Facilitators and Barriers to Digital Mental Health Interventions for Depression, Anxiety and Stress in Adolescents and Young Adults: A Systematic Review

Shimin Zhu, Yongyi Wang, Yuxi Hu

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Shimin Zhu[1, 2] PhD; Yongyi Wang[1] MS; Yuxi Hu[1] MS

[1]Department of Applied Social Sciences The Hong Kong Polytechnic University Hong Kong SAR, China Hong Kong SAR HK
[2]Mental Health Research Centre The Hong Kong Polytechnic University Hong Kong SAR, China Hong Kong SAR HK

Corresponding Author:
Shimin Zhu PhD
Department of Applied Social Sciences
The Hong Kong Polytechnic University
Hong Kong SAR, China
Room GH348, Department of Applied Social Sciences
The Hong Kong Polytechnic University, Kowloon
Hong Kong SAR
HK

Abstract

Background: Digital Mental Health Interventions (DMHIs) have unique strengths as emerging services with practical applications among adolescents and young adults (AYAs) with depression, anxiety, and stress. Though promising, the acceptance and participation of DMHIs vary in different interventions, participants and contexts. The factors for promoting or hindering the use of DMHIS need to be delineated and synthesised.

Objective: To assess and synthesise facilitators and barriers to accessing DMHIs for depression, anxiety, and stress in AYAs with a systematic review.

Methods: A comprehensive retrieval across multiple databases was conducted by October 31st, 2023. Data synthesis and analysis included quality assessment, the frequency of popular items, thematic analysis, and relative frequency of occurrence.

Results: The final 27 records met the inclusion criteria. Depression, female/male/humans, adolescent, and internet are typical terms of the four clusters identified. Fourteen facilitators and thirteen barriers at the external, intervention, and individual levels were consolidated. The relative frequency of occurrence demonstrated quality and effect as the predominant facilitators and barriers of the DMHIs in portable or non-portable devices, single or multiple platforms.

Conclusions: The study developed organised themes and subthemes, and synthesised fourteen facilitators and thirteen barriers in three levels. Quality and effect is the key focus in the use of DMHIs among AYAs with depression, anxiety, and stress. The results of the study provide detailed and structured information for future digital mental health service design and implementation.

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Shimin Zhu[1, 2#]*, PhD, Yongyi Wang[1#], MS, Yuxi Hu[1], MS
1. Department of Applied Social Sciences, The Hong Kong Polytechnic University, Hong Kong SAR, China
2. Mental Health Research Centre, The Hong Kong Polytechnic University, Hong Kong SAR, China

[#] Co-first authors
*Corresponding Author:
Shimin Zhu, PhD
Room GH348, Department of Applied Social Sciences
The Hong Kong Polytechnic University
Kowloon, Hong Kong
China
Tel: +852 2766 5787
E-mail: jasmine.zhu@polyu.edu.hk

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Keywords: digital mental health interventions; adolescents; young adults; common mental disorders; thematic analysis; relative frequency of occurence

Introduction

Digital Mental Health Interventions (DMHIs) have emerged and grown in popularity as new tools and approaches for mental health services with the development of the internet and mobile devices [1]. Nearly half of people worldwide with mental health needs lack access to treatment or services, but more than half of the population have access to smartphones and the internet globally. This striking fact highlights the trend of shifting mental health services to mobile or digital health [2]. Here, DMHIs focus on intervention processes and programs that deliver mental health services through the web, technology, and mobile platforms [3, 4]. Various forms of DMHIs are found helpful for promoting mental health, including smart digital apps, such as innovative communication apps that focus on improving communication between users to help young people experiencing low

mood and suicidal thoughts [5]; web-based programs, such as a web-based psycho-educational multimedia program for young people suffering from, or at high risk of, depression, and their families, caregivers, friends and professionals [6, 7]; and interactive games [8], email and text message communication [9, 10], etc.

DMHIs have several advantages and are very promising to be popular service options, especially for adolescents and young adults (AYAs). Firstly, DMHIs conform to the digital times and are well-suited to a new generation who are easily accessible, accustomed to, and frequent users of the web, digital media, and screens. According to the International Telecommunication Union's Facts and Figures 2023, 79% of people aged 15-24 use the Internet globally [11]. Secondly, compared with face-to-face help-seeking or treatment, DMHIs alleviate AYAs' feelings of shame and can be effective in addressing concerns about stigmatisation [12]. This was confirmed by young people's feedback on the DMHI app, suggesting that discrete and easy-to-hide apps helped to avoid the stigma associated with mental health problems [13]. Third, user friendly. Some DMHI services use youth-friendly words and expressions and adjust the layout to reflect user-friendliness [12]. DMHIs are flexible and not limited to time of use so that users can organise their activities according to their schedules [14]. Fourth, high accessibility. Whereas traditional approaches to psychotherapy, like counselling, take a significant amount of a visitor's time to queue and wait, DMHIs have greatly enhanced AYAs' access to mental health support through digital and online mediums [15]. At the same time, DMHIs can somewhat overcome the inaccessibility of mental health services due to geographical remoteness or special periods such as lockdowns during infectious disease outbreaks [16, 17]. Fifth, scalability. DMHIs can potentially reach more people due to their anonymity, accessibility, cost-effectiveness, and timely feedback [4].

AYAs' health, including mental health, has an important place in the whole life course [18]. Health during this period is fundamental to the development of AYAs, determining the healthy trajectory of the entire life and influencing the beginning of a healthy life for the next generation [18]. However, Common Mental Disorders (CMDs) alone among adolescents are already highly prevalent and pose a significant burden of non-communicable diseases [19-21]. CMDs are a group of distress states manifesting with anxiety, depression, and unexplained somatic symptoms [22]. According to the data from the World Health Organization and different regions, one in seven people aged 10-19 years had a mental disorder in 2021, accounting for 13% of the global burden of disease in that age group [19]. Moreover, nearly 90% of youth faced mental health challenges in a 2023 survey in the US [23]. In the post-pandemic era, CMDs pose a challenge for more accessible mental health services [24].

CMDs in AYAs need early and timely intervention, but the uptake of mental health services is inadequate [25-27]. The incidence of mental disorders was reported to increase significantly after the age of 14 [28]. If not intervened in time, they continue into adulthood and may impair physical and mental health, limiting opportunities for a fulfilling life in adulthood [19]. Although some mental health services and helpful resources are currently available [18], a large proportion of AYAs do not access them [26]. Reasons for low service use include stigma, limited knowledge, low trust in the therapeutic relationship, high costs, and more [27], making those in need missed out on early interventions. DMHIs may be a potential alternative for youth who need mental health services.

Although DMHIs have multiple advantages as outlined above, and their effectiveness has been proven [8, 10, 17], the usage/intention to use varies. For effectiveness, a web-based mental health intervention program for adolescents showed that participants with high levels of adherence (using the site for 30 minutes or more per week) reported significantly lower depression and stress, and significantly improved well-being [7]; Another study that examined the effectiveness of a new computerised cognitive-behavioural therapy showed that the program resulted in significant improvements in participants' depression levels [8]. However, the usage, intention, engagement, and adherence of DMHIs were relatively low [29]. For example, a study in the UK explored young people's attitudes towards computerised therapy and showed only 25% said they were interested, the

other 25% said they were not interested, and half were unsure [30]. In several intervention studies, the engagement and completion rates of participants in DMHIs remained inadequate, with low user adherence and high attrition rates [31]. Given the high mental health service need for CMDs among AYAs, it is essential to examine the users' views about what boosts and what hinders their use of DMHIs. Discovering the facilitators and barriers associated with DMHIs use is essential for the development and promotion of DMHIs.

Previous studies have rarely investigated the experiences, attitudes, or perceptions of AYAs regarding DMHIs as a main focus [32, 33]. Lots of research often collected participants' feedback after evaluating a particular DMHI [17, 33]. Consequently, the present findings on the facilitators or barriers of DMHI utilisation are predominantly indirect and fragmented and necessitate a cohesive and logical integration of information about the factors that hinder and promote the use of DMHIs.

This study aims to use a systematic review to examine the existing literature on the facilitators and barriers to the use of DMHIs among AYAs with depression, anxiety, and stress. Here, facilitators refer to the factors that promote the access, use or intention to use DMHIs, and barriers refer to the factors that hinder the use or decrease the intention to use DMHIs [34]. The synthesis of the facilitators and barriers will provide crucial insights into the promotion of DMHIs to address mental health needs.

Methods

Search strategy and selection criteria

The systematic review was guided by the PRISMA guidelines to develop a literature search strategy [35] and registered in PROSPERO (CRD42023479880). The following major electronic databases were searched by October 31st, 2023: PubMed, Web of Science, PsycINFO, and CNKI. Considering that DMHIs are emerging technologies, no start time was set for the literature search to retrieve a wider range of publications. Manual retrieval of bibliographies of relevant studies and grey literature (OpenGrey, PsycExtra) was supplemented to the search strategy. These searches were restricted to English and Chinese. More details can be seen in Multimedia Appendix 1.

This research included studies of facilitators and barriers to access to DMHIs among AYAs with disorders/symptoms of depression, anxiety, and stress. Reviews, recommendations, comments, newspapers, letters, conference abstracts, and research from other stakeholders' perspectives were used only to better understand the topic of this study but were excluded from the analysis. However, there are some exclusion criteria:(1) studies in which participants had serious illnesses (such as heart failure and trauma) were excluded, as these physical conditions may have caused greater limitations on their thoughts and behaviours; (2) excluded studies in which participants were less than 10 years old)or over 26 years old; (3) exclude studies of digital health services that are not mental health related; (4) exclude studies that only assess the effectiveness of DMHIs participant attitudes, and willingness without discussing influencing factors; (5) exclude unavailable literature.

Screening and data extraction

The literature data management and screening process was carried out using EndNote 20 and Microsoft Excel 2020 was used to record the extracted data. Two independent researchers (YW and YH) reviewed and extracted the data separately, and in case of inconsistency, discussions were held first to resolve the differences; for the parts that were still inconsistent, a third researcher (SZ) assessed them to reach a consensus. These included data from each study across four dimensions: (1) metadata and context of the study (i.e., article title, authors, study design, sample size); (2) characteristics of the study population (i.e., country or region, race, sample type, basic characteristics); (3) characteristics of DMHIs (i.e., ways of DMHIs, sessions, whether or not self-help tools contained); and (4) facilitators and barriers for AYAs with common mental health problems to access to DMHIs.

