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CONNAISSANCES SCIENTIFIQUES - COVID-19

Issue Note

Evidence on the Use of Virtual Mental Health Care Technologies for Youth

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Executive Summary

This CanCOVID rapid review summarizes the evidence on scope, use, and outcomes of Virtual Mental Health Care (VMHC) technologies in youth with mental illness. The question posed for this review is:

Question

What virtual mental health care (VMHC) technologies have been used by youth in Organisation for Economic Co-operation and Development (OECD) countries, and what were the effectiveness and uptake of those technologies?

While the question is not specific to COVID-related illness and its consequences, the intent is to consider these technologies in the context of the COVID pandemic, which has had serious and long-term implications for youth mental health and for the rapid development of these technologies for this population.

We conducted an electronic systematic search using the search strings developed for each database for the period of January 1, 2021, to December 31, 2022, and found 24 eligible studies for inclusion in this review.

Summary of the key findings

- **What youth mental health issues were covered by studies in this review?**
  VMHC services were investigated in more than 50 mental health issues among youth. The most commonly studied mental illnesses were anxiety and mood disorders, including post-traumatic stress disorder (PTSD), obsessive-compulsive disorder (OCD), and depression. The broader spectrum of mental health concerns studied in VMHC research included stress, attention deficit hyperactive disorder (ADHD); autism; chronic illness-associated mental health issues in youth; early psychosis; eating disorders; body image disorders; insomnia; loneliness; schizophrenia; speech disorders; substance (alcohol, cannabis, tobacco) use disorders; and suicidal ideation. Additionally, virtual mental health care services were studied in youth life satisfaction, mental health well-being, quality of life, and self-efficiency, mostly for self-assessment and prevention purposes.

- **What VMHC technologies were used by youth in these studies?**
  More than 20 VMHC delivery technologies, including synchronous, asynchronous, or a combination of both modalities, were investigated in research on youth mental health. Smartphone and non-smartphone apps (much less frequently); web-based apps; computer-based but not internet-based apps; chatbots; social media; tele-consultation; tele-psychiatry; tele-psychotherapy using videoconferencing; email; phone; text messaging; SMS; and WhatsApp; or a combination of these

technologies all were used to address mental health among youth. Applied gaming and virtual reality (VR) technologies are also emerging.

- **How effective were VMHC technologies in addressing youth mental health issues?** Effectiveness of VMHC technologies varies according to diagnosis, severity of illness, and type of technology. There was often insufficient evidence to determine the long-term effectiveness and cost-effectiveness of VMHC technologies. Youth tele-psychotherapies have been found to be as effective as in-person therapies, although the effectiveness of tele-psychotherapies might be enhanced when delivered with the support of a therapeutic provider and were more effective in the management of depression and anxiety than in ADHD. Analysis of using smartphone apps in the management of anxiety, depression, insomnia, and stress showed a small but significant reduction in symptoms or intensity of those conditions. Using social media could help youth with depression and anxiety feel a sense of connecting and bonding to others through sharing experience. Effectiveness of smartphone apps in suicide prevention among youth has been demonstrated, but its clinical effectiveness needs to be further assessed. A significant association between telemedicine and mental health improvement was found, indicating that telemedicine could probably be efficacious in improving mental health during the COVID-19 pandemic. Computerized cognitive behavioral therapy (CBT) was reported to be effective for the management of anxiety and depression, particularly, with an in-person presence. Using SMS text messages, tele-mental health, and mobile apps to optimise medication adherence among youth with mental health disorders improved medication adherence. Online mental health interventions were effective in managing diverse mental health conditions among youth and self-help platforms were the most frequently used modality.

