model can be used in planning, development, evaluating, and implementing digital technologies that support young people's mental health.

6.2 Validity and reliability of the study

In **Phase I**, the validity of the systematic review was ensured by publishing the study protocol in the Cochrane Database of Systematic Reviews (CDRS). By publishing the research protocol, the aim was to reduce the impact of the author's biases, promote the transparency of methods and processes, reduce the possibility of duplication, and enable peer review of the planned methods. The Handbook of Cochrane Reviews guided the study and its detailed systematic literature review

process was adhered to (Higgins & Green, 2011). A Cochrane Schizophrenia Group information specialist conducted a search of the Cochrane Schizophrenia Group Register of trials in 2011, 2012, and 2013 (The Cochrane Collaboration, 2022). A search of the PubMed database was conducted in 2011 by the authors. The search terms are described in Paper I. To minimize errors and reduce potential biases, the study selection and data extraction was done individually by the authors (Higgins & Green, 2011). Extraction issues were discussed, decisions were recorded, and the first authors of the studies that were included were contacted for the clarification of information. Flowcharts for the research selection are presented in Paper I.

The validity of the included studies was evaluated independently by the authors according to selection bias, (sequence generation, allocation sequence concealment), performance bias (blinding of participants and personnel), detection bias (blinding of outcome assessment), attrition bias (incomplete outcome data), reporting bias (selective outcome reporting), and other sources of bias (such as small-study publication) (Higgins & Green, 2011). All studies were small pioneering studies, and there was moderate risk of bias in all outcomes; therefore, there was a risk of overestimating any positive effects. The risk of bias for each study is described in detail in Paper I.

In **Phase II,** regarding credibility, the purpose was to bring out, from the young people's point of view, how and for what purpose they used the e-diary (Graneheim et al., 2017). The young people were allowed to use the e-diary when it suited them best. Moreover, they were allowed to express themselves freely in writing. Credibility was also ensured by focusing on manifest content rather than interpreting any hidden content during analysis and reporting (Graneheim et al., 2017). (Paper II.)

Regarding dependability, the criteria of reporting qualitative research was followed (Tong et al., 2012). The qualitative data analysis software NVivo was used to manage the data. The themes of the content analysis were formed by three researchers to limit the influence of researcher subjectivity (Graneheim et al., 2017). In addition, quotations from text data were used in the analysis and presentation (Creswell & Plano Clark, 2018). (Paper II.)

To support the transferability of the context of study, the intervention and characteristics of participants were described (Korstjens & Moser, 2018). The number of participants was small (N=89) and nearly half of them (42/89, 47%) did not use the e-diary (Paper II). The systematic review by Lehtimaki et al. (2021) shows that dropping out is common in web-based mental health interventions for young people, and this was also the case in this study.

In **Phase III,** credibility was supported through data triangulation by collecting the data from two different sources (Creswell et al., 2014). Even though there was a large amount of data, credibility was ensured by focusing on manifest content rather

than interpreting any hidden content (Graneheim et al., 2017). (Papers III and IV.) Further, results were confirmed with members of MLL (Graneheim and Lundman, 2004; Korstjens and Moser, 2018) (Paper III).

Regarding dependability, coding frames were developed by two researchers and were used in the content analysis and formatted as a part of the qualitative analysis (Creswell & Plano Clark, 2018; Graneheim et al., 2017; O'Connor & Joffe, 2020). In addition, the reliability of the coding frames was assessed using intercoder reliability (ICR) (Creswell & Plano Clark, 2018; O'Connor & Joffe, 2020) it was acceptable (Paper III) and good (Artstein & Poesio, 2008) (Paper IV). The qualitative data analysis software NVivo was used to manage the data. In addition, quotations from the text data were used in the analysis and presentation (Creswell & Plano Clark, 2018). (Papers III and IV.)

Regarding transferability, the context of study, setting, characteristics of participants, inclusion and exclusion criteria, and analyzing process were described (Korstjens and Moser, 2018). The number of participants was large (N=2,193). A systematic review by Mathieu et al. (2021) of different types of helplines (e.g., telephone, web-based) shows that there are a limited number of studies on text-based web services. Further, these studies examined the content of the writings of young people from a certain point of view (Mathieu et al., 2021). In the current study, the purpose of using the text-based web service was explored with inductive thematic analysis from the perspective of young people (Papers III and IV).

6.3 Strengths and limitations of the study

First strength of this study is that it explored different technologies used in various mental health service systems: specialized psychiatric, psychiatric outpatient, and community-based services. Digital technologies can be utilized to increase the availability and content of all of these types of mental health services (Ferrari et al., 2022; Singh et al., 2022). Second, strength is that the study used a large amount of real-world data (Papers III and IV), the analysis of which provides important information about usage of digital technologies by young people in real life (Fleming et al., 2018). Third, a mixed methods approach was used to gain a deeper insight into the use of digital technologies aimed at to supporting young people's mental health (Creswell & Plano Clark, 2018). The use of both quantitative and qualitative methods can be considered a strength of this study (NIH Office of Behavioral and Social Sciences Research, 2018) as can the fact that data were collected from different sources (Fetters et al., 2013).

First limitation of the study was that the data also included adults (Paper I). However, the main part of the data consisted of young people (Papers II–IV). Second limitation related to the data of this study is the fact that the data was collected

between 2008 and 2018, so the up-to-dateness of the data may be questioned. Although there was a long time between the data collection for Paper II (2008–2010) and for Papers III and IV (2018), the results were similar: most of the users were female, digital technologies were mostly used in the evenings, and young people openly discussed and described their mental health and wider personal issues. Further, a systematic review of Youth Helplines shows that young people have a positive attitude towards written interaction when seeking support (Mathieu et al., 2021). Third, interpersonal dynamics could have impacted negotiations regarding the content analysis process (Campbell et al., 2013). For example, background, education, working life, or research experience might have affected one's way of thinking (Vaismoradi et al., 2013). In this study, even though the researchers had different backgrounds and research experience, they collaborated well and were able to discuss and solve any differing perspectives through discussions (Papers II–IV).

6.4 Implications of the study

Clinical practice

This study shows that young people used text-based technologies to describe and discuss their lives, themselves, and their mental health, and they were willing to do it quite openly. Young people should have various opportunities—for example, face-to-face, chat room, web-messaging, and video conferencing—to connect with mental health services to get support for their mental health needs. Further, it is good to ask and discuss with the young person whether they use digital technologies to support their mental health, for example through social media, especially if they are already in some form of treatment. Also, it is good to find out whether it would be possible to use the digital technologies the young person is already involved with to support treatment, for example, practicing self-control with the help of games. This can be a way of appreciating and supporting the young person's own resources, control, and empowerment, as well as their commitment to participating in their own care.

Healthcare administration

As there is an urgent need to find ways to support the mental health of young people, the use of digital technologies can bring new opportunities and solutions. Digital technologies offer opportunities to improve access and adherence to mental health services. For example, the possibility of using different communication technologies (e.g., text, voice, video) between the young person and the service provider can lower the threshold for a young person to seek and receive support. The present study shows that young people use digital technologies mostly in the evenings and during

the school year. It is worth taking this into account when planning and organizing mental health services for young people to ensure youth friendliness. This research provides information that can be used to develop and integrate digital technologies into mental health services for young people, from specialized psychiatric care to community services. However, when implementing digital technologies in mental health services for young people, it must be considered that digital technologies can supplement support and treatment, but they do not replace human contact.

Nursing science

In nursing science, it is necessary to evaluate and study how digital technologies can be used efficiently and effectively in nursing, especially with young people. Young people are living through a unique period of transition into adulthood. During this period, young people define their relationships with others, form their independent identity, and make decisions regarding their future. They may also experience anxiety and struggle, which can be associated with the development towards adulthood. Therefore, young people with various health needs require special attention and care.