Quality assessment

A critical assessment tool was used to assess the quality of the included literature: the Mixed Methods Appraisal Tool (MMAT) [36]. This study used the 2018 version of MMAT, which was

developed based on a literature review of critical appraisal tools, interviews with MMAT users, and eDelphi findings with international experts. It primarily focuses on five research categories: a) qualitative; b) randomised controlled; c) non-randomised; d) quantitative descriptive; and e) mixed methods. Besides the two screening questions set for all types, five criteria were set separately for each type for researchers to assess, including qualitative, quantitative randomised controlled trials, quantitative non-randomised, quantitative descriptive and mixed methods studies [36].

Data synthesis and analysis

The popular terms under the research topic were evaluated and presented by VOSviewer based on the co-occurrence analysis [37]. The full counting method was used, and the minimum number of occurrences was set as 2. Random starts, random seed and resolution were set as 1. By merging repetitive terms, each term shown in the final presentation was more meaningful. The thickness of the lines indicates the strength of the links between items, the size of the labels represents the weight of the items, and labels with the same colour belong to the same cluster [30].

With reference to the digital health outcomes assessment of World Health Organization (WHO) [38], a three-level framework for this systematic review was drawn up: 1) external level, 2) intervention level, and 3) individual level. Thematic analyses for this study were guided by a six-phase process [39] in the framework. Step 1: Familiarise with the data. All researchers (SZ, YW and YH) read through the literature completely, annotating the data or recording analytical ideas for follow-up discussion. Step 2: The initial coding process was performed manually and independently by YW and YH. Valid data segments on facilitators and barriers were identified, coded, copied, and recorded with matches. The results of both were collated together to ensure the accuracy and diversity of the codes. Step 3: SZ, YW and YH initiated discussions to appropriately categorise codes into themes, sub-themes, and levels, and to clarify their relationships. YW later collated and supplemented the original literature data corresponding to the sub-themes for a clear presentation. Step 4: YW reviewed the initial data extraction again, clarified the data segments, coding, sub-themes, and themes, and discussed with SZ and YH until all researchers agreed with the overall thematic framework. Step 5: We identified and determined the essence of each theme and sub-theme. The narratives were first drafted by YW and reviewed by SZ and YH for modifications, to ensure the definitions were appropriate, coherent, consistent, and to minimise overlap. Step 6: Finally, a logical report was generated.

After generating the themes and sub-themes, meta-analyses of proportions were carried out to assess the frequency of occurrence of each facilitator and barrier, based on different types of delivery modes: completely non-portable devices, portable devices, single platform, and multiple platforms. Studies that did not specify the delivery model were not included. Relative Frequency of Occurrence (RFO) and 95% confidence interval (95% CI) were used as indicators and analysed using the metaprop function package of the R software [40].

Results

Screening

A total of 6063 records were retrieved from the electronic database and grey area, and after the deletion of duplicates, 2498 records remained. After excluding other forms of records and screening the title and abstract, 131 studies were eligible for full-text screening. A total of 27 articles met the inclusion criteria and were included in data extraction, data synthesis and subsequent analysis (Figure 1).

Description of included studies

Table 1 describes the characteristics of the included studies. Of the 27 included studies, there were seven (25.93%) quantitative studies, six (22.22%) qualitative studies and 14 (51.85%) mixed methods studies. And there were four (14.81%) studies were conducted in England, five (18.52%) in America, three (11.11%) in New Zealand, seven (25.93%) in Australia, two (7.41%) in Ireland, two (7.41%) in China, three (11.11%) in Canada, Sweden, and South Africa, respectively, and one (3.70%) in Chile and Colombia. For participant recruitment channels, five (18.52%) studies were

recruited from health institutions, four (14.81%) from the community, six (22.22%) from schools, and two (7.41%) from youthreach centres and a survey, respectively. In addition to this, ten (37.04%) studies jointly recruited participants from a variety of sources, including health institutions, schools, communities, teams, and studies. In summary, DMHIs of the included materials can be broadly divided into web/internet-based, computer-based, app-based, game-based, and others: 13 (48.15%) studies had DMHIs delivered through web/internet-based programs, six (22.22%) were app-based, two (7.41%) were game-based, one (3.70%) was text message tool and one (3.70%) was chatbot. Other interventions were delivered in hybrid ways, such as text messaging and web (1, 3.70%), computer and web (2, 7.41%), and web and app (1, 3.70%).

A total of 19 studies contained a conflict-of-interest component, of which seven [5, 8, 10, 16, 17, 41, 42] declared a potential or actual conflict of interest. Via quality assessment (Table 2), it was found that the quality of qualitative studies and quantitative randomised controlled trial studies was generally good, while all quantitative descriptive studies vary in degrees of sample representativeness.

Based on the visual analysis of the bibliometrics, our data were classified into four clusters of 30 items, and their attribution categories, links and total link strengths are presented in Figure 2 and Table 3. The ten most common items were adolescents, depression, female, humans, male, mental health, internet, young people, cognitive behavioural therapy, and feasibility studies.

Figure. 1 Preferred Reporting Items for Systematic Reviews Flow Diagram.

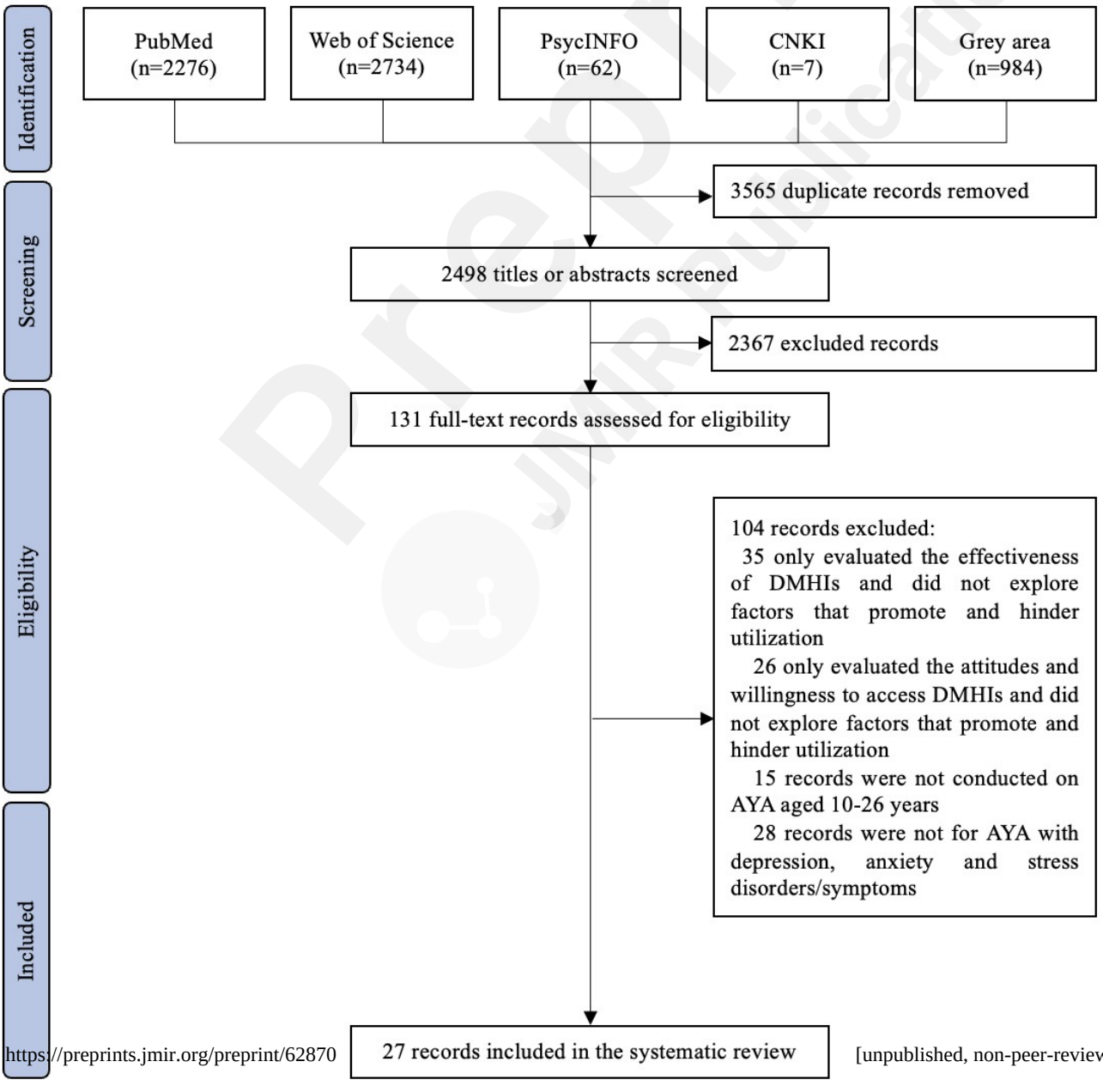


Table 1 Characteristics of articles included in the systematic review.