- **What was the uptake of VMHC technologies by youth to address their mental health?** Uptake of VMHC technologies was generally positive. Uptake measures to assess use of chatbots demonstrated overall positive perceptions and opinions about chatbots. More work is needed to improve the implementation and uptake of smartphone apps for prevention and/or treatment of youth mental health. Severe illness, technical issues, and lack of personalization were common barriers that influenced youth engagement with VMHC interventions. Apps that could enhance social connectedness, increase insight into health, and give young people a feeling of being in control of their health facilitated user engagement. Health care providers, adolescents, and their parents or caregivers had an overall positive experience with VMHC services; and several qualitative studies reported that teleconsultations might promote continuity of care for adolescents in rural and remote settings. majority of youth found VMHC services provided though applied gaming and VR technologies were relevant and acceptable to address their mental health symptoms. Positive results were reported on the feasibility and/or usability of smartphone apps to reduce substance use among youth. The feasibility of tele-mental health for youth with chronic illnesses was appropriate, acceptable, and satisfactory to patients and their parents. Among college students, there was a good

level of acceptance and adherence to VMHC services. Videoconferencing or audio tele-mental health interventions appeared to be feasible, preferred, and easy-to-apply for youth in the treatment and monitoring of youth depression, anxiety and OCD. Indigenous youth and their family members in rural communities were increasingly comfortable with teleconferencing after they had used it during consultations.

Limitations

- We included only systematic, scoping, narrative reviews, and meta-analyses in this rapid review. We did not include single/empirical studies in this brief.
- We included only English-language articles.
- In several studies, a combination of synchronous and asynchronous mental health services was used or evaluated as a single intervention; therefore, it was not always possible to distinguish evaluations on the effectiveness of each modality.
- Most reviews did not provide any detailed information about the context of the primary studies.
- We completed the report within a short timeframe; as such, this is not an exhaustive nor comprehensive review, and relevant information may have been missed due to time constraints.

Conclusion

VMHC technologies may offer promising results in the treatment and management of youth mental issues, particularly, for anxiety and mood disorders. However, the clinical effectiveness of some of VMHC interventions was uncertain and further research is needed in various settings and with larger sample sizes. Uptake of VMHC technologies was generally positive and can be increased through personalization and fostering social connectedness. VMHC technologies improved access to services and reduced cost and travel time as compared to in-person face-to-face services. However, some technology-related barriers, like internet access, connection disruptions, and low internet speed persist. Co-designing digital products with youth, particularly in certain settings such as with Indigenous youth, and enhancing partnership with academics and commercial partners, could increase uptake of VMHC technologies. There was often insufficient evidence to determine the long-term effectiveness and cost-effectiveness of the interventions.

Introduction

The use of virtual mental health care (VMHC) technologies began in mid-20th century in the form of teleconsultation and was mainly provided in that form until the 21st century, when health care providers (HCPs) started to use improved internet and communication technologies in different settings. [1] Until 2020, when the COVID-19 pandemic necessitated implementation of various public health protections, the majority of mental health care was provided through face-to-face consultations. When the pandemic was declared, there was a quick shift to VMHC technologies and platforms. [2-4]

VMHC technologies refers to any app, website, online tool, or other online support application that provides mental health care support in either real-time (synchronous) or not real-time (asynchronous).We defined VMHC interventions/services as any remotely provided intervention/services that used phone, smartphone/mobile health (mHealth) apps, computer- and tablet-based apps, internet-based apps, rule-based response-generator chatbots, artificial intelligence (AI)-based programs/chatbots, videoconferencing (Skype, Zoom, WebEx, etc.), social media, WhatsApp, SMS, instant messaging, pre-recorded video, email, written text (text messaging), long-form feedback and wearable devices that help users with management of their mental health concerns and disorders, either synchronous or asynchronous.

The COVID-19 pandemic had a huge impact on young people at a critical period of psychosocial development. Youth and early adulthood are peak periods of a vulnerability for developing mental illness; about 75% of mental disorders emerges during this time. [5] High levels of clinical depression, anxiety, and loneliness were reported in youth, including those with and without diagnosed mental issues. [6] Over 80% of youth in the general population and about 75% of young people in primary mental health care services experienced negative impact on their activities, mental health, and wellbeing. [6]

Disruptions to key developmental milestones that affect relationships and limited capacity for self-care are some of the consequences of worsening of youth mental health. Quick support is needed to reduce the psychosocial impacts on youth, particularly among those with existing mental health disorders. [6]

Even before the COVID-19 pandemic, a gap in access to mental health care existed. Structural barriers within the health system include a shortage of trained professionals, and social barriers like the stigma associated with mental health concerns. [7] In addition to offering a potential solution for common barriers to accessing mental health care, VMHC technologies for youth are crucial during any crises that prevent in-person delivery of services, such as pandemics19. [8] Experts expect that pandemic-related restrictions on in-person interactions persist in many countries and they predict similar pandemics, with comparable restrictions, will emerge in the future. [7] These expectations and predictions demonstrate the paramount role of the VMHC technologies in providing support and treatment for youth, especially since most of them are familiar and comfortable using digital health technologies.