There is a need to find a balance between human involvement and digital technologies so that digital technologies can be utilized in the best possible way to support the mental health of young people. Overall, the technical possibilities of various digital technologies are greater than the research on their use to prevent, promote or care the mental health and well-being of young people. It is necessary to develop digital-based services in such a way that they are useful and are desired in support of mental health, either as the main option or as a supplement to other treatments. This requires cooperation between experts in the field of science, especially with researchers of digital technologies.

This study focused on young people with mental health or well-being problems. More nursing research on this group should be conducted to further identify their health care needs and how to meet them. In terms of nursing, this research provides information on promoting mental health and preventing mental health problems in young people and on treating young people with mental health problems in all healthcare and community settings. The study describes how young people used digital technologies to support their mental health and well-being. It is important to consider what role different technologies plays in the lives of young people, and how the technologies can be used in care when young people seek and receive help.

Nursing education

Digital technology is already part of nursing and is developing all the time. Nurses need continuous education and training to use and utilize digital technologies in their work. They need to know how young people use digital technologies and how they, as nurses, can support mental health and well-being with digital technologies. Nurses need the knowledge and expertise to utilize communication technologies in an evidence-based way to effectively assist and care for young people with mental health problems. Nurses must also have knowledge on how they can support young people in using digital technologies to benefit their mental health and well-being.

Further research

More robust research is needed to assess the effectiveness of using digital technologies in supporting the mental health of young people. The challenge for research is that technologies develops faster than research has time to produce evidence-based information about their use and effectiveness. It is necessary that research on the use of digital technologies in supporting young people's mental health is an interdisciplinary effort. For this reason, it is important that, in addition to nursing researchers and digital technology researchers, researchers focused on youth psychology should participate. In order to ensure that digital technology interventions are youth-friendly, it is essential that young people also participate in the research and development of digital technologies that support their mental health. However, this cooperation can be hampered by the fact that the terms and concepts used for digital technologies are not clear and consistent. Further research is needed to develop a suitable model, or to refine and modify an already existing model, for example the BIT Model, to support cooperation between disciplines.

It is important to study each digital technology on its own when developing effective interventions for mental health. It is also necessary to evaluate different behavioral techniques and their applicability to various digital technologies. Further, a balance needs to be found between digital technologies and human components—in other words, figuring out what kind of technology needs what kind of human components to make the best use of the digital technology to support the mental health of young people. In particular, research is needed on the gender-specific elements of digital technologies that support young people's mental health, especially on which elements appeal to males.

In addition, it is necessary to consider what kinds of roles different digital technologies have in the lives of young people and in supporting and treating their mental health, from the young people's own perspective. In this way, mental health support for young people could be better personalized.

7 Conclusions

This study aimed to describe how digital technology can support young people's mental health. This study shows that there is insufficient research evidence on the effectiveness and effective use of digital technologies that support young people's mental health, indicating that the use of these technologies is still in the development phase.

Mental health services for young people in Finland are insufficient for their needs. This study shows that digital technology services provide support for young people when they are stressed and when other services are not available. In addition, young people are ready to discuss personal issues such as mental health, relationships, identity, social life, health and illness, and self-perception. It can therefore be assumed that digital technologies have the potential to help young people monitor their behavior, symptoms, and experiences and get support when they need it. Therefore, digital technologies can offer opportunities to increase the availability and adequacy of mental health services for young people.

There are a number of digital technologies that can be used in various mental health services to support the mental health of young people. In this study, the largest group of users of digital technologies were female. Previous studies have shown that females have been the majority of users of digital technologies that connect users and service providers, digital mental health interventions, mobile applications, and VR interventions. Digital technologies that support young people's mental health may have gender-specific elements that appeal more to females than to males. Therefore, when developing and implementing digital mental health support, it is important to consider the different mental health and gender-specific needs of young people, as well as their readiness to use digital technologies for mental health support.

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Appendices

Appendix 1. Search strategy for a literature review of digital technologies that support young people's mental health and their effectiveness.

Digital technology	Database	Search terms	Results
Technologies connecting users and service providers telephone, videoconferencing, instant messaging, and email	PubMed Meta-analysis Systematic review English 2013-2023	(("Mental Health"[MeSH Terms] OR "Mental Health"[Title/Abstract]) AND ("adolescent"[MeSH Terms] OR "adolescent*"[Title/Abstract] OR ("adolescent"[MeSH Terms] OR "youth*"[Title/Abstract]) OR "young people"[Title/Abstract]) AND ("telecommunications"[MeSH Terms] OR "telecommunication*"[Title/Abstract] OR ("electronic mail*"[Title/Abstract] OR "email*"[Title/Abstract]) OR "videoconferenc*"[Title/Abstract] OR "chat*"[Title/Abstract]))	34
	PsychInfo Meta analysis Systematic review Literature review English Academic Journals 2013-2023	(MA (mental health or mental illness or mental disorder or psychiatric illness OR TI (mental health or mental illness or mental disorder or psychiatric illness) OR AB (mental health or mental illness or mental disorder or psychiatric illness)) AND (MA (young people or youth or adolescents or young adults or teenagers or children) OR TI (young people or youth or adolescents or young adults or teenagers or children) OR AB (young people or youth or adolescents or young adults or teenagers or children)) AND (MA (	49

		telecommunication or technology or digital) OR TI (telecommunication or technology or digital) AND AB (telecommunication or technology or digital)) OR (MA (electronic mail OR TI electronic mail OR AB electronic mail)) OR (MA(email OR TI email OR AB email)) OR (MA (videoconference or videoconferencing) OR TI (videoconference or videoconferencing) OR AB (videoconference or videoconferencing)) OR (MA (chat OR TI chat OR AB chat))	
	CINAHL English Academic Journals 2013-2023	(MH (mental health or mental illness or mental disorder or psychiatric illness) OR TI (mental health or mental illness or mental disorder or psychiatric illness) OR AB (mental health or mental illness or mental disorder or psychiatric illness)) AND (MH (young people or youth or adolescents or young adults or teenagers or children) OR TI (young people or youth or adolescents or young adults or teenagers or children) OR AB (young people or youth or adolescents or young adults or teenagers or children)) AND (MH (telecommunication or technology or digital) OR TI (telecommunication or technology or digital) OR AB (telecommunication or technology or digital)) OR (MH electronic mail OR TI electronic mail OR AB electronic mail) OR (MH email OR TI email OR AB email OR MH (videoconferencing or teleconferencing) OR TI (videoconference or videoconferencing) OR AB (videoconference or videoconferencing)) AND (MH (	116

		systematic review or meta-analysis or literature review or review of literature) OR TI (systematic review or meta-analysis or literature review or review of literature) OR AB (systematic review or meta-analysis or literature review or review of literature))	
Web based interventions	PubMed Meta-analysis Systematic review English 2013-2023	((("mental health"[MeSH Terms] OR ("mental health"[MeSH Terms] OR ("mental"[All Fields] AND "health"[All Fields]) OR "mental health"[All Fields])) AND ("adolescent"[MeSH Terms] OR "adolescent"[Title/Abstract] OR ("adolescent"[MeSH Terms] OR "youth"[Title/Abstract])) AND ("internet based intervention"[MeSH Terms] OR "internet based intervention"[Title/Abstract] OR "web based intervention"[Title/Abstract])) OR "online intervention"[Title/Abstract])	40
	PsychInfo Meta analysis Systematic review Literature review English Academic Journals 2013-2023	(MA (mental health or mental illness or mental disorder or psychiatric illness) OR TI (mental health or mental illness or mental disorder or psychiatric illness) OR AB (mental health or mental illness or mental disorder or psychiatric illness)) AND (MA (young people or youth or adolescents or young adults or teenagers or children) OR TI (young people or youth or adolescents or young adults or teenagers or children) OR AB (young people or youth or adolescents or young adults or teenagers or children)) AND (MA (internet-based interventions or ehealth or web-based or electronic health intervention or internet based therapy) OR TI (internet-based interventions or ehealth or web-based	25