Study Id	Study Design	Location	Race[a]	Sample Type	Participants Number*	Participants' Characteristics[a]	Type and Delivery mode	Sessions	Self-help/ Self-directed Tool
Aine Horgan 2013	Mixed methods	Ireland	White: 98.3%, Asian or Asian Irish: 1.7%	School	118	Age: 18–24, Mean: 20.6, 64.4% males	A Web site (www.losetheblues.ie), no specific mode of delivery	Not specific	No, peer support
Alison Giovanelli 2023	Mixed methods	America	64% White, 14% Asian, 14% Black, 7% Mixed race	Community & School	14 Interviews: 5	Age: 15-18, Mean: 16	Appa Health, a smartphone app	Video sessions Weekly	Not specific
Benjamin W. Van Voorhees 2009	Quantitative	America	23% African American, 5% Hispanic, 6% Asian, 4% Other	Health institution	83	Age: 14–21, Mean (SD): 17.4 (2.14), 56% females	Internet-Based Depression Prevention Program, no specific mode of delivery	Not specific	Not specific
Brian Suffoletto 2021	Quantitative	America	92.30% White, 1.92% Black, 5.77% More than one	Health institution (Primary care & Mental Health clinic)	52 at baseline 45 completed follow ups	Age, Mean (SD): 18.7 (0.42-0.48), 86.54% females	MoST-MH, an automated Mobile Support Tool, delivered by phones	Not specific	Yes
Felicity Goodyear-Smith 2016	Mixed methods	New Zealand	Not specific	School & Community	30	Age: <25, 93% females	YouthCHAT, questions delivered on an e-tablet	Not specific	Yes
Franco Gericke 2021	Qualitative	South Africa	77.78% White, 22.22% Black)	School	9	Age: 17-20, Mean (SD): 18.9 (1.2), 66.67% females	ICare, transdiagnostic semi-guided iCBT intervention, no specific mode of delivery	7	Not specific
Grace M	Quantitative	Australia	Not specific	Community	217	Age: 13-18,	Online therapy,	Not	Not

Study Id	Study Design	Location	Race[a]	Sample Type	Participants Number*	Participants' Characteristics[a]	Type and Delivery mode	Sessions	Self-help/ Self-
Sweeney 2016						Mean: 16.98, 71.9% females	no specific mode of delivery	specific	specific
Hao Fong Sit 2021	Mixed methods	China	Not specific	School	38 Interviews: 6	Age: 18-25	Step-by-Step, a mobile app, delivered by smartphones or laptops	5	Yes
Hiran Thabrew 2023	Mixed methods	New Zealand	15% Māori, 65% New Zealand European, 15% Asian, 4% MELAA	Health institution & Community	Quantitative: 26 young people Qualitative: 13 young people	Age (of young people): 16-25, Mean: 17.7, 65% females	"Village," a Digital Communication App, delivered by smartphones	Not specific	Not sure
Josefine Lotten Lilja 2021	Mixed methods	Sweden	Not specific	Health institution	14	Age: 13-18, 93% females	iCBT program "Anxiety Help for Adolescents," a guided internet-delivered self-help treatment program, no specific mode of delivery	Not specific	Yes
Kaveh Monshat 2011	Qualitative	Australia	Not specific	Community	13	Age: 16–26, Mean: 22, 60% females	Online mindfulness training program, no specific mode of delivery	Not specific	Not specific
Kaylee Payne Kruzan 2022	Qualitative	America	56% White, 10% Asian, 8% Black or African American, 2% American Indian or Alaskan	Health institution	50	Age: 18-25, 76% females	Online screening, delivered by mobile phones	First ARC: 6 Second ARC: 8	Yes

Study Id	Study Design	Location	Race[a]	Sample Type	Participants Number*	Participants' Characteristics[a]	Type and Delivery mode	Sessions	Self-help/ Self
			Native, 12% More than one race, 14% Not reported						
Kuosmanen T. 2018	Mixed methods	Ireland	Not specific	Youthreach Centers	40	Age: 15-20	SPARX-R computerised mental health program, a game	Not specific	Yes
Kylie M Dingwall 2023	Mixed methods	Australia	Not specific	Community	33 at baseline, 30 completed the 4-week follow-ups	Age (of 30 young people): 12-18, Mean (SD): 14.0 (1.55), 43.33% females	AIMhi-Y app, smartphone-based	4	Not specific
Laura H Clark 2020	Qualitative	Australia	Not specific	Health institution & Research institution & Community & School	29	Age: 12–18, Mean: 15.17	Computerised Mental Health Help-Seeking	Not specific	Not specific
Lori Wozney 2015	Mixed methods	Canada	Not specific	Community	Cycle 1: 4 young people Cycle 2: 4 young people	Age (of young people): □20 (The age range for selecting participants was 15-24 years old), 50% females	Breathe, an internet-based cognitive behaviour therapy program, delivered by computers, phones and emails	2	Yes
Louise Birrell 2023	Mixed methods	Australia	Not specific	School	166	Mean (SD): 15.3 (0.41)	Mind your Mate, a mobile app, delivered by smartphones	Not specific	Yes

Study Id	Study Design	Location	Race[a]	Sample Type	Participants Number*	Participants' Characteristics[a]	Type and Delivery mode	Sessions	Self-help/ Self
Paul Stallard 2010	Mixed methods	Australia	Not specific	Health institution	37	Age: 8-17, Mean: 14.5	Computerised Therapy	Not specific	Not specific
Rachel Kornfield 2022	Qualitative	America	54.84% White, 16.13% More than one race, 12.90% Black or African American, 9.68% Asian, and not reported	Survey	Discussion Group: 22 Co-Design Workshops: 9	Age: 18-25	Automated Text Messaging Tool, delivered by mobile phones	Not specific	Yes
Rebecca Grist 2018	Quantitative	England	Not specific	School	775	Age: 11–16	Internet and smartphone/tablet apps	Not specific	Yes
Rhys Bevan Jones 2018	Qualitative	England	Not specific	Health institution & study	Interviews: 4 young people Focus groups: 29 young people in three groups	Age (of young people interviewed): 13-18, 75% females Age (of young people in focus groups): 13-19, 68.97% females	MoodHwb, a Web-based program, delivered by tablets or laptops	Not specific	Yes
Rhys Bevan Jones 2020	Mixed methods	England	(young people interviewed) White, 5% Other	Health institution & school & team & study	Quantitative: 43 young people at baseline, 36 young people completed the follow-ups; Qualitative: 19 young people	Age (of young people at baseline): 13-23 , Mean (SD): 16.3 (2.36), 79% females; Age (of young people interviewed): 14-19, Mean (SD): 16.5 (1.78), 74% females	MoodHwb, a multi-platform	Not specific	Yes
Sally N Merry 2012	Quantitative	New Zealand	New Zealand European: 58.5%-	Health institution & School	baseline: 187 post-intervention: 170	Age: 12-19	Computerised cognitive behavioural therapy	7 modules	Yes

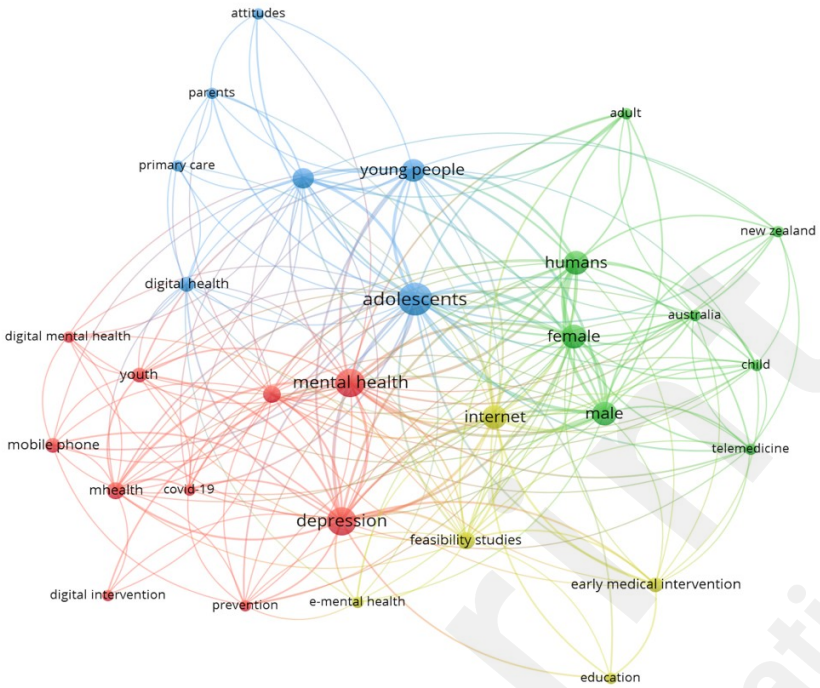
Study Id	Study Design	Location	Race[a]	Sample Type	Participants Number*	Participants' Characteristics[a]	Type and Delivery mode	Sessions	Self-help/ Self-
			60.2%, Māori: 22.6%-25.5%, Pacific people: 7.5%-8.5%, Asian: 4.3%-8.6%, Other: 1.1%-3.2%		three-month follow-up: 168		intervention (SPARX), a game		
Vania Martínez 2021	Mixed methods	Chile and Colombia	Not specific	School	199	Mean (SD): 14.8 (1.0), 53.27% females	Take Care of Your Mood, an Internet-Based Program for Prevention and Early Intervention, delivered by computers or smartphones	Not specific	Not specific
Vijaya Manicavasagar 2014	Mixed methods	Australia	Not specific	School & Community	235	Age: 12-18	Web-Based Positive Psychology Program, delivered by computers	Not specific	Yes
Vilas Sawrikar 2022	Quantitative	England	Not specific	Community & School	248	Age: 17-25, Mean (SD): 23.31 (1.91), 40.7% females	DMHIs, delivered by the internet or on a smartphone	Not specific	Not specific
Yuhao He 2022	Mixed methods	China	92.57% Han	Community & School	148	Mean (SD): 18.78 (0.88)	Chatbot, a software program with artificial intelligence, delivered by WeChat platform, e-book, etc.	25.54 sessions in average	Yes

[a]The three columns of Race, Participants' number, and Participants' characteristics only present data of AYAs and exclude relevant data of other stakeholders (e.g., parents, clinicians, school staff).

Table 2 Quality assessment of articles included by the Mixed Methods Appraisal Tool, 2018 version[b] [36].