In this brief, we summarize evidence from the literature on VMHC technologies to better understand what technologies are being used by young people in OECD countries. This rapid review also summarizes the reported effectiveness and uptake of VMHC technologies to offer a more holistic understanding of their impact on youth.

Question

This brief addresses the following broad question:

What VMHC technologies have been used by youth in the Organisation for Economic Co-operation and Development (OECD) countries, and what were the effectiveness and uptake of those technologies?

Methods

We electronically searched MEDLINE via PubMed, Scopus, Cochrane Database of Systematic Reviews (CDSR) for the period of January 1, 2021 to December 31, 2022 using the search strings developed for each database. We also searched WHO COVID-19 Global Literature, Google Scholar (limited to the first 50 pages) and Open Grey to find and retrieve relevant grey literature. To broaden the scope of the question related to the used technologies we used the following terms: telemonitor, telehealth, digital health, digital clinic, E-mental health, mHealth, mobile apps, apps, instant chats, text messages, social media, patient portals, smartphone, mobile device, chatbots, artificial intelligence (AI), tele-medicine, telemental health, and telepsychiatry. Terms related to mental health included: depression, anxiety, wellbeing, cognitive behavioural therapy (CBT), psychiatry, counselling, psychotherapy, consults, therapy, and spiritual health.

We included only systematic, scoping, and narrative reviews, and meta-analyses that reported on youth aged 15 to 24 years, and which were conducted in, or included studies from, OECD countries. Potentially eligible articles had to include at least one VMHC technology. We considered only English language publications.

We imported the retrieved resources into the desktop bibliographic manager Zotero and removed duplicates. First, we screened titles and abstracts, and then the full texts of potentially eligible articles. Two reviewers screened all articles and if the reviewers were uncertain about inclusion/exclusion of a particular article, they discussed in a team meeting and resolved.

We extracted data from eligible articles in an MS Excel spreadsheet for data extraction. The data extraction form included article details (e.g. year of publication, authors' names and initials, etc.) and study characteristics (i.e., country of study, mental health condition focused on, methodology, and results). Two team members charted the data independently. We included a total of 24 eligible studies for this rapid review (**Appendix 1**).

Limitations

- We included only systematic, scoping, narrative reviews, and meta-analyses in this rapid review. We did not include single/empirical studies in this brief.
- We included only English-language articles.
- In several studies, a combination of synchronous and asynchronous mental health services were used or evaluated as a single intervention, therefore it was not always possible to distinguish
- evaluations on the effectiveness of each modality.
- Most reviews did not provide any detailed information about the context of the primary studies.
- We completed the report within a short timeframe; as such, this is not an exhaustive nor comprehensive review, and relevant information may have been missed due to time constraints.

Results

We included 19 systematic reviews with or without meta-analysis, two scoping reviews, two narrative reviews, and one meta-analysis. [7,9-31] Researchers with affiliations from the US (7), the UK (7), Australia (4), Canada (3), Italy (2), Qatar (2), Switzerland (2), China (1), Germany (1), Iran (1), Israel (1), Portugal (1), and Malaysia (1) conducted the studies. In several instances, researchers from more than one country contributed to a single study; therefore, the total number of the countries included is more than 24.

Based on our inclusion criteria we focused on reviews that included studies conducted in the OECD countries; however, one systematic review included studies from Brazil, Hong Kong, and Oman in addition to several studies conducted in the OECD countries. [20] The included studies reviewed evidence of the use of more than 20 VMHC technologies in the treatment and management of more than 35 mental health disorders and concerns among youth.

What mental health conditions were studied in the youth population and their use of virtual mental health care services?