		or electronic health intervention or internet based therapy) OR AB (internet-based interventions or ehealth or web-based or electronic health intervention or internet based therapy))	
	CINAHL English Academic Journals 2013-2023	(MH (mental health or mental illness or mental disorder or psychiatric illness OR TI (mental health or mental illness or mental disorder or psychiatric illness) OR AB (mental health or mental illness or mental disorder or psychiatric illness)) AND (MH (young people or youth or adolescents or young adults or teenagers or children) OR TI (young people or youth or adolescents or young adults or teenagers or children) OR AB (young people or youth or adolescents or young adults or teenagers or children)) AND (MH (internet-based interventions or ehealth or web-based or electronic health intervention or internet based therapy) OR TI (internet-based interventions or ehealth or web-based or electronic health intervention or internet based therapy) OR AB (internet-based interventions or ehealth or web-based or electronic health intervention or internet based therapy) AND (MH (systematic review or meta-analysis or literature review or review of literature) OR TI (systematic review or meta-analysis or literature review or review of literature) OR AB (systematic review or meta-analysis or literature review or review of literature))	25
Mobile	PubMed Meta-analysis	(("mental health"[MeSH Terms] OR "mental health"[Title/Abstract]) AND ("adolescent"[MeSH Terms] OR "adolescent*"[Title/Abstract] OR	28

	Systematic review English 2013-2023	("adolescent"[MeSH Terms] OR "youth*"[Title/Abstract]) OR "young people"[Title/Abstract]) AND ("mobile applications"[MeSH Terms] OR "mobile application*"[Title/Abstract] OR ("smartphone"[MeSH Terms] OR "smartphone*"[Title/Abstract]) OR ("wearable electronic device*"[Title/Abstract] OR "wearable electronic device*"[Title/Abstract]))	
	PsychInfo Meta analysis Systematic review Literature review English Academic Journals 2013-2023	(MA (mental health or mental illness or mental disorder or psychiatric illness) OR TI (mental health or mental illness or mental disorder or psychiatric illness) OR AB (mental health or mental illness or mental disorder or psychiatric illness)) AND (MA (young people or youth or adolescents or young adults or teenagers or children) OR TI (young people or youth or adolescents or young adults or teenagers or children) OR AB (young people or youth or adolescents or young adults or teenagers or children)) AND (MA (mobile applications or apps or mobile apps or smartphone) OR TI (mobile applications or apps or mobile apps or smartphone apps) OR AB (mobile applications or apps or mobile apps or smartphone apps)) OR (MA (wearable technology or wearable devices or wearable sensors) OR TI (wearable technology or wearable devices or wearable sensors) OR AB (wearable technology or wearable devices or wearable sensors)) OR (MA (smartphone or cell phone or mobile device or mobile phone) AND TI (smartphone or cell phone or mobile device or mobile phone)	29

		AND AB (smartphone or cell phone or mobile device or mobile phone))	
	CINAHL English Academic Journals 2013-2023	(MH (mental health or mental illness or mental disorder or psychiatric illness OR TI (mental health or mental illness or mental disorder or psychiatric illness) OR AB (mental health or mental illness or mental disorder or psychiatric illness)) AND (MH (young people or youth or adolescents or young adults or teenagers or children) OR TI (young people or youth or adolescents or young adults or teenagers or children) OR AB (young people or youth or adolescents or young adults or teenagers or children)) AND (MH (mobile applications or apps or mobile apps or smartphone apps) OR TI (mobile applications or apps or mobile apps or smartphone apps) OR AB (mobile applications or apps or mobile apps or smartphone apps)) OR (MH (wearable technology or wearable devices or wearable sensors) OR TI (wearable technology or wearable devices or wearable sensors) OR AB (wearable technology or wearable devices or wearable sensors)) OR (MH (smartphone or cell phone or mobile device or mobile phone) OR TI (smartphone or cell phone or mobile device or mobile phone) OR AB (smartphone or cell phone or mobile device or mobile phone)) AND (MH (systematic review or meta-analysis or literature review or review of literature) OR TI (systematic review or meta-analysis or literature review or review of literature) OR AB (systematic review or meta-analysis or literature review or review of literature))	39

Social Media	PubMed Meta-analysis Systematic review English 2013-2023	(("mental health"[MeSH Terms] OR "mental health"[Title/Abstract]) AND ("adolescent"[MeSH Terms] OR "adolescent*"[Title/Abstract] OR ("adolescent"[MeSH Terms] OR "youth*"[Title/Abstract]) OR "young people"[Title/Abstract]) AND ("social media"[MeSH Terms] OR "social media"[Title/Abstract]))	30
	PsychInfo Meta analysis Systematic review Literature review Metasynthetis English Academic Journals 2013-2023	(MA (mental health or mental illness or mental disorder or psychiatric illness OR TI (mental health or mental illness or mental disorder or psychiatric illness) OR AB (mental health or mental illness or mental disorder or psychiatric illness)) AND (MA (young people or youth or adolescents or young adults or teenagers or children) OR TI (young people or youth or adolescents or young adults or teenagers or children) OR AB (young people or youth or adolescents or young adults or teenagers or children)) AND (MA (social media or facebook or twitter or instagram or snapchat or tumblr or social networking) OR TI (social media or facebook or twitter or instagram or snapchat or tumblr or social networking) OR AB (social media or facebook or twitter or instagram or snapchat or tumblr or social networking))	56
	CINAHL English Academic Journals 2013-2023	(MH (mental health or mental illness or mental disorder or psychiatric illness OR TI (mental health or mental illness or mental disorder or psychiatric illness) OR AB (mental health or mental illness or mental disorder or psychiatric illness)) AND (MH (young people or youth or adolescents or young adults or teenagers or children) OR TI (young	53