	Qualitative					Quantitative randomised controlled trials					Quantitative non-randomised					Quantitative descriptive					Mixed methods				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Aine Horgan 2013	Y	Y	N	C	Y	-	-	-	-	-	-	-	-	-	-	Y	N	Y	N	C	Y	Y	Y	C	N
Alison Giovanelli 2023	Y	Y	Y	Y	Y	-	-	-	-	-	-	-	-	-	-	Y	N	Y	Y	Y	Y	Y	Y	Y	N
Benjamin W. Van Voorhees 2009	-	-	-	-	-	Y	C	Y	Y	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brian Suffoletto 2021	-	-	-	-	-	Y	Y	Y	Y	Y	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Felicity Goodyear-Smith 2016	Y	Y	Y	Y	Y	-	-	-	-	-	-	-	-	-	-	C	N	Y	C	Y	Y	Y	Y	Y	N
Franco Gericke 2021	Y	Y	Y	Y	Y	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Grace M Sweeney 2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C	N	Y	C	Y	-	-	-	-	-
Hao Fong Sit 2021	Y	Y	Y	C	Y	-	-	-	-	-	N	Y	Y	C	Y	-	-	-	-	-	Y	Y	Y	Y	C
Hiran Thabrew 2023	Y	Y	Y	Y	Y	-	-	-	-	-	-	-	-	-	-	C	C	Y	N	Y	Y	Y	Y	Y	N
Josefine Lotten Lilja 2021	Y	Y	Y	Y	Y	-	-	-	-	-	-	-	-	-	-	C	N	Y	Y	Y	Y	Y	Y	Y	N
Kaveh Monshat 2011	Y	Y	Y	Y	Y	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kaylee	Y	Y	C	Y	Y	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

	Qualitative					Quantitative randomised controlled trials					Quantitative non-randomised					Quantitative descriptive					Mixed methods				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Payne Kruzan 2022 Kuosmanen T. 2018	Y	Y	C	Y	Y	-	-	-	-	-	-	-	-	-	-	C	N	Y	C	Y	Y	Y	Y	Y	N
Kylie M Dingwall 2023	Y	C	Y	Y	Y	-	-	-	-	-	N	Y	Y	Y	Y	-	-	-	-	-	Y	Y	Y	C	N
Laura H Clark 2020	Y	Y	Y	C	Y	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lori Wozney 2015	Y	Y	Y	Y	Y	-	-	-	-	-	-	-	-	-	-	Y	N	Y	Y	Y	Y	Y	Y	Y	N
Louise Birrell 2023	Y	Y	C	C	Y	Y	N	Y	N	N	-	-	-	-	-	-	-	-	-	-	Y	Y	Y	Y	N
Paul Stallard 2010	Y	Y	Y	Y	Y	-	-	-	-	-	-	-	-	-	-	C	N	Y	Y	Y	Y	Y	Y	Y	N
Rachel Kornfield 2022	Y	Y	Y	C	Y	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rebecca Grist 2018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C	N	Y	C	Y	-	-	-	-	-
Rhys Bevan Jones 2018	Y	Y	Y	Y	Y	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhys Bevan Jones 2020	Y	Y	Y	Y	Y	-	-	-	-	-	-	-	-	-	-	Y	C	Y	C	Y	Y	Y	Y	Y	C
Sally N Merry 2012	-	-	-	-	-	Y	Y	Y	Y	Y	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vania Martínez 2021	Y	Y	Y	C	Y	-	-	-	-	-	-	-	-	-	-	Y	C	Y	Y	Y	Y	Y	Y	Y	C
Vijaya Manicavasagar 2014	Y	C	C	Y	Y	Y	Y	Y	Y	Y	-	-	-	-	-	-	-	-	-	-	Y	Y	Y	Y	C
Vilas Sawrikar 2022	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	N	Y	C	Y	-	-	-	-	-
Yuhao He 2022	Y	Y	C	C	Y	Y	N	Y	Y	N	-	-	-	-	-	-	-	-	-	-	Y	Y	Y	Y	N



[b]Y=yes; N=no; C=can't tell.

Figure 2 Visualisation network diagram of the items with the highest frequency of occurrence in the included studies.

Table 3 Clusters, links, and total link strength of identified terms.

item	occurrences	links	total link strength	cluster
adolescents	15	28	96	3
depression	11	24	66	1
female	8	21	65	2
humans	8	21	65	2
male	8	21	65	2
mental health	11	25	65	1
internet	8	21	57	4
young people	7	20	50	3
cognitive behavioural therapy	6	21	38	3
feasibility studies	4	20	32	4
anxiety	4	21	28	1
mhealth	4	17	26	1
early medical intervention	3	13	21	4
australia	2	14	20	2
child	2	15	19	2
youth	3	14	19	1
telemedicine	2	13	18	2
covid-19	2	13	17	1
adult	2	9	16	2
digital health	3	14	15	3
prevention	2	13	15	1
new zealand	2	9	13	2
mobile phone	3	10	12	1
digital mental health	2	10	10	1
e-mental health	2	9	10	4
parents	2	8	10	3
education	2	5	9	4
attitudes	2	5	6	3
primary care	2	6	6	3
digital intervention	2	4	5	1

Thematic synthesis

The thematic analysis yielded facilitators and barriers at the external, intervention, and individual levels. The themes of facilitators and barriers and the examples are introduced in Table 4. All themes, sub-themes, and extracts from the original articles are detailed in Multimedia Appendix 2.

1) Facilitators

a. External level

It is recommended that the uptake and implementation of DMHIs could be

integrated with other services [43, 44], and schools are one of the essential environments of AYAs [6]. Social norms, specifically the subjective norm, acted as a pressure related to the expectations of AYAs [45]. Notably, the marketing and universality of DMHIs appeared as a vital part of influencing users' motivations [6, 44, 46], stigma and social isolation [15]. Likewise, endorsements from friends, peers, care providers, professionals and even reputable programs can achieve positive effects as well [10, 44].

b. Intervention level

Some literature demonstrated that the promoting factors for extensive approval of DMHIs were closely linked to what the programs presented, relating to the various information types, personalisation, multiple aspects of support, and communication sessions for feedback and sharing [6, 14, 16, 32, 33, 41-44, 46-49]. Testimonials and entertainments were suggested and favoured, as well as the retention booster which could firstly function as notifications and messages and secondly, incentives [15, 42, 43, 47, 48]. Evidence showed that the multimedia delivery, a good and professional look, co-design, inclusion of characters, personalisation, multiple forms of presentation and appropriate language were critical for improving the products' design quality and being praised by users [6, 10, 12, 15, 16, 32, 33, 42-44, 46-50]. Many participants were surprised at the high quality of the programs and liked the overall feel [47, 48]. Concrete good effects were commended such as the ability to track progress [14]. The fun and engaging nature, good emotional experiences, ease of interaction, ease of use, high relevancy and visual perception, were highlighted to contribute to more and sustained acceptance [5-7, 10, 12, 14-16, 41-43, 45-48, 51-53]. Appropriate durations and timetables were highly valued [6, 12, 16, 42, 43, 46, 47], referring to a fit of convenience and flexibility. High accessibility of programs indeed provides users with more opportunities for reaching, as they can use them at any time or remotely [6, 14, 16, 42]; A large number of participants identified free or low-cost as a very important enabling factor to promote the use of DMHIs [14, 43, 44].

c. Individual level

Female participants were reported to significantly higher helpfulness of the intervention [14]. People with more severe psychological symptoms, greater knowledge and prior experience with online therapies would have stronger motivation to seek help and enrol [14, 45, 50]. If AYAs truly had needs for mental health purposes [6, 33, 49, 53, 54], preferred to be alone, at home, anonymity and greater freedom [5, 30, 33, 46], and had positive attitudes and beliefs for mental health problems and technologies [14, 45], they would show more willingness towards DMHIs. Possible perceived benefits, including helpfulness, usefulness, privacy, and time management in tough periods were frequently mentioned [33, 48, 51]. Lastly, the environment here refers to the overall environment in which an individual grows and lives, with a technical environment and interpersonal catalysts [6, 44].

2) Barriers

a. External level

Several documents showed an opposing view that integrating DMHIs with schools would make the service less appealing [43] and reduce participation rates [41, 55]. Because students would be offended by the association with school tasks [43] and the fact that schools would monitor and limit the use of electronic mobile devices [55].

b. Intervention level

Some components of the content have been criticised. Religious overtones, especially meditators and spirituality, were not flattering [46]. Similarly, the lack of therapist support and direct human contact made users frustrated and disappointed [14, 33, 47]. Roboticism, inappropriate multimedia and language in design were regarded as obstacles to some extent, leading to feelings of confusion and off-putting [5, 43, 46]. The degree of project personalisation is a matter of inconsistent thoughts: more customisation [15, 47] might trigger confusion, difficulty, and burdens [5, 15], while inadequate would only give generalised information [14]. In quality and effect, unattractive, irrelevancy, unsatisfying experiences and feelings during usage were hindering factors [7, 14, 15, 51]. Moreover, repetitiveness was recognised to easily lose initial elegance for a website[7]. Inappropriate durations and schedules were covered under this theme [15, 46, 47, 51] and inaccessibility caused predominately by technical issues and finance was a relatively objective barrier [5, 16, 44, 48, 52].

c. Individual level

Physically unwell was a common reason that would keep participants from attending appointments [8]. Additional causes linked to lacking confidence and connections to complete internet therapies [17, 32]. No motivation was proposed for not even downloading the app [17]. Participants who favoured face-to-face help and had reservations about a human-like messaging system might had greater hesitancy to accept DMHIs [30, 49, 54]. Perceived probable risks were particularly emphasised by many AYAs, one being privacy, security and credibility concerns and the second was stigma and cyberbullying [14, 50]. Typically, non-use or non-completion due to questioning of DMHIs' helpfulness, validity and usefulness, low priority, low interest, and deficient persistence [5, 8, 14, 17, 33, 46, 48, 53, 54]. Finally, limited time and technical issues remained to be addressed [7, 8, 14, 17, 33, 48].

Table 4 Themes, sub-themes definitions and related examples.