The studies included in this rapid review reported on VMHC services and applications involving a very wide spectrum of youth mental health and substance use conditions and issues. Mental health disorders and mental health concerns are listed in Table 1 and Table 2, respectively **(Appendix 2)**. We used the International Classification of Diseases, Tenth Revision (ICD-10) to differentiate between mental disorders and mental issues or concerns that were not classified as a mental disorder. [32]

Depression and anxiety were the most common mental health disorders in studies of VMHC technologies involving the youth population. [7,9-12,14,20,23,25,26,29-31] Additionally, in a number of studies, VMHC were used not only for youth with existing condition, but also for those who were healthy and wanted to take care of their mental well-being more proactively. [10,11,16,17,20,23,25,27,31]

What virtual mental health care technologies were used by youth?

Youth use various types of VMHC technologies and platforms, including chatbots, mobile-only and web-based apps, phones, tablets, and wearable technologies.

One systematic review evaluated the studies that used chatbots that operate as stand-alone software or a web browser and generate either rule-based or AI response with the ability to initiate the dialogue by the chatbot or chatbot/client as an intervention. [9]

Another systematic review, reported on using 'native' mobile apps (i.e., not on a web browser); web-based, computer-based but not web-based, mobile phone but not smartphone, wearable technology, tablet-based, or combination of technologies. [10,11]

VMHC interventions using tele-consultation via videoconferencing (only), multiple technologies such as videoconferencing, phone, email, text, non-videoconferencing including SMS, email, and WhatsApp were reviewed in another article. [13] Other reviews reported on the Digital Health Interventions, such as social media, language detection technologies, tele-psychiatry, eMental Health provided via telehealth and mHealth; and digital interventions, such as applied games and virtual reality (VR). [15,16,18,19]

Apps such as PsyCOVID and Go Health; automated text messaging platforms, online sessions for both individual and groups, SMS, telephone contact, tele-psychotherapy via videoconferencing were reviewed too. [20]

mHealth apps targeted to reduce consumption of substances (excluded if only used for screening); tele-mental health interventions using Skype, Zoom, or WebEx, and AIMhi-Y app - Aboriginal and Islander Mental Health Initiative for Youth App were among other VMHC interventions that were evaluated. [21,22,27]

Phone, computer-based programs, instant messaging, pre-recorded video, email, written text (text messaging), and long-form feedback, smartphone applications with a mood or anxiety monitoring feature, web-based self-help platforms (including those guided by therapist, clinician, real-time therapist sessions via chat, WhatsApp messages sent by coaches, etc.), online videos, peer-to-peer discussion forums, video conferences, brief web-based synchronous chat, computerized gamified self-help program, fully automated text-based conversational agent (Weobot), and AI-based chatbot (Tess) were reviewed in other included publications. [7,28,30,31]

The most commonly studied VMHC technologies were apps, particularly, smartphone apps. [10,11,21,22,27] Tele-consultation, which has been delivered through various technologies such as videoconferencing, audio-call, different methods of texting were also commonly studied. [13, 20] Emerging VMHC technologies such as AI-based chatbots, applied and computerized gaming, and VR were also included in recent studies. [7,9,19,31]

How effective are VMHC technologies used by youth?

Effectiveness of VMH technologies varied according to diagnosis, severity of illness, and type of technology. VMHC technologies were associated with promising results in the treatment and management of youth mental health issues, particularly, for anxiety disorders and mood disorders. [7,9,12,14,19,23,24,31] There was often insufficient evidence to determine the long-term effectiveness and cost-effectiveness of VMHTs. Further research in different settings and populations is needed for more conclusive evidence on effectiveness of VMHC technologies.

Tele-psychotherapies were generally as effective as in-person therapies

A meta-analysis found that the youth tele-psychotherapies were as effective as in-person therapies. Effectiveness of tele-psychotherapies might be increased when they were delivered with therapeutic provider support, particularly when the provider taught specific skills or discussed difficulties patients face while they were implementing skills. Remote youth psychotherapies were significantly more effective for anxiety and conduct problems than for ADHD. [7]

Smartphone apps were effective in supporting symptom management and treatment adherence