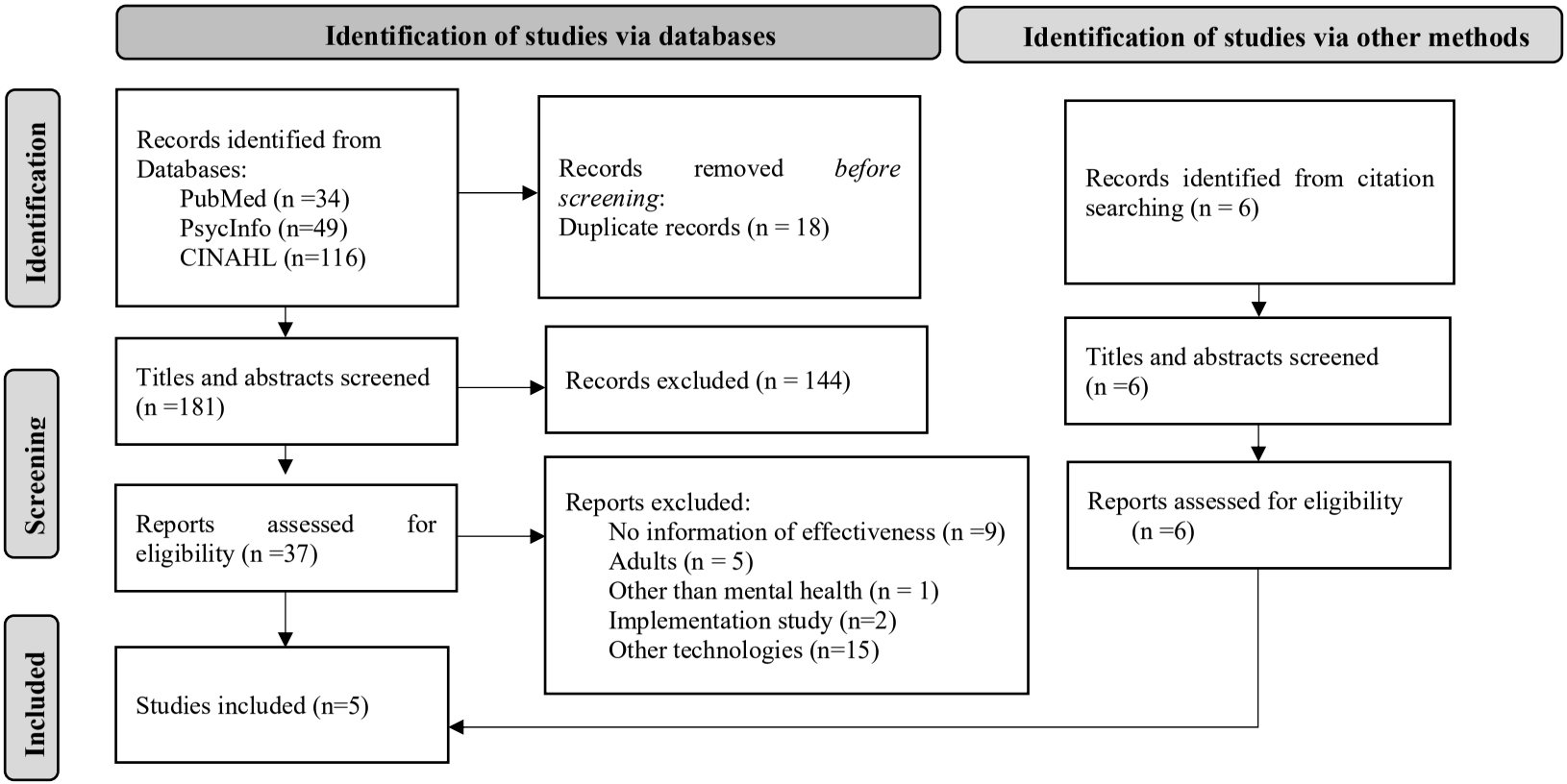
		people or youth or adolescents or young adults or teenagers or children) OR AB (young people or youth or adolescents or young adults or teenagers or children)) AND (MH (social media or facebook or twitter or instagram or snapchat or tumblr or social networking) OR TI (social media or facebook or twitter or instagram or snapchat or tumblr or social networking) OR AB (social media or facebook or twitter or instagram or snapchat or tumblr or social networking)) AND (MH (systematic review or meta-analysis or literature review or review of literature) OR TI (systematic review or meta-analysis or literature review or review of literature) OR AB (systematic review or meta-analysis or literature review or review of literature))	
Virtual reality, chatbot	PubMed Meta-analysis Systematic review English 2013-2023	((("mental health"[MeSH Terms] OR "mental health"[Title/Abstract]) AND ("adolescent"[MeSH Terms] OR "adolescent*"[Title/Abstract] OR ("adolescent"[MeSH Terms] OR "youth*"[Title/Abstract]) OR "young people"[Title/Abstract]) AND ("virtual reality"[MeSH Terms] OR "virtual realit*"[Title/Abstract])) OR ("conversational agent*"[Title/Abstract] OR "chatbot*"[Title/Abstract] OR "virtual assistant*"[Title/Abstract] OR "virtual agent*"[Title/Abstract]))	63
	PsychInfo Systematic review	MA (mental health or mental illness or mental disorder or psychiatric illness) OR TI (mental health or mental illness or mental disorder or psychiatric illness) OR AB (mental health or mental illness or mental	11

	Literature review English Academic Journals 2013-2023	disorder or psychiatric illness)) AND (MA (young people or youth or adolescents or young adults or teenagers or children) OR TI (young people or youth or adolescents or young adults or teenagers or children) OR AB (young people or youth or adolescents or young adults or teenagers or children)) AND (MA virtual reality OR TI virtual reality OR AB virtual reality) OR (MA (conversational agent or chatbot) OR TI (conversational agent or chatbot) OR AB (conversational agent or chatbot)) OR (MA virtual assistant OR TI virtual assistant OR AB virtual assistant) OR (MA virtual agent OR TI virtual agent OR AB virtual agent))	
	CINAHL English Academic Journals 2013-2023	(MH (mental health or mental illness or mental disorder or psychiatric illness) OR TI (mental health or mental illness or mental disorder or psychiatric illness) OR AB (mental health or mental illness or mental disorder or psychiatric illness)) AND (MH (young people or youth or adolescents or young adults or teenagers or children) OR TI (young people or youth or adolescents or young adults or teenagers or children) OR AB (young people or youth or adolescents or young adults or teenagers or children) AND (MH (virtual reality) OR TI (virtual reality) OR AB (virtual reality) OR (MH (conversational agent or chatbot)) OR TI (conversational agent or chatbot) OR AB (conversational agent or chatbot)) OR (MH virtual assistant) OR TI (virtual assistant) OR AB (virtual assistant) OR (MH (virtual agent OR TI (virtual agent) OR AB (virtual agent)) AND (MH (	8

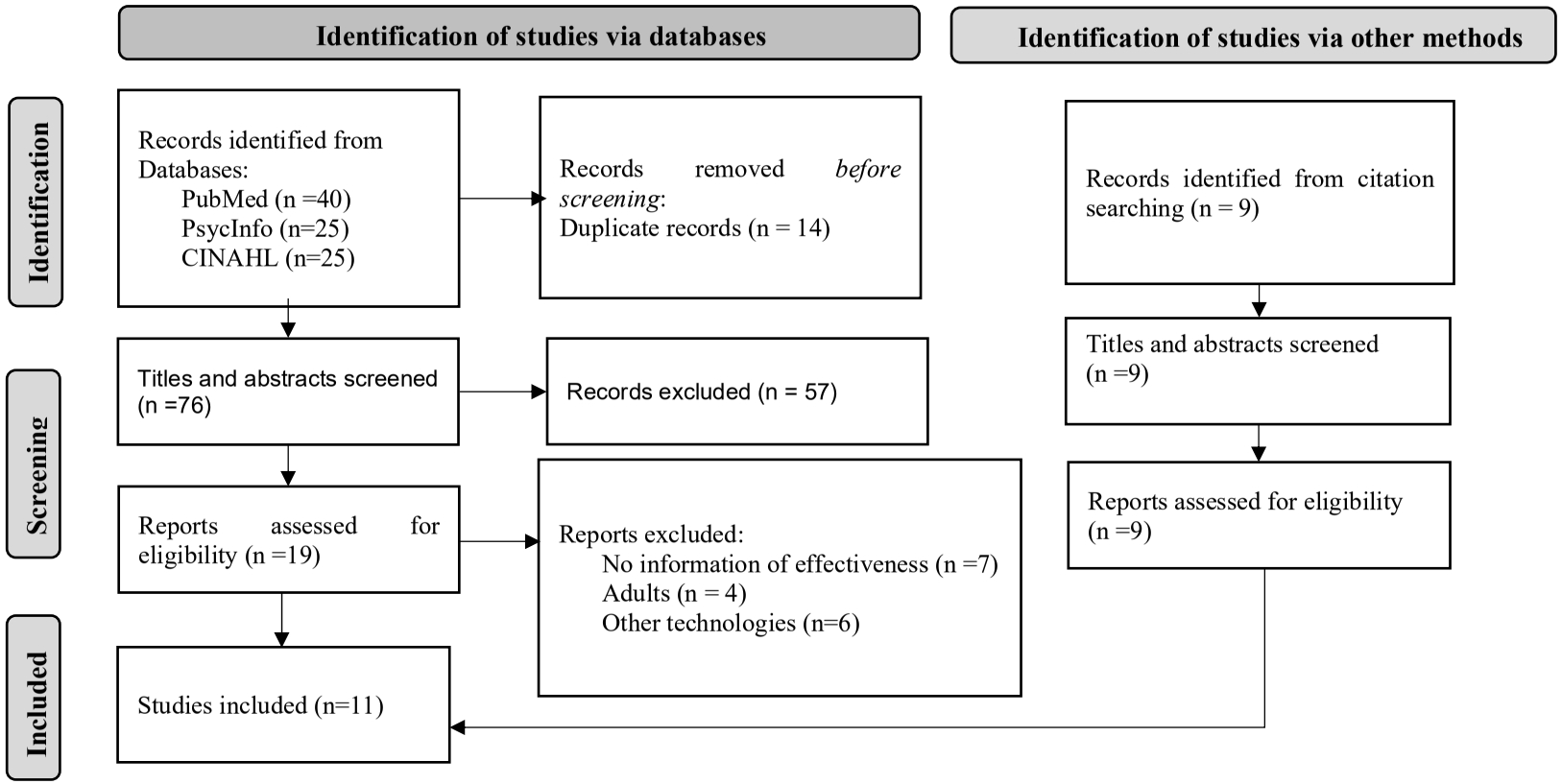
		systematic review or meta-analysis or literature review or review of literature) OR TI (systematic review or meta-analysis or literature review or review of literature) OR AB (systematic review or meta-analysis or literature review or review of literature))	
Game	PubMed PubMed Meta-analysis Systematic review English 2013-2023	(("mental health"[MeSH Terms] OR "mental health"[Title/Abstract]) AND ("adolescent"[MeSH Terms] OR "adolescent*"[Title/Abstract] OR ("adolescent"[MeSH Terms] OR "youth*"[Title/Abstract]) OR "young people"[Title/Abstract]) AND ("gamification"[MeSH Terms] OR "gamification"[Title/Abstract] OR "game*"[Title/Abstract] OR ("video game*"[MeSH Terms] OR "video game*"[Title/Abstract])))	25
	PsycInfo Meta analysis Systematic review Literature review English Academic Journals 2013-2023	(MA (mental health or mental illness or mental disorder or psychiatric illness OR TI (mental health or mental illness or mental disorder or psychiatric illness) OR AB (mental health or mental illness or mental disorder or psychiatric illness)) AND (MA (young people or youth or adolescents or young adults or teenagers or children) OR TI (young people or youth or adolescents or young adults or teenagers or children) OR AB (young people or youth or adolescents or young adults or teenagers or children)) AND (MA (games OR TI games OR AB games)) OR (MA (gamification or serious game) OR TI (gamification or serious game) OR AB (gamification or serious game)) OR (MA (video games or computer games or gaming or online games or internet games or online gaming) OR TI (video games	37