Level-Theme (Definitions)	
Subthemes (Definitions)	Examples
Facilitators - External level	
Theme 1. Integration (The act or process of combining DMHIs and others so that they work together.)	
1.1. Integration with Schools (Combining DMHIs with the school setting or curriculum.)	…schools were considered an important setting for the intervention, particularly personal, social, and health education sessions.[6]
1.2. Integration with Others (Combining	Several participants mentioned that they took the online screener because it was included as

Level-Theme (Definitions)	
Subthemes (Definitions)	Examples
DMHIs with health services, jobs, etc.)	a resource in school 1.1, their job, or part of a professional training.[44]
Theme 2. Social Norms (The informal rules that govern behaviour in groups and societies.)	
——	Higher intentions to use DMHIs were significantly correlated with …, social norm, ….[45]
Theme 3. Marketing (The activity of presenting, advertising DHMIs.)	
3.1. Avenues (Choices and ways of marketing.)	Aside from formal avenues of advertising one interviewee suggested the study have a Facebook and a Twitter presence.[46]
3.2. Focus (Key points in the marketing.)	They suggested instead focusing on the likely benefits of the programme.[46]
3.3. Naming (Appropriate naming of programs.)	The name and promotion of the program was discussed, and the use of the term 'mood' was considered more acceptable than 'well-being' to young people.[6]
Theme 4. Universality (Universal nature and status.)	
——	Universal delivery of cCBT can reduce stigma and social isolation.[15]
Theme 5. Endorsements (Approval, support and recognition from professionals, peers, and famous programs.)	
5.1. Care Providers (Endorsements by caregivers.)	…, the study was introduced by a care provider, increasing trust in the intervention.[10]
5.2. Peers (Endorsements by friends and who have the same status.)	Endorsements from friends and others "like them" were most likely to get them to try a service.[44]
5.3 Reputable Programs (Endorsements by well-known programs.)	Endorsements from reputable programs or mental health professionals were also perceived positively and contributed to their willingness and interest in the service.[44]
Facilitators - Intervention level	
Theme 1. Content (The sections contained in DMHIs.)	
1.1. Information (Details, facts, materials and resources for mental health and services.)	Several stated that the self-help section was 'motivational' and their favorite section, and some asked for more self help approaches in specific situations.[43]
1.2. Personalisation (Sections that are customised or tailored to the individual.)	Most found "My goals" to be helpful and motivating.[43]
1.3. Support (Provision of encouragement and assistance.)	Other participants agreed that sufficient support – in terms of app features (e.g., technical assistance, frequently asked questions) as well as human support (e.g., a coach) – was essential for sustained engagement.[44]
1.4. Communication (Ability to express ideas, feedback, and feelings.)	All interviewees agreed that an online forum, which enabled discussion about their programme experiences, was highly desirable and was likely to boost retention, ….[46]
1.5. Testimonial (Sections that contain raise and evidence.)	Young people, parents, carers, and a small number of the professionals suggested adding stories from 'celebrities', ….[43]
1.6. Entertainment (Activities used to entertain people.)	The participants also suggested introducing games and videos to improve the program's level of interactivity and entertainment value: "I would like it to be more fun, with games and videos".[42]
1.7. Retention Booster (Promote participant retention.)	For instance, the app should … provide … sufficient notification to remind the participants to do the exercise or activities that they planned….[47]
Theme 2. Design (The actions, arrangements, and process of deciding how DMHIs will look and work.)	
2.1. Multimedia (Using different ways (e.g., sound, pictures, videos) of giving information.)	The introduction of designs for the program, including elements such as illustrations, characters, metaphors, moving images, and audio, helped to guide group discussions.[6]
2.2. Good Look (Pleasant and satisfying appearance.)	Participants liked the look and feel of the app, ….[48]
2.3. Co-design (The design process also involves	Participants thought that having mental health professional involved in the creation of such a

Level-Theme (Definitions)	
Subthemes (Definitions)	Examples
user representatives and professionals.)	service (at a minimum) was essential, ….[44]
2.4. Characters (Unusual people, like real people, role models, celebrities, etc.)	The stories could include both older and younger characters, role models (e.g., famous people and their stories), ….[48]
2.5. Personalisation (Customised or individually tailored schemes and approaches.)	They said that the individualised interaction helped to make iCBT more personable and helped them to consolidate the learning in each session.[33]
2.6. Multi-presentation (Different forms of presenting information, including files, hierarchies, visualisations, etc.)	Focus group participants agreed there should be levels of information, with a hierarchy of sections and subsections.[6]
2.7. Appropriate Language (Appropriate language style that is more common or accessible.)	Two interviewees encouraged the use of slang and mobile telephone text message language ….[46]
Theme 3. Quality and Effect (Produced positive results and produced the intended outcome.)	
3.1. Overall (Good overall effects.)	Some noted they were surprised by the high quality, …[43]
3.2. Effect (Good specific effects.)	The participants also stated that the CTA website … was a useful tool for depression detection.[42]
3.3. Interesting/Engaging (Pleasant that attracts people's attention.)	One in three considered programs being interesting (n=78, 37.5%) as beneficial.[14]
3.4. Good Emotional Experience (Good emotions that are subjectively felt or realised.)	…, with an example: "always makes me laugh! $_{3.4}$ Ha ha ha ha, the pressure suddenly disappeared, and I am so happy $_{3.4}$".[52]
3.5. Ease of Interaction (Sharing, communicating, and collaborating easily during DMHIs intake.)	Third, using text messaging …, thus increasing ease of interaction $_{3.5}$.[10]
3.6. Ease of Use (The usage is not hard and complicated.)	It was easy to use. We're all used to the technology.[51]
3.7. Relevancy (Closely connected with users.)	Overall, both young people and clinicians were positive about the age-appropriateness of the program content; its relevance for use by anxious adolescents….[12]
3.8. Visual Perception (Visually pleasing experience.)	Both user groups generally found the site to be user-friendly and visually pleasing.[12]
Theme 4. Duration and Schedule (Appropriate length of time that DMHIs last or continue, and arrangements.)	
4.1. Appropriate Duration (Suitable, correct, and acceptable length of time of DMHIs.)	To avoid boredom they suggested no more than four videos each week with a maximum duration of 10 min each (three suggested a maximum of 5 min).[46]
4.2. Appropriate Schedule (Suitable, correct, and acceptable timetables.)	Sunday morning was suggested by two interviewees as a suitable time for each weekly module of the programme…[46]
Theme 5. Accessibility (Enter or reach DMHIs.)	
5.1. Multiplatform (Various operating systems or environments.)	Interview participants suggested that the program should be multiplatform, ….[6]
5.2. Free/Low Cost (No or low financial burden.)	Not surprisingly, many participants … said they would be more willing to try services if they were free.[44]
5.3. Ease of Access (Easily enter or reach DMHIs.)	…be in the comfort of your own home, and do things more remotely.[16]
Facilitators - Individual level	
Theme 1. Personal Characteristic (Personal features and traits.)	
1.1. Gender (females) (The fact of being female.)	In the final model, participants who were female, … reported significantly greater perceived helpfulness.[14]

Level-Theme (Definitions)	
Subthemes (Definitions)	Examples
1.2. High Symptom Severity (Bad or serious mental condition.)	The motivation to “get help” was conceptualised as being directly associated with symptom severity ….[50]
1.3. Great Knowledge (Good information, understanding and skills.)	In the final model, participants who … reported … greater knowledge of online therapies … reported significantly greater perceived helpfulness.[14]
1.4. Previous Experiences (The things, event and activities that happened before.)	Higher intentions to use DMHIs were significantly correlated with previous use of DMHIs (yes), ….[45]
Theme 2. Needs and Disposition (Demands for DMHIs and personal tendency.)	
2.1. Needs (Demands for DMHIs.)	If I had a mental health problem and apps were available, I would use them.[54]
2.2. Preferences (Great interest or desire for something.)	If given the choice, the vast majority (29, 88%) would prefer to use a computer program at home.[30]
2.3. Positive Attitudes/Beliefs (Good think and feel about DMHIs.)	… less stigmatised mental health attitudes significantly predicted greater perceived benefits. [14]
Theme 3. Perceived Benefits (Perceived advantages and good results.)	
3.1. Helpfulness/Usefulness (Being useful/helpful or possible to use/help)	It helped one reflect on their life or “check back in with yourself”.[48]
3.2. Privacy/Security (Being alone and not watched or disturbed by other people.)	Security and confidentiality were also key considerations, ….[6]
3.3. Time Management (Use the time to think or do something else.)	Using waiting time … Stopped me from being bored.[51]
Theme 4. Environment (Conditions for personal life, growth, and development.)	
4.1. Technical Environment (Technology-related conditions.)	Participants across the interviews and groups noted that using digital technologies was a valid approach to engagement, as young people use these in everyday life, ….[6]
4.2. Interpersonal Catalysts (Relationships between people that make a change.)	Some participants described … hitting a personal low, which prompted them look for answers online.[44]
Barriers - External level	
Theme 1. Integration with Schools (Combining DMHIs with the school setting or curriculum.)	
——	However, some young people noted that associating it with schools might make it less appealing.[43]
Barriers - Intervention level	
Theme 1. Content (The sections contained/not contained in DMHIs.)	
1.1. Cultural/Religious/Spirituality Issues (Issues related customs, beliefs, faith, religion, soul.)	All interviewees suggested not having pictures of meditators on the site ….[46]
1.2. Support Lacking (Lack of encouragement and assistance.)	The majority of adolescents rated the following factors as at least moderately problematic: …, being without therapist support (n = 107, 51.5%), ….[14]
1.3. Communication Lacking (Inability to expression of ideas, feedback, and feelings.)	Nonetheless, most participants reported … disappointment with the lack of immediate responsiveness, ….[33]
Theme 2. Design (The actions, arrangements, and process of deciding how DMHIs will look and work.)	
2.1. Roboticism (Stiff responses like a robot.)	I’m not sure how useful it was because he mentioned that it was like canned responses ….[5]
2.2. Multimedia Issues (Using inappropriate ways of giving information.)	All young people stated they preferred the illustrative approach to a more inappropriate ways of giving information one.[43]
2.3. Inappropriate Language (Inappropriate language	All interviewees advised against the use of the word 'homework' as it may remind