A systematic review and meta-analysis evaluated the effectiveness of smartphone apps intervention in managing anxiety, depression, insomnia, and stress and found a small but significant reduction in symptoms or intensity of those disorders. [12] A systematic review and meta-analysis evaluated the efficacy of portable device (smartphone and tablet) stand-alone self-management apps in reducing the symptoms of depression, anxiety and stress among youth and reported promising in improving symptoms compared to groups. [23] Evidence of efficacy was found for stress, anxiety, depression and risky behaviors such as alcohol and tobacco abuse in a systematic review conducted to evaluate effectiveness of mobile apps psychological interventions for college students. [25] A rapid review of the impact of digital health interventions on optimising medication adherence among youth with mental health disorders compared to treatment as usual reported improvement of medication adherence using SMS text messages, tele-mental health, and mobile apps. [29]

Social media platforms were effective for sharing experiences but led to isolation and disconnection

A scoping review found that using social media could help youth with depression and anxiety to feel a sense of connecting to others, bonding with them through shared experience or understanding, and enabling them to disclose their thoughts and feelings to others, as well as learning that others were experiencing similar feelings. However, negative feelings such as loneliness or hurt, and a sense of isolation because of disconnecting from other people were among negative effects of using those technologies. [14]

Effectiveness of technologies to prevent suicide is unclear

Findings of a systematic review suggested that new technologies like smartphone apps, language detection and tele-psychiatry provided support for suicide prevention in adolescents; however, the data on clinical use were very limited and despite being promising, clinical effectiveness of those interventions was unclear. [16] There is also supporting evidence for preventing suicide and reducing substance use[21], however, the clinical effectiveness of VMHC interventions for preventing suicide is still uncertain because of reliance on small-sample-size studies. [16]

Justice-involved youth benefitted from access to mobile phones

A systematic review on technologies for assessment and treatment of justice-involved youth reported that using mobile phones facilitated behavioral health assessment and treatment services. E-mental health technologies especially telehealth, were potentially effective for treatment and assessment of youth mental health conditions involved in the justice system. Reported advantages were positive opinions of users, increased access to care, and efficiency. Barriers to accessing the technology, privacy concerns, and lack of clear effectiveness, validity or reliability of data were reported disadvantages. [18]

Telemedicine is effective, but effectiveness of different modalities across disorders and populations is indeterminate

Another systematic review reported that more than 90% of the included articles showed a significant association between telemedicine and mental health improvement and concluded that telemedicine was probably efficacious in improving mental health disorders during the COVID-19 pandemic. However, it could not determine the best telecommunication method for each mental disorder in different populations. [20]

Effectiveness of online CBT was enhanced by the presence of a support person

A systematic overview, which included 18 systematic reviews and meta-analyses, found evidence on the effectiveness of computerized cognitive behavioral therapy (CBT) for anxiety and depression. [24] It also reported that interventions with an in-person presence (e.g. a professional, peer, or parent) increased effectiveness, adherence, and decreased dropout compared to self-administered or fully automatized interventions. [24]

Effectiveness of web-based apps was mixed

A systematic review found mixed evidence on the effectiveness of web-based applications in managing mental health issues among youth. [31] It reported that online mental health interventions were found to be effective in managing diverse mental health conditions among youth and that online self-help platforms were the most frequently used modality. It also reported that AI-based chatbots were emerging as

potential solutions; however, a low retention rate was a problem in implementing such interventions and further studies to find proper approaches to engage youth was suggested. [31]

VMHC services were associated with promising results in the treatment and management of youth mental health issues, particularly, for anxiety disorders and mood disorders. [7,9,12,14,19,23,24,31] Further research in different settings and populations are needed for more conclusive evidence on effectiveness of VMHC services.

What factors determine the uptake of VMHC technologies by youth?

Youth with mental health issues, their parents and caregivers, and HCPs, demonstrated overall good uptake of VMHC technologies, which could be attributed to the improved access to the services, and reduced cost and time need for travel to receive traditional face-to-face services that VMHC technologies provide. However, personal barriers (severe mental illness) may limit uptake of VMHC services among youth. More work needs to be done to improve uptake of VMHC services among youth.