		or computer games or gaming or online games or internet games or online gaming) OR AB (video games or computer games or gaming or online games or internet games or online gaming))	
	CINAHL English Academic Journals 2013-2023	(MH (mental health or mental illness or mental disorder or psychiatric illness OR TI (mental health or mental illness or mental disorder or psychiatric illness) OR AB (mental health or mental illness or mental disorder or psychiatric illness)) AND (MH (young people or youth or adolescents or young adults or teenagers or children) OR TI (young people or youth or adolescents or young adults or teenagers or children) OR AB (young people or youth or adolescents or young adults or teenagers or children)) AND (MH games OR TI games OR AB games)) OR (MH (gamification or serious game) OR TI (gamification or serious game) OR AB (gamification or serious game)) OR (MH (video games or computer games or gaming or online games or internet games or online gaming) OR TI (video games or computer games or gaming or online games or internet games or online gaming) OR AB (video games or computer games or gaming or online games or internet games or online gaming)) AND (MH (systematic review or meta-analysis or literature review or review of literature) OR TI (systematic review or meta-analysis or literature review or review of literature) OR AB (systematic review or meta-analysis or literature review or review of literature))	28
Total			696

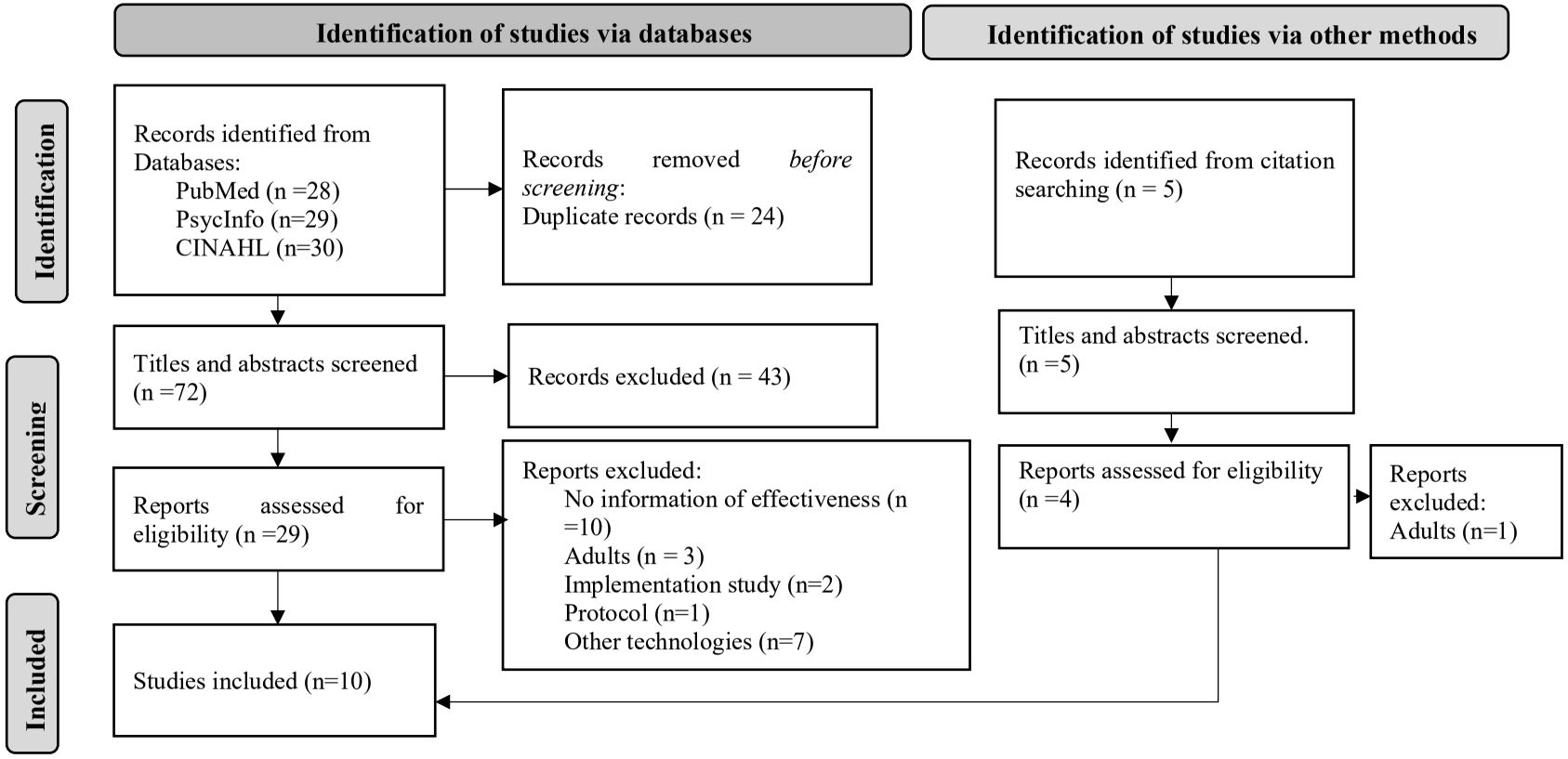
Appendix 2. PRISMA flow diagram showing the selection of articles on digital technologies connecting users and service providers (Page et al., 2021).