Level-Theme (Definitions)	
Subthemes (Definitions)	Examples
style that is unpleasant.)	participants of their university or school homework and thus be off putting.[46]
2.4. Burden (Things that confuse and cause challenges.)	…, a quarter (25.0%) of the participants also agreed that it was difficult for them to find their way around the program, ….[15]
2.5. Personalisation Lacking (Too general, lacks customisation.)	The majority of adolescents rated the following factors as at least moderately problematic: …, information being too general, ….[14]
Theme 3. Quality and Effect (Produced negative results and produced the negative outcome.)	
3.1. Unattractive (Not good, interesting, or pleasant.)	The site's design was not appealing to me, ….[7]
3.2. Irrelevancy (Lack of importance to or connection with people or situations.)	Four participants (11%) reported that Bite Back did not seem relevant for them.[7]
3.3. Negative Using Experience (Negative feelings in the process of using.)	While some enjoyed the games, others said they were too easy or too slow and ….[7]
3.4. Poor Emotional Experiences (Bad emotions that are subjectively felt or realised.)	Almost a half (42.8%) of the participants had felt annoyed or frustrated going through the program.[15]
3.5. Repetitiveness (Doing the same or similar thing again or more than once.)	The website was very similar each time I visited it and thus lost the initial flair it once had. [7]
3.6. Negative Effect (Bad specific effects.)	In terms of dislikes, the participants referred ... the advice being too 'hard going' (i.e. difficult to deal with) by focusing unduly on negative aspects of mental health.[15]
Theme 4. Duration and Schedule (Inappropriate length of time that DMHIs last or continue, and arrangements)	
4.1. Inappropriate Duration (Unsuitable, incorrect, and unacceptable length of time of DMHIs.)	All interviewees preferred a series of short videos each week rather than one long presentation.[46]
4.2. Inappropriate Schedule (Unsuitable, incorrect, and unacceptable timetables.)	Other concerns raised by the users about the app were that…, app notifications were not frequent enough or occurred at an unwanted time.[47]
Theme 5. Inaccessibility (Hard to enter or reach DMHIs.)	
5.1. Technological issues (Inaccessibility due to lack of technical support or technology-related usage issues.)	Barriers to use included not having the app on their own phone (due to it only being available on Android devices for the trial), ….[48]
5.2. High cost (High financial burden.)	In total, 2 of these 3 participants cited high costs associated with mental health services as a major barrier.[16]
Barriers - Individual level	
Theme 1. Personal Characteristic (Personal features and traits.)	
1.1. Physically Unwell (The body is not in a healthy state.)	The most common reasons for non-completion were … being physically unwell and unable to attend appointments.[8]
1.2. Lack of confidence (Uncertainty about the ability to do something.)	…, they lacked confidence in their own ability to work therapeutically via the internet.[32]
1.3. Lack of connection (Lack of being related to other people.)	Participants' reasons for not downloading the app were as follows, …, no one to connect to, ….[17]
Theme 2. Motivation and Disposition (Enthusiasm for DMHIs and personal tendency.)	
2.1. No Motivation (Lack of enthusiasm for doing something.)	Participants' reasons for not downloading the app were as follows, … no motivation, ….[17]
2.2. Preferences (Great interest or desire for something.)	…, three quarters of young people would prefer to meet face to face and talk with someone, ….[30]

Level-Theme (Definitions)	
Subthemes (Definitions)	Examples
2.3. Negative Attitudes/Beliefs (Bad think and feel about DMHIs.)	…, participants had reservations about human-like support from a messaging system, ….[49]
Theme 3. Perceived Risks (Perceived disadvantages and bad results.)	
3.1. Privacy/Security/Credibility Concerns (Concern about not being alone and watched or disturbed by other people, and the quality that makes people believe and trust.)	One interviewee pointed out that young people may be reluctant to undertake the programme because of concerns about privacy (e.g. when using a family or other public computer).[46]
3.2. Stigma and Cyber Bullying Concerns (Feelings of disapproval and being frightened or hurt by others through the internet.)	According to this theme, help-seeking was conceptualised as involving "risk," more specifically exposure to peer stigma and cyber bullying.[50]
Theme 4. Question (Doubts or suspicions.)	
4.1. Question the Helpfulness (Doubts or suspicions about the helpfulness.)	The most common reasons for non-completion were …, not finding the resource helpful, ….[8]
4.2. Question the Validity (Doubts or suspicions about the validity.)	Some participants questioned the validity of the Web site, ….[53]
4.3. Question the Usefulness (Doubts or suspicions about the usefulness.)	Participants' reasons for not downloading the app were as follows, … not useful, ….[17]
Theme 5. Retention Issues (Problems that make it hard to keep on and continue.)	
5.1. Low Priority (Don't think it needs to be addressed or conducted first.)	Barriers to use included …, forgetting about it, ….[48]
5.2. Low Interest (Lack of attention, not wanting to know more.)	The most common reasons for non-completion were …, lack of interest, ….[8]
5.3. Cannot Preserve (Unable to keep or continue.)	Ten interviewees commented that …, persevering in the programme to the end and completing home practices were likely to prove difficult.[46]
Theme 6. No/Limited Time (Lack of time or lack of sufficient time.)	
——	Of the 36 participants who responded, 21 (58%) cited that the reason for their underusage was time constraints.[7]
Theme 7. Technical Issues (Personal reasons related to techniques, skills, or devices.)	
——	Technical issues accounted for 5 participants' (14%) underusage, predominantly issues with Internet access.[7]

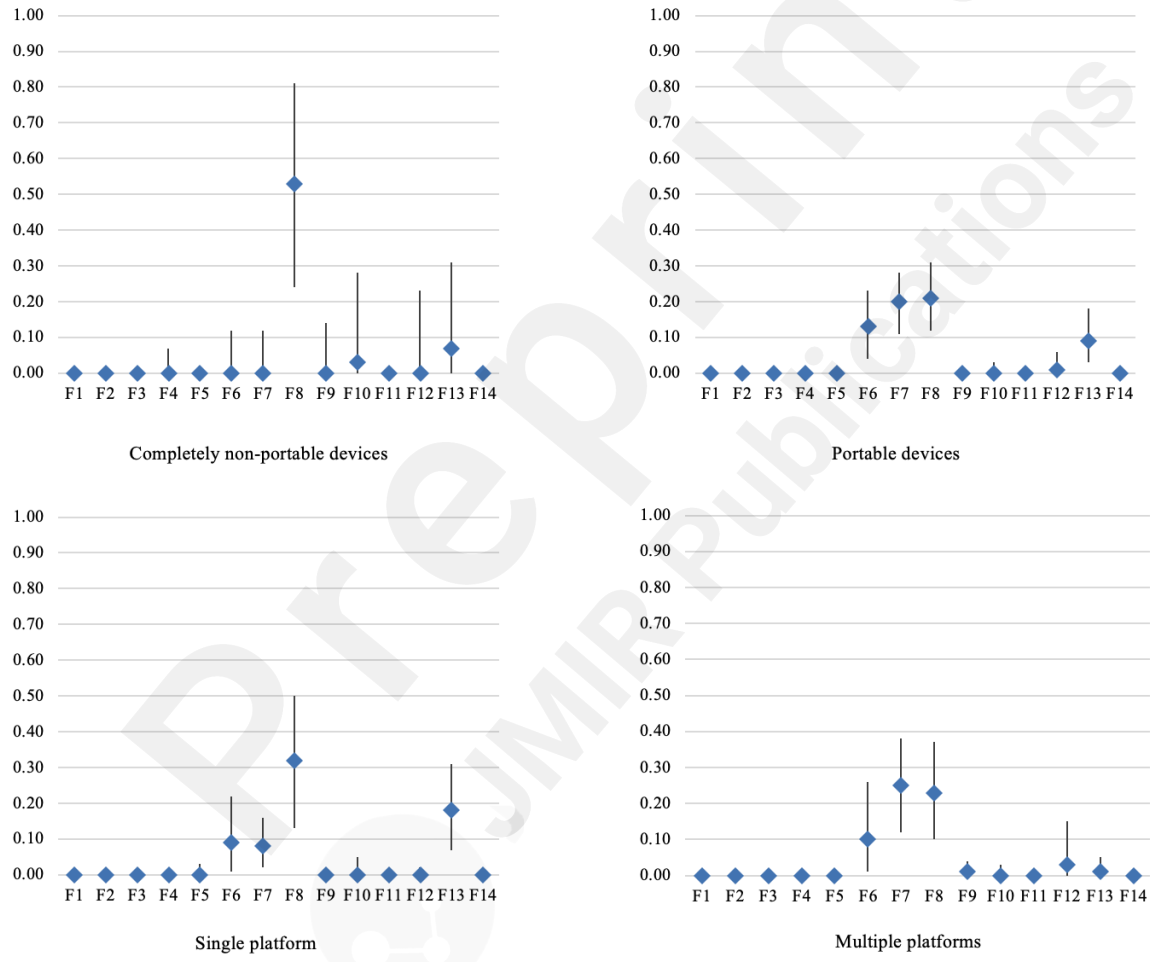
Relative frequency meta-analysis

Based on the themes generated, the predominant facilitators and barriers in different delivery models were assessed in Figure 3 and 4. As for completely non-portable devices, quality and effect was the most relevant facilitator (RFO of 53%, [95%CI .24, .81]) and barrier factors (RFO of 42%, [95%CI .01, .91]) to DMHIs use. For potable devices, The primary facilitators were quality of effect (RFO of 21%, [95%CI .12, .31]), design (RFO of 20%, [95%CI .11, .28]), and content (RFO of 13%, [95%CI .04, .23]); the only barrier that dominates was quality and effect (RFO of 15%, [95%CI .02, .35]). In terms of single-platform, DMHIs usage was connected mostly to two facilitators: quality and effect (RFO of 32%, [95%CI .13, .50]), and

perceived benefits (RFO of 18%, [95%CI .07, .31]); similarly, the dominant barrier was only quality and effect (RFO of 30%, [95%CI .05, .60]). Regarding DMHIs in multiple platforms, design (RFO of 25%, [95%CI .12, .38]), quality and effect (RFO of 23%, [95%CI .10, .37]), and content (RFO of 10%, [95%CI .01, .26]) were the most contributing facilitators; perceived risks (RFO of 17%, [95%CI 0, .54]), and quality and effect (RFO of 13%, [95%CI 0, .36]) acted as main barriers. More details can be found in Multimedia Appendix 3.

Figure 3 RFO of facilitators in four delivery modes. [c, d]

[c]Facilitators: F1-Integration, F2-Social Norms, F3-Marketing, F4-Universality, F5-Endorsements, F6-Content, F7-Design, F8-Quality and Effect, F9-Duration and Schedule, F10-Accessibility, F11-Personal Characteristic, F12-Needs and Disposition, F13-Perceived Benefits and F14-Environment.



[d]The ordinate represents a 95% confidence interval.