Chatbots enabled youth uptake of VMHC technologies

One of the included reviews evaluated usefulness, ease of use, responsiveness, understandability, acceptability, attractiveness, trustworthiness, enjoyability, as well as content of the chatbots as interventions for VMHC services, comparing them to other VMHC interventions. Patients had an overall positive perceptions and opinions about chatbots as a VMHC service. [9]

Co-design would enhance youth uptake of smartphone apps

Another review reported on coproduction, acceptability, appropriateness, feasibility, fidelity, adoption, engagement, penetration, implementation cost and sustainability of the smartphone apps used for prevention and/or treatment of mental health issues among youth and concluded that more work is needed to improve the implementation and uptake of the apps for VMHC. The author suggested co-designing with youth, partnership with academics and commercial experts, and addressing affordability and access disparities of the underserved populations as potential solutions. [10]

VMHC technologies reduced some barriers to accessing care, but other barriers remain

Severe mental illness, technical issues, and lack of personalization are common barriers that influence youth engagement with digital mental health care interventions. Apps could enhance social connectedness, increase insight into health, give young people a feeling of being in control of their health, and enable user engagement. [11]

A scoping review reported on acceptability, advantages and barriers of teleconsultations among youth and found that HCPs, adolescents, and their parents or caregivers had an overall positive experience with those services. However, the authors noticed that a couple of qualitative studies showed that face-to-face consultations were preferred to teleconsultations. [13] They reported that multiple studies demonstrated that

teleconsultations reduced barriers to accessing health care by reducing the time and cost of travelling to the health care site, reducing the amount of missed schooling, and, for parents, reducing time away from paid work and caring for other children. Several qualitative studies reported that teleconsultations might promote continuity of care for adolescents in rural and remote settings too. [13] Technological barriers such as internet connection interruptions, and speed-problems and concerns about privacy were barriers they found in the empirical studies they reviewed. [13]

Preliminary evidence shows that youth uptake of VMHC may be enabled through gaming and VR technologies

A systematic review reported that the majority of children and young people found that VMHC services provided through applied gaming and VR technologies were relevant and acceptable in addressing their mental health symptoms. However, it is important to mention that the existing evidence is at a very early stage and studies varied extensively in key methodological characteristics. [19]

MMHC technologies can help youth manage substance use

Another systematic review, which examined the feasibility and/or usability of the smartphone apps to reduce substance use including alcohol, tobacco and cannabis reported positive results on the feasibility and/or usability of the used apps, mainly based on how often the app was used and how much time the participants spent on the app. [21]

VMHC technologies are appropriate for youth with chronic mental illnesses

A systematic review of tele-mental health for youth with chronic illnesses evaluated the feasibility including acceptability and satisfaction, and concluded that tele-mental health interventions were appropriate, acceptable, and satisfactory to patients and their parents and that technology did not create barriers in access to care. [22]

Uptake of VMHC technologies by college-age youth may help to address provider shortages

College students accepted and adhered to the interventions. [25] Counseling services at universities and colleges may benefit from mHealth interventions, not only to support the provision of mental health care to students, but to address shortages of human resources. [25]

Youth prefer VMHC technologies but quality and safety is unclear as compared to in-person care

Videoconferencing based interventions or audio call tele-mental health interventions appear to be feasible, preferred, and easy to apply for youth in the treatment and monitoring of youth depression, anxiety, and OCD. However, it was not clear if the quality of care for those using these interventions met in-person face-to-face care and the safety and protection standards of youth and their parents. [26]

Designing VMHC apps appropriate for Indigenous youth is complex and requires community consultation

A qualitative study and narrative review reported on the development of an app that aimed to increase mental health literacy, self-management, and help seeking for Aboriginal and Torres Strait Islander young people in Australia. [27] The study considered storytelling as a way to develop relationships and facilitate skill development in a safe, non-threatening environment and that youth expected that the app be user-friendly with intuitive designs and nonclinical youth-friendly language. However, the integration of findings into app design proved complex. Although most preferred features identified by young people were included to some degree, budget and time constraints, and the need to integrate best practice recommendations did not allow inclusion of all requirements. [27]

Canadian researchers conducted a systematic review of electronic mental health interventions for indigenous youth and found that family members in rural communities engaged in teleconferencing were increasingly comfortable with the technology after they had used it during consultations. The availability of consultation from a larger centre ultimately allowed for an increased service capacity for youth within one of the smaller communities and accelerated access to youth mental health services. [28]

Several factors affect the uptake of apps for self-monitoring of depression and anxiety in youth