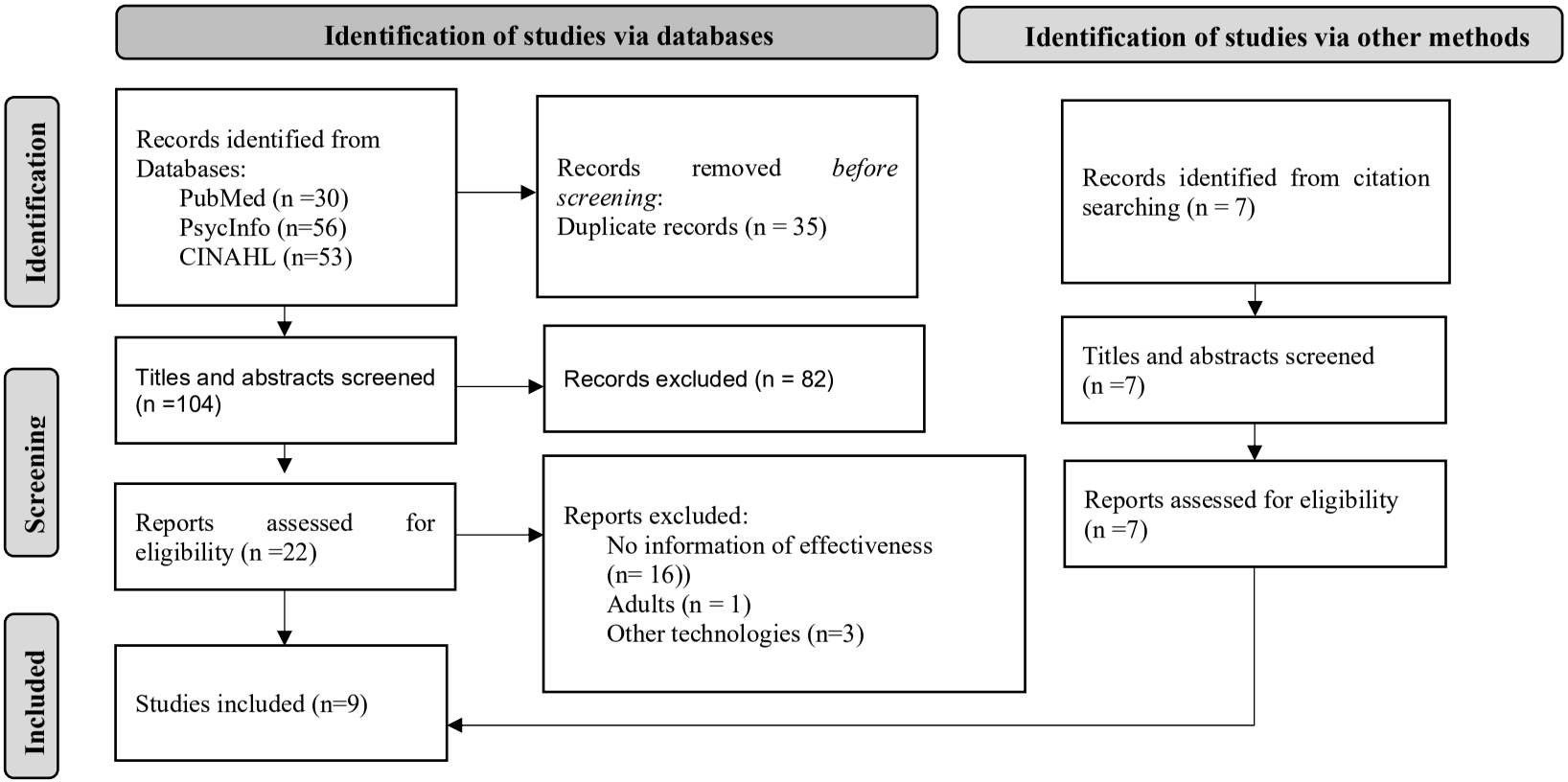
Appendix 3. PRISMA flow diagram showing the selection of articles on web-based mental health interventions (Page et al., 2021).



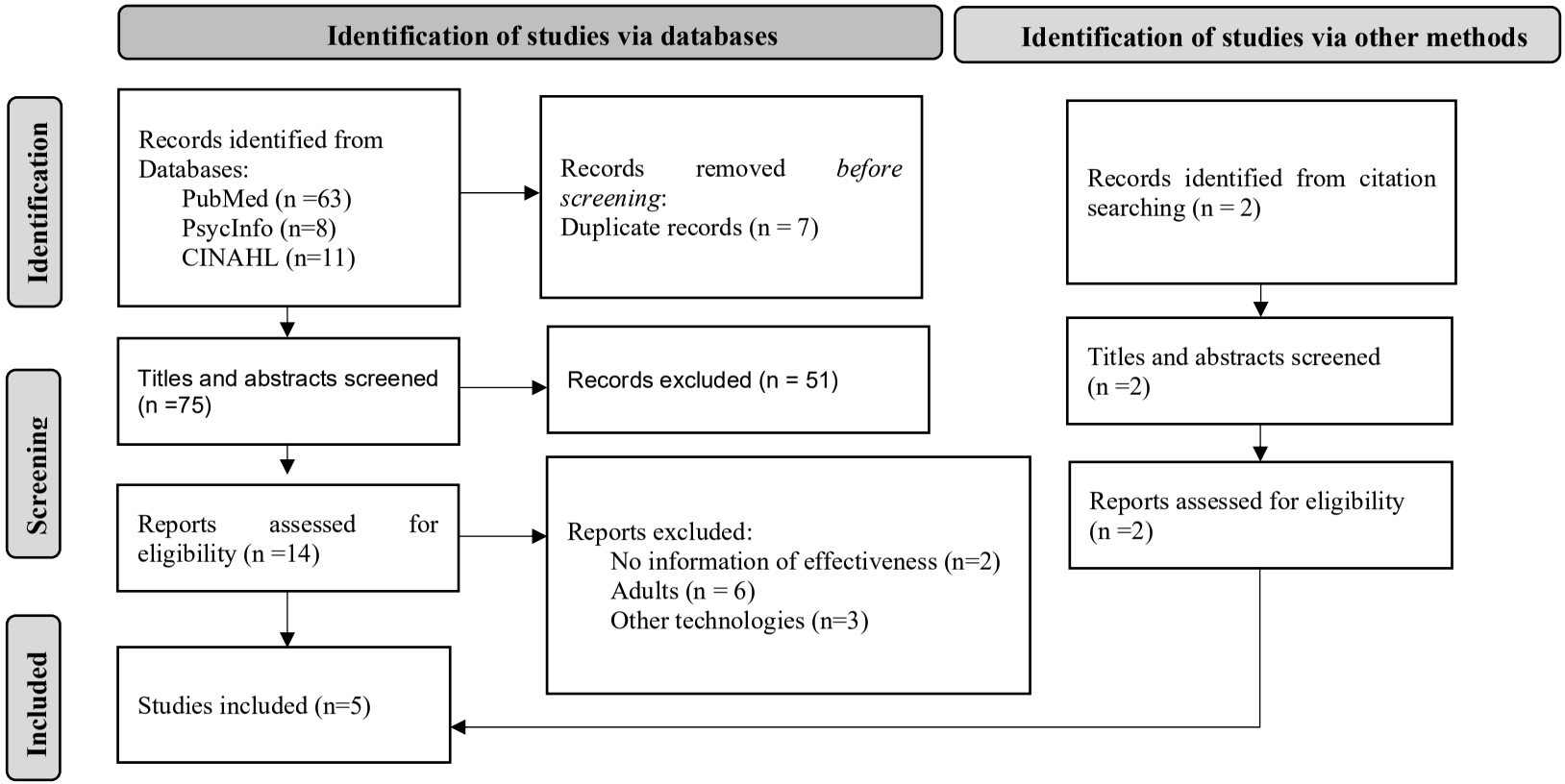
Appendix 4. PRISMA flow diagram showing the selection of articles on digital mobile – and remote technologies (Page et al., 2021).