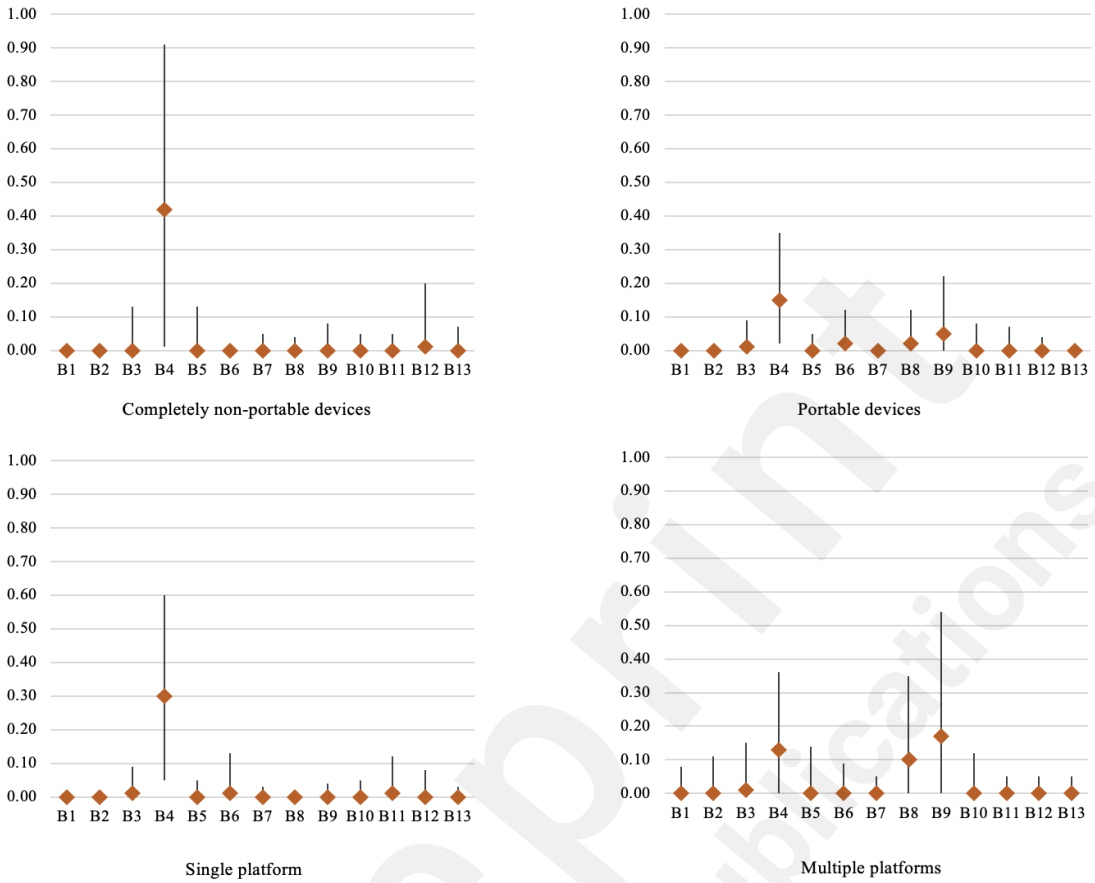


Figure 4 RFO of barriers in four delivery modes. [d,e]

[d]The ordinate represents a 95% confidence interval.

[e]Barriers: B1-Integration with Schools, B2-Content, B3-Design, B4-Quality and Effect, B5-Duration and Schedule, B6-Inaccessibility, B7-Personal Characteristic, B8-Motivation and Disposition, B9-Perceived Risks, B10-Question, B11-Retention Issues, B12-No/Limited Time and B13-Technical Issues.

Discussions

In this review, we sorted out, collated, and summarised facilitators and barriers to AYA's access to DMHIs from quantitative, qualitative, and mixed-methods literature through a six-step thematic analysis approach. Under the WHO guidelines, we considered a three-tier theoretical framework to encompass these influential factors. A wide range of interrelated factors at the external, intervention level, and individual levels promote or impede the uptake and implementation DMHIs.

Our co-occurrence word cloud map revealed that current research hotspots have particularly focused on depression and cognitive-behavioural therapies for participating subjects, as researchers have progressively incorporated face-to-face, commonly used counselling or therapeutic approaches into their techniques to carry out more flexible interventions. During the RFO analysis, wefocused on digital modes of intervention for the review, thus, studies that did not specify delivery modes were excluded. This is a classification that has been supported in another study [56], and

the different types of platforms implied that there could be potential differences in functionality, usage, and performance [56]. The theme of quality and effect was identified as the predominant facilitator and barrier for each mode of DMHIs.. This indicated that the quality and effect of DMHIs were more mentioned by the participants and received more attention from the researchers; thus, the quality and effect of DMHIs are the key factors for promoting DMHIs.

When reaching into the sub-themes, the most common and consistent points under the three levels are summarised: Participants expressed more willingness to engage when DMHIs were integrated with other resources [43, 44], potentially due to the lower risk of being judged and embarrassed [57]. Previous research and professionals particularly appreciated the advantages of combining DMHIs with traditional medical resources and introducing them into daily life [55, 58, 59]. It was widely accepted and recommended that the use of multimedia, also referred to as "aesthetics" or "visual assets", could go a long way towards attracting attention, raising interest, facilitating understanding, and enhancing usability and satisfaction [12, 60, 61]. Perceived helpfulness/usefulness fits with the concept of the Technology Acceptance Model by influencing participants' attitudes to use to shape behavioural intentions and actual use behaviours [62]. Bad emotional experiences resulted in AYAs' less engagement [15], and some negative emotions, such as frustration and nervousness, caused physical and mental stress [63]. Privacy/security/credibility concerns remained a common barrier in DMHIs as in traditional psychotherapy. Even due to technological advances and digitisation, these remote services present unique and intense privacy risks to clients [55, 64].

Furthermore, two sub-themes are simultaneously positive and negative: integration with school and personalisation. The reason for integration with schools as a facilitator has already been stated. However, the integration with schools has been criticised because it could be less appealing to students and easily evoke negative feelings [43, 46]. In addition, schools may set many restrictions on the use of smart devices [55]. Personalisation was most often pushed by the participants because it gave the users more freedom, personalised monitoring and feedback, etc. [46, 47]. Participants who disliked personalisation may have done so because it required more actions and steps to complete, invariably adding burden and hassle [15].

Even though many randomised controlled trials showed that the use of DMHIs were satisfying, [8, 10], DMHIs could not be a substitute for traditional mental health services, but more of an augmentation and adjunct [57]. Most intuitively was the feedback from some participants about a preference for face-to-face communication, as well as their dissatisfaction with the mechanical and fixed responses from DMHIs [5]. The idea that DMHIs can act as a 'digital glue' to enhance user engagement in mental health services is relatively more agreeable, enhancing services by building digital and non-digital services into a loop or channel that can be switched back and forth [57]. That's why supporting hybrid digital and traditional mental health services should be the appropriate central idea for the future development and implementation of DMHIs.

An effective design process is essential for DMHIs to be effective in the mental

health field, and human-centred or user-centred design is particularly emphasised [65, 66]. Developers and designers of DMHIs may need to embrace this principle to refine and improve the details to fit the needs of the users. It may be important for future research to identify key components of the myriad and complex facilitators and barriers to bring the design process into sharper focus and to explore what kind of DMHIs are appropriate for different mental health problems.

This systematic review summarised the facilitators and barriers to DMHIs for AYAs wtih depression, anxiety, and stress and categorised them in a structured way. The review synthesised literature and provided ideas to future intervention service designers and therapists, and helping to promote the translation of DMHIs from research to practice, which is fundamental to mental health and public health. Our review also has some limitations. First, the quality assessment of the included studies showed that they were not entirely of high quality. Second, the participant characteristics and age in the studies were limited according to the exclusion criteria of our literature search. Some factors facilitating or hindering the exposure of adults or elderly with CMDs to DMHIs may likewise have the same effect on AYAs. Third, we excluded studies in languages other than English and Chinese, which may have overlooked some factors in other culture. We were explicitly aware that the frequency of an individual factor was not indicative of its significance, so follow-up studies were needed to clarify the importance.

Conclusions

This systematic review searched, screened, and synthesised the literature on facilitators and barriers to DMHIs for AYAs with depression, anxiety, and stress. The thematic synthesis identified a series of themes and sub-themes at the external level, intervention level, and individual level. These themes and subthemes indicate that the usage and intention to use DMHIs are determined by many factors. The successful DMHIs highly rely on the usage and intention to use. This review crystallised these factors and will help improve the design and implementation of DMHIs for AYAs.

Conflicts of Interest

None declared.

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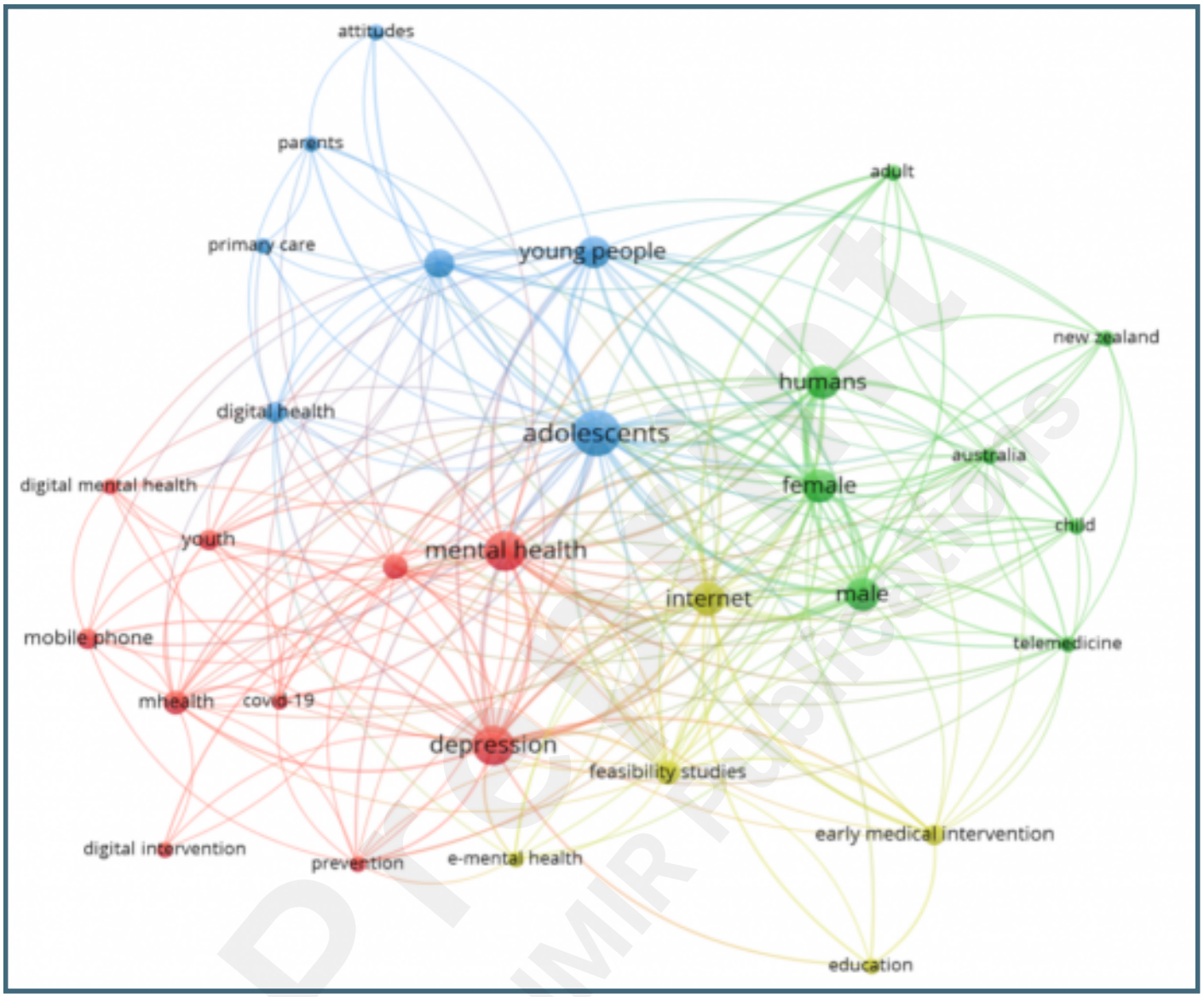
Abbreviations