A scoping review and critical ecological analysis on mental health monitoring apps for depression and anxiety in youth included 23 primary studies. Nine articles were about acceptability, app design and/or usability studies. Five studies use methods of ecological momentary assessment (EMA) delivered via smartphone apps that in varying ways, explored the use of EMA in researching the fluctuation of mood and/or symptoms of anxiety within ‘real-world’ settings. Six papers reported feasibility studies with a trial element, whereby participants used a mental health-monitoring app for a set period of time. Two studies were random-controlled trials (RCTs) with one demonstrated positive outcome data related to depression and the other reporting no significant reduction for measures of anxiety and depression. [30]

Conclusion

The use of VMHC services for the treatment and management of youth mental health issues is promising, particularly for anxiety disorders and mood disorders. There is also supporting evidence on preventing suicide and reducing substance use among those using VMHC technologies. However, the clinical effectiveness of some VMHC technologies remains uncertain because of small sample sizes and further research is needed across different settings and with larger sample sizes. There was often insufficient evidence to determine the long-term effectiveness and cost-effectiveness of the VMHC interventions.

Overall, the uptake – including feasibility and acceptability – of VMHC technologies was generally positive among the patients, their parents and caregivers, and HCPs. VMHC technologies improved access to the services, and reduced the cost and time need for travel to receive in-person services. However, some technology-related barriers such as internet access, connection disruptions, and low internet speed continue to pose challenges for certain groups and hinder access to certain VMHC services. Co-designing digital products with youth, especially in certain settings and with particular populations, such

Indigenous communities, as well as enhanced partnerships with academics and commercial partners, may increase the uptake of VMHC technologies.

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Appendix 1: List of included articles.

No.	Authors, Year	Country(ies)	Title	Type
1	Abd-Alrazaq AA, et al. 2021	Qatar, UK, Switzerland	Perceptions and Opinions of Patients About Mental Health Chatbots: Scoping Review.	Scoping review
2	Bear H, et al. 2022	UK, Canada	Determination of Markers of Successful Implementation of Mental Health Apps for Young People: Systematic Review.	Systematic review
3	Borghouts J, et al. 2021	US	Barriers to and Facilitators of User Engagement With Digital Mental Health Interventions: Systematic Review.	Systematic review
4	Buttazzoni A, 2021	Canada	Smartphone-Based Interventions and Internalizing Disorders in Youth: Systematic Review and Meta-analysis.	Systematic review and meta-analysis
5	Davidson SK, et al. 2022	Australia, Switzerland	Best Practice During Teleconsultations With Adolescents: A Scoping Review.	Scoping review
6	Dewa LH, et al, 2021	UK	Quality Social Connection as an Active Ingredient in Digital Interventions for Young People With Depression and Anxiety: Systematic Scoping Review and Meta-analysis.	Systematic scoping review and meta-analysis
7	Domhardt M, et al. 2021	Germany, Israel (All included studies are from the OECD Countries)	Mechanisms of Change in Digital Health Interventions for Mental Disorders in Youth: Systematic Review.	Systematic review
8	Forte A, 2021	Italy, US	The Role of New Technologies to Prevent Suicide in Adolescence: A Systematic Review of the Literature.	Systematic review
9	Girela-Serrano BM, et al. 2022	UK	Impact of mobile phones and wireless devices use on children and adolescents' mental health: A systematic review.	Systematic review
10	Grove L, et al. 2021	US	Technology for assessment and treatment of justice-involved youth: A systematic literature review.	Systematic review
11	Halldorsson B, et al. 2021	UK (All included studies are from the OECD Countries)	Annual Research Review: Immersive virtual reality and digital applied gaming interventions for the treatment of mental health problems in children and young people: the need for rigorous treatment development and clinical evaluation.	Annual research review
12	Hatami H, et al. 2022	Iran (Included studies are from the OECD countries, Brazil, Hong Kong and Oman)	Tele-medicine and improvement of mental health problems in COVID-19 pandemic: A systematic review.	Systematic review