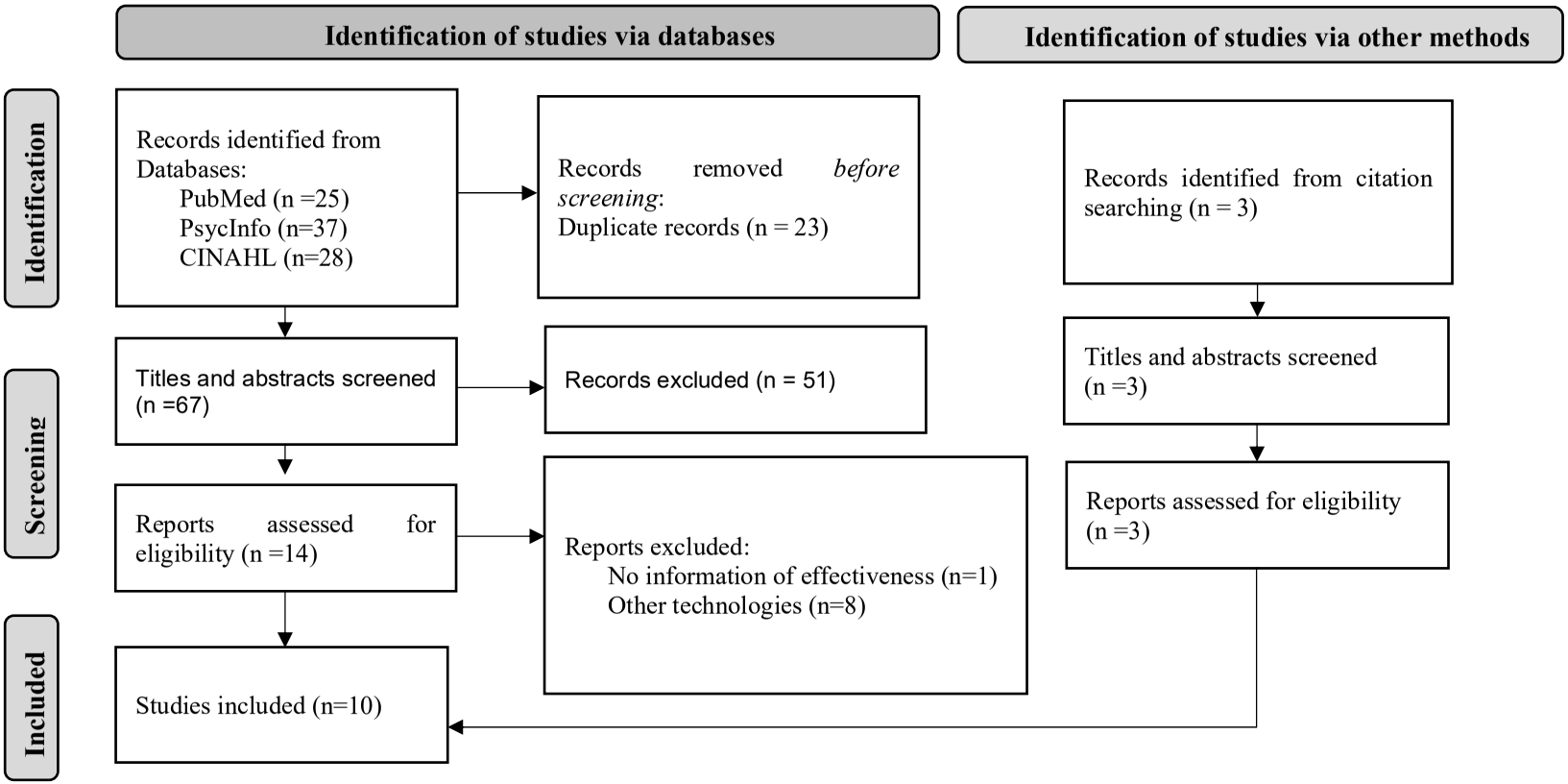
Appendix 5. PRISMA flow diagram showing the selection of articles on social media intended to support mental health (Page et al., 2021).



Appendix 6. PRISMA flow diagram showing the selection of articles on virtual reality and conversational agents (Page et al., 2021).



Appendix 7. PRISMA flow diagram showing the selection of articles digital serious games (Page et al., 2021).



APPENDIX 8. Details of previous systematic reviews (N=33) related to digital technologies supporting young people's mental health and their effectiveness.

Author, year	Technology used in interventions	Aim of review	Mental health problem	Effectiveness	Number of studies / participants	Age of participants
Ali, K., Farrer, L., Gulliver, A., Griffiths, K.M., 2015	Web- and text-based peer-to-peer interaction either stand-alone intervention or component of an intervention.	Evaluate the evidence regarding the effectiveness of web- and text-based peer-to-peer support.	Depression, anxiety, general psychological problems, eating disorders and substance use (tobacco).	Mixed evidence of effectiveness.	6/663	12-25
Babbage, C. M., Jackson, G. M., Davies, E. B., & Nixon, E., 2022	Web-based and off-line interventions with digital technology	Explore the efficacy of predominantly self-administered digital interventions.	Perceived or clinically diagnosed reduced psychological well-being	Interventions were effective in the areas targeted by the intervention.	12/1460	9-25

Barnes, S., Prescott, J., 2018	Serious games	Assess the effectiveness of serious games.	Anxiety disorder.	No effectiveness was found.	5/410	10-19
Bennett, S. D., Cuijpers, P., Ebert, D. D., McKenzie Smith, M., Coughtrey, A. E., Heyman, I., Manzotti, G., Shafran, R. 2019	Web-based interventions	Assess the evidence for the use of guided and unguided self-help.	Symptoms of common mental health disorders	Self-help is efficacious in treating common mental health disorders.	50/3396	< 18
Choi, E., Yoon, E.H., Park, M.H., 2022	Video games	Explore the therapeutic effects using video games to treat or prevent targeted mental health problems.	Perceived or clinically diagnosed mental health problems.	No effects were found.	22/n/a	n/a

Clarke, A. M., Kuosmanen, T., & Barry, M. M. 2015	Online interventions e.g., web-based interventions, social media, serious games, mobile applications.	Examine the effectiveness of online mental health promotion and prevention interventions	No specific mental health problem	No effectiveness was found.	28/n/a	12-25
David, O.A., Costescu, C., Cardos, R., Mogoaşe, C., 2020	Serious games	Review evidence-based status of serious games for mental health promotion and health-related behavioral change	No specific mental health problem.	No effectiveness was found.	34/n/a	<18
Davidson, S. K., Sanci, L., de Nicolás Izquierdo, C., Watson, C. J., Baltag, V., & Sawyer, S. M. 2022	Synchronous video contact, phone, SMS, email, WhatsApp	Synthesize the literature on synchronous teleconsultations e.g., provision of real-time clinical services to a remote client by a health care professional.	No specific mental health problem.	No effectiveness was found	59 /n/a	10-19

Dewa, L.H., Lawrance, E., Roberts, L., Ashrafian, H., Fontana, G., Aylin, P., 2021	Digital intervention, software, or internet-delivered services (e.g., smartphone app, virtual reality, internet-based treatment, and chat room)	Conceptualize, appraise, and synthesize evidence on quality social connections (QSCs) within digital interventions.	Depression and anxiety, prevention / symptoms / disorders	Digital quality social connections are important component of depression and anxiety outcomes.	42/23319	14-24
Farrer, L., Gulliver, A., Chan, J.K.Y., Batterham, P.J., Reynolds, J., Calear, A., Tait, R., Bennett, K., Griffiths, K.M., 2013	Web-based interventions, Interventions used technical devices (e.g., computer, smartphone), or connecting technologies (voice, text, video)	Evaluate both the effectiveness of interventions and the methodological quality of studies.	No specific mental health problem.	No effectiveness was found.	27/n/a	18-25