DMHIs: Digital Mental Health Interventions
AYAs: Adolescents and Young Adults
CMDs: Common Mental Disorders
MMAT: Mixed Methods Appraisal Tool
WHO: World Health Organization
RFO: Relative Frequency of Occurrence
95%CI: 95% confidence interval

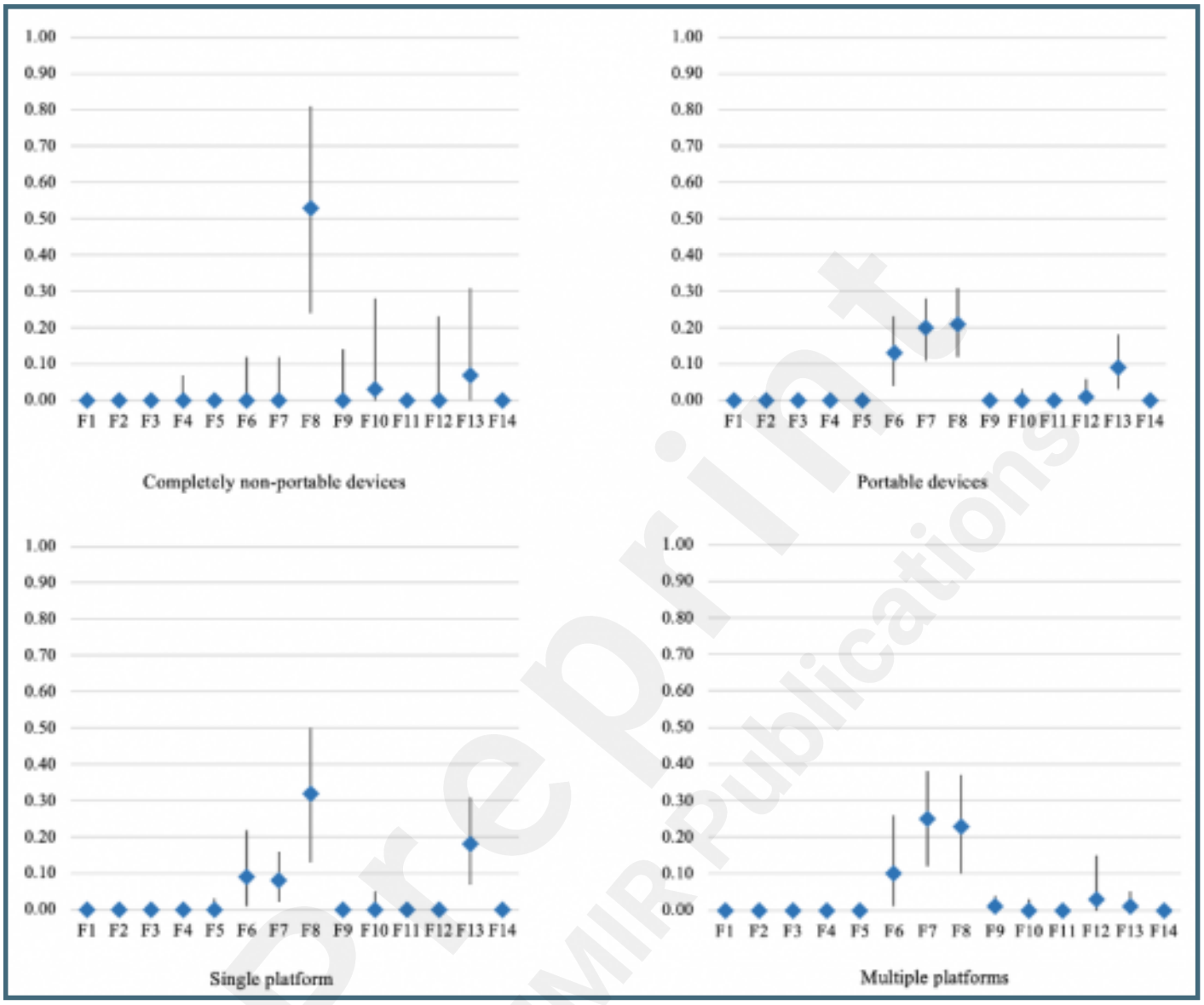
Supplementary Files

Figures

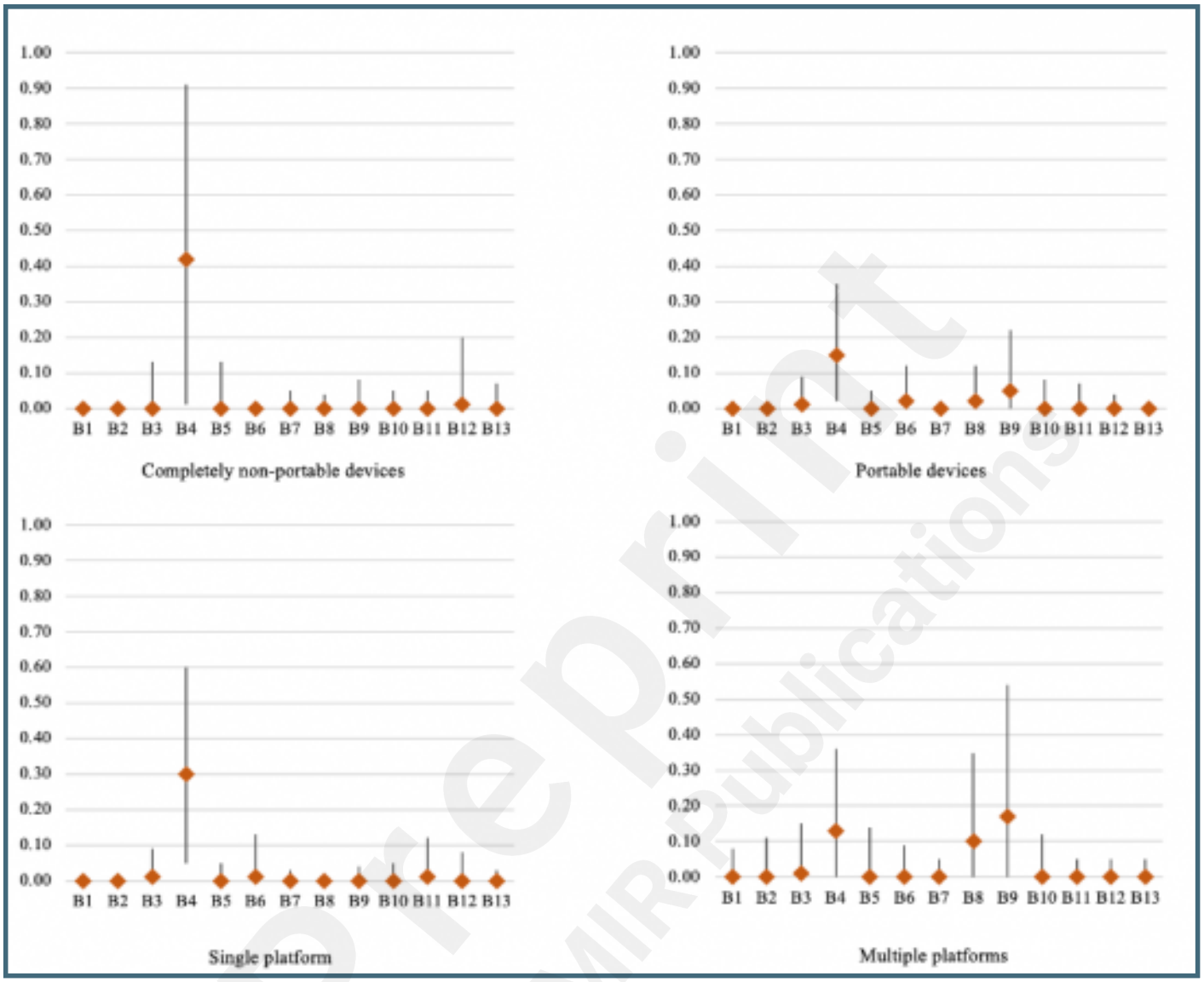
Visualisation network diagram of the items with the highest frequency of occurrence in the included studies.



RFO of facilitators in four delivery modes.



RFO of barriers in four delivery modes.



Multimedia Appendixes

Literature Search Strategy.
URL: http://asset.jmir.pub/assets/b4cdca5fba7dc565c9d7e6fa19c5957c.docx

Facilitators and Barriers.
URL: http://asset.jmir.pub/assets/a6311eb9eba04533ef27a7e8a5212650.docx

Metaprop Results.
URL: http://asset.jmir.pub/assets/8e7c69af418ac92531b961e2166d036c.docx