No.	Authors, Year	Country(ies)	Title	Type
13	Kazemi DM, et al. 2021	US	Systematic Review of Smartphone Apps as a mHealth Intervention to Address Substance Abuse in Adolescents and Adults.	Systematic review
14	Lau N, 2021	US	Telemental Health For Youth With Chronic Illnesses: Systematic Review.	Systematic review
15	Leech T, et al. 2021	Australia	Mental health apps for adolescents and young adults: A systematic review of randomised controlled trials.	Systematic review [and meta-analysis]
16	Lehtimaki S, et al. 2021	US, Malaysia	Evidence on Digital Mental Health Interventions for Adolescents and Young People: Systematic Overview.	Systematic overview
17	Oliveira C, et al. 2021	Portugal	Effectiveness of Mobile App-Based Psychological Interventions for College Students: A Systematic Review of the Literature.	Systematic review
18	Orsolini L, et al. 2021	Italy	A Systematic Review on TeleMental Health in Youth Mental Health: Focus on Anxiety, Depression and Obsessive-Compulsive Disorder.	Systematic review
19	Povey J, et al. 2022	Australia	Determining Priorities in the Aboriginal and Islander Mental Health Initiative for Youth App Second Phase Participatory Design Project: Qualitative Study and Narrative Literature Review	Qualitative study and narrative literature review
20	Toombs E, et al. 2021	Canada	A systematic review of electronic mental health interventions for Indigenous youth: Results and recommendations.	Systematic review
21	Venturo-Conerly KE, et al. 2022	US	Effectiveness of youth psychotherapy delivered remotely: A meta-analysis.	Meta-analysis
22	Vitija A, et al. 2022	UK and Qatar	The impact of digital interventions on medication adherence in paediatric populations with attention deficit hyperactivity disorder, depression, and/or anxiety: A rapid systematic review and meta-analysis.	Rapid systematic review and meta-analysis
23	Williams JE, Pykett J. 2022	UK	Mental health monitoring apps for depression and anxiety in children and young people: A scoping review and critical ecological analysis.	Systematic review and critical ecological analysis
24	Zhou X, 2021	Australia, China	Are online mental health interventions for youth effective? A systematic review.	Systematic review

Appendix 2: List of included articles.

Table 1. List of mental health disorders and conditions based on the ICD-10 that were investigated in the included reviews.

#	Mental Health Disorder/Condition	Reference
1	Anxiety disorder, unspecified	7, 9, 10, 11, 12, 14, 20, 23, 25, 26, 29, 30, 31
2	Autism	9, 13
3	Chronic tic disorders	22
4	Disturbance of activity and attention (attention deficit hyperactivity disorder)	7, 13, 30
5	Depression	7, 9, 10, 11, 12, 14, 20, 23, 25, 26, 29, 30, 31
6	Depressive mood	10, 11, 31
7	Early psychosis	10
8	Eating disorders, unspecified	11, 13
9	General anxiety disorder	31
11	Insomnia	12, 20,
12	Mental and behavioural disorders due to use of alcohol	21, 25
13	Mental and behavioural disorders due to use of cannabinoids	21
14	Mental and behavioural disorders due to use of psychoactive substance	9
15	Mental and behavioural disorders due to use of tobacco	21, 25
16	Mental disorders, not specified	9, 15, 17, 18, 19, 22, 23, 24
17	Mental issues associated with chronic disease (e.g. diabetes, cancer)	13, 22
18	Mood disorders, unspecified	12, 27
19	Obsessive compulsive disorder	7, 10, 26
20	Post-traumatic stress disorder	7, 9, 20, 25
21	Schizophrenia, unspecified	10
22	Social anxiety disorder	31
23	Speech disorders (Developmental disorder of speech and language, unspecified	13
24	Stress (reaction to)	9, 10, 11, 12, 20, 23, 25, 31
25	Suicidal ideation	16
26	Unspecified behavioural and emotional disorders with onset usually occurring in childhood and adolescence	7

Table 2. List of mental health-related concerns that are not defined as mental health disorders in the ICD-10 and were investigated in the included reviews.

#	Improve and prevent mental health related concerns	Reference
1	Adjust to distress	20, 23, 25, 31
2	Enhance mental health well-being	31
3	Enhance psychological well-being	11
4	Help with loneliness	11, 20, 25
5	Improve mental health	10, 11, 17, 20, 27
6	Improve quality of life	20, 31
7	Increase self-efficiency	20,
8	Increase life satisfaction	31
9	Increase knowledge of sexual behaviour	25
10	Increase mental health literacy	27
11	Prevent self-harm and self-injury thoughts and behaviour	10