Garrido, S., Millington, C., Cheers, D., Boydell, K., Schubert, E., Meade, T., & Nguyen, Q. V. 2019	Interventions delivered by computer, on smartphones, or web.	Investigate the effectiveness of digital mental health interventions without supervision.	Depression , anxiety	Interventions were effective when involved human interaction. Without human interaction effectiveness reduced.	41/n/a	12-25
Grist, R., Croker, A., Denne, M., & Stallard, P. 2019	Interventions delivered by computer, on smartphones, or web.	Investigate the evidence for the effect of technology delivered interventions	Diagnosed anxiety or depression disorder or elevated symptoms	Interventions based on CBT technology are effective for both depression and anxiety.	34/3113	6-18
Grist, R., Porter, J., Stallard, P., 2017.	Mobile application	Appraisal research evidence for the efficacy and acceptability of mobile apps to support the management of mental health.	Depression, bipolar disorder, anxiety disorders, self-harm, suicide prevention, conduct disorder, eating disorders and body image issues, schizophrenia,	No effectiveness was found.	24/473	9-30

			psychosis, and insomnia.			
Halldorsson, B., Hill, C., Waite, P., Partridge, K., Freeman, D., Creswell, C., 2021.	VR intervention, serious games	Review of studies that have evaluated the effectiveness of serious games or VR	Mental health disorder or elevated symptoms of mental health problem/s	Limited number of interventions and evidence of efficacy.	19/ n/a	<18
Kelson, J.N., Ridout, B., Steinbeck, K., Campbell, A.J., 2021	VR intervention	To appraise the empirical status of VR interventions for	Symptoms of psychological distress symptoms psychological distress	The effectiveness is limited by the lack of high-quality controlled studies.	7/n/a	10-19
Leech, T., Dorstyn, D., Taylor, A., Li, W., 2021	App-based stand-alone interventions used in mobile device (i.e., tablet, smartphone)	Evaluate the evidence of app-based stand-alone interventions.	Depression, anxiety, stress, distress, and mental health in general	Mixed evidence of effectiveness.	11/1706	10-35

Lehtimaki, S., Martic, J., Wahl, B., Foster, K. T., & Schwalbe, N. 2021	Digital mental health intervention delivered through a digital platform (e.g., web-based, computer, or mobile phone)	Synthesize evidence on digital health interventions effectiveness, cost-effectiveness.	Diagnosed or self-reported mental health conditions, including affective, behavioral, and trauma-related conditions	cCbT (computerized cognitive behavioural therapy) is effective on anxiety and depression. The effectiveness of other digital mental health interventions (e.g., video games, mobile applications, or social networks) is unclear. No evidence of cost-effectiveness due to lack of evaluation.	18/n/a	10-24
Martinez, K., Menéndez-Menéndez, M.I., Bustillo, A., 2021.	Serious games developed by research teams for children and adolescents.	To study serious games	Depression or anxiety	Comparison of effectiveness is not possible.	34/n/a	6-19

Mathieu, S. L., Uddin, R., Brady, M., Batchelor, S., Ross, V., Spence, S. H., Watling, D, Kõlves, K. 2021	Connecting users and service providers via telephone-based, text-based, and web-based modalities.	Review knowledge about the use and effectiveness of helpline services.	No specific mental health problem.	No effectiveness was found.	52/n/a	<25
Orsolini, L., Pompili, S., Salvi, V., & Volpe, U. 2021	Web-based interventions, technologies connecting users and service providers via videoconferencing and, audio calls	Providing an overview on the current state-of-the-art in the field of telemedicine health interventions.	Anxiety, obsessive-compulsive disorder, and affective disorders.	Computer-based and therapist-delivered web-based intervention (i.e., cognitive behavior therapy, CBT) for depression is effective, cost-effective, and comparable with face-to-face treatment.	56/n/a	n/a

Punukollu, M., Marques, M., 2019	Mobile or internet application or intervention	Evaluate literature concerning the use of apps in the detection, management and maintenance of young people mental health and well-being and determine their effectiveness.	No specific mental health problem.	No effectiveness was found, limited number of studies	6/n/a	10-29
Rice, S.M., Goodall, J., Hetrick, S.E., Parker, A.G., Gilbertson, T., Amminger, G.P., Davey, C.G., McGorry, P.D., Gleeson, J., Alvarez-Jimenez, M., 2014.	1) Web based intervention 2) social networking sites and support groups	Appraise of web-based approaches	Depression	No effectiveness was found	1) 15/n/a 2) 22/n/a	1) 12-25 2)n/a
Ridout, B., Campbell, A., 2018	Social networking sites	Identify evidence regarding the use, effectiveness,	No specific mental health problem	No effectiveness was found, lack of high-quality	9/n/a	<25

		suitability, and safety		evidence for efficacy		
Sequeira, L., Perrotta, S., LaGrassa, J., Merikangas, K., Kreindler, D., Kundur, D., Courtney, D., Szatmari, P., Battaglia, M., Strauss, J., 2020.	Mobile and wearable technologies	Evaluate applications and wearable technologies	Depression	No effectiveness was found, limited number of studies of clinical outcomes.	30/n/a	<24
Stewart, E., Milton, A., Yee, H.F., Song, M.J., Roberts, A., Davenport, T., Hickie, I., 2022	Digital device to assess or track health.	Summarize eHealth tools for health assessment and monitoring; clarity about the population and settings, the characteristics of digital devices, the primary outcomes, and the risks and	No specific mental health problem	No effectiveness was found, limited number of studies of clinical outcomes.	39/n/a	<24

		challenges of implementation.				
Temkin, A.B., Schild, J., Falk, A., Bennett, S.M., 2020	Mobile application	Review the evidence around user satisfaction and applications impact on symptoms.	Anxiety disorders	No effectiveness was found, limited number of studies of clinical outcomes.	22/n/a	<29
Townsend, C., Humpston, C., Rogers, J., Goodyear, V., Lavis, A., Michail, M., 2022.	Serious games	Evaluate the effectiveness of gaming interventions	Depression, anxiety	Gaming interventions designed for the treatment of mental health problems are effective.	12/844	12-25
Välimäki, M., Anttila, K., Anttila, M., & Lahti, M. 2017	Web based interventions	To describe effectiveness of Web-based interventions to support mental health	Depression or anxiety	Effective in short-term effects. Limited number of studies of long-term effects.	review 27/ n/a meta-analysis 15/4979	10-24

van Doorn, M., Nijhuis, L.A., Egeler, M.D., Daams, J.G., Popma, A., van Amelsvoort, T., McEnery, C., Gleeson, J.F., Öry, F.G., Avis, K.A., Ruigt, E., Jaspers, M.W.M., Alvarez-Jimenez, M., Nieman, D.H., 2021	Web-based or mobile based interventions	Overview of the research of indicated preventive interventions for emerging mental health symptoms	Self-reported or assessed signs or symptoms of a mental disorder.	Preventive interventions are effective to reduce subclinical symptoms of various mental illnesses and improve several outcome measures such as quality of life and mindfulness.	30/4950	12-25
Verran, A., Uddin, A., Court, R., Taggart, F., Sutcliffe, P., Sturt, J., Griffiths, F., Atherton, H., 2018.	Connecting users and service providers via telephone, text-based modalities, and video	Describe evidence of effectiveness and impact of technologies connecting user and service provider.	Chronic mental health disorder.	No effectiveness was found.	6 / n/a	12-25

Williams, J.E., Pykett, J., 2022.	Mobile applications (smartphone) with monitoring feature	Outline the extent of the clinical evidence base of mental health apps and analyze 'technical mechanisms' in apps from the perspective of critical ecological analysis.	Depression, anxiety	No effectiveness was found, limited number of studies of clinical outcomes.	39/n/a	0-25
Wright, M., Reitegger, F., Cela, H., Papst, A., & Gasteiger-Klicpera, B. 2023	Digital technology-based interventions (including interventions delivered with or without internet connection)	To determine digital-based interventions that promote mental health, analyze the effectiveness of interventions, and assess factors underlying effectiveness.	No specific mental health problem	Small effects on promoting well-being, relieving anxiety, and enhancing protective factors. Factors influencing efficacy include the given setting, the level of guidance and support, and the adherence to the intervention.	27 / 13216	11-18

Zhou, X., Edirippulige, S., Bai, X., & Bambling, M. 2021	Web-based interventions and applications, web-based synchronous chat and AI-based chatbot.	To determine the effects of online mental health interventions.	Depressive symptoms, anxiety related symptoms, psychological stress level	Interventions were effective in managing depression, anxiety, stress, insomnia and improving quality of life.	45/ 13291	15-24

n/a information was not available

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