

Youth Mental Health Interventions via Mobile Phones: A Scoping Review

Yukari Seko, PhD,¹ Sean Kidd, PhD, CPsych, CPRP,² David Wiljer, PhD,²
and Kwame McKenzie, MD, MRCPsych³

Abstract

Mobile phone technologies have been hailed as a promising means for delivering mental health interventions to youth and adolescents, the age group with high cell phone penetration and with the onset of 75% of all lifetime mental disorders. Despite the growing evidence in physical health and adult mental health, however, little information is available about how mobile phones are implemented to deliver mental health services to the younger population. The purpose of this scoping study was to map the current state of knowledge regarding mobile mental health (mMental Health) for young people (age 13–24 years), identify gaps, and consider implications for future research. Seventeen articles that met the inclusion criteria provided evidence for mobile phones as a way to engage youth in therapeutic activities. The flexibility, interactivity, and spontaneous nature of mobile communications were also considered advantageous in encouraging persistent and continual access to care outside clinical settings. Four gaps in current knowledge were identified: the scarcity of studies conducted in low and middle income countries, the absence of information about the real-life feasibility of mobile tools, the need to address the issue of technical and health literacy of both young users and health professionals, and the need for critical discussion regarding diverse ethical issues associated with mobile phone use. We suggest that mMental Health researchers and clinicians should carefully consider the ethical issues related to patient–practitioner relationship, best practices, and the logic of self-surveillance.

Introduction

OVER THE LAST TWO DECADES, the field of mobile health (mHealth) has been growing exponentially, with healthcare providers leveraging mobile phone technologies, including Short Messaging Services (SMS) and mobile phone applications (apps), to deliver health information and interventions. The efficacy of mHealth intervention has been well established in the area of physical and lifestyle interventions, such as smoking cessation,¹ diabetes self-management,² asthma support,³ and anti-obesity behavior modification.⁴

More recently, the adoption of mobile technology for mental health has been on the rise. There are a growing number of mobile Mental Health (mMental Health) programs for clinical and general populations, including SMS-based interventions in the aftercare of bulimia nervosa patients^{5,6}; a cell phone app for mood tracking⁷; and a cognitive behavioral therapy (CBT)–based self-management program for depression and anxiety.⁸ According to a 2012

report by the California Healthcare Foundation, the number of mobile apps featuring mental health grew from 246 in early 2010 to 518 in 2011, and was anticipated to exceed 700 by July 2012.⁹

The potential of mHealth is particularly significant for younger populations, who have a high level of cell phone use across diverse sociodemographic domains.^{10,11} Adolescence and young adulthood are also critical life stages for early intervention around mental health, during which three quarters of all lifetime mental disorders have their first onset^{12,13} yet often remain untreated due to the lack of help-seeking and health literacy.¹⁴ mMental Health may present a promising mode of intervention and prevention for younger population.

Despite such promise, there appears to be a paucity of information about the extent and effectiveness of mobile phone use in youth and adolescent mental health. To address the gap in the literature, this scoping study provides a summary of existing work in this area and highlight next steps in the effort to capture the use and utility of mHealth

¹Self-Injury and e-Mental Health Lab, Department of Psychology, University of Guelph, Ontario, Canada.

²Centre for Addiction and Mental Health (CAMH), Toronto, Ontario, Canada.

³Social Aetiology of Mental Illness (SAMI) Training Program, Centre for Addiction and Mental Health (CAMH), Toronto, Ontario, Canada.

interventions for youth and adolescents—an area in which the use of technology is rapidly outpacing the research.

Methods

This scoping review employed the methodological framework developed by Arskey and O'Malley.¹⁵ This method is optimal for investigating research areas early in their development, as it aims to “map” the current state of knowledge rapidly and identify gaps in existing research.¹⁵ Unlike a systematic review, a scoping study does not conduct quality assessment; rather, the objective is to identify the breadth of literature and understand the extent of work within the subject field. The research question guiding this scoping review was:

RQ1: What is the current state of knowledge regarding the use of mobile phone technology for delivering mental health interventions to adolescents and youth?

Identification and selection of study

We conducted a structured literature search from the inception of databases through June 2013, with the following eight electronic databases: MEDLINE, PsycINFO, EMBASE, CINAHL, Web of Science, Health Technology Assessment Guide, Health Psychosocial Instruments, and Social Work Abstracts. For gray literature, we searched ProQUEST Dissertations and Theses, and ProQUEST Telecommunications. Search terms and databases were determined in consultation with a health science librarian at the Centre for Addiction and Mental Health.

Medical subject heading (MeSH) and selected keywords were searched within three groups using “OR,” then groups 1–3 were combined using the “AND” function. Keywords used in these searches included: (a) *Cellular Phone* (MeSH), *Text Messaging* (MeSH), *mobile phone**; (b) *Mental Disorders* (MeSH), *Mental Health* (MeSH), *Behavioral Symptoms* (MeSH); and (c) *Adolescent* (MeSH), *youth**, *young adult** (see Appendix 1 for complete list of search terms). No restriction was placed on publication date. Following the database search, we also hand searched reference lists within identified studies to ensure an exhaustive search.

Inclusion criteria

The retrieved titles and abstracts were screened for relevance against the following five inclusion criteria by two reviewers (YS and SK): (a) the article is a research study; (b) the study uses the mobile phone as the primary means of delivering mental health intervention; (c) the study focuses on mental disorders (e.g., depression, anxiety), including substance and alcohol use disorders; (d) the study targets primarily youth and adolescents aged 13–24 years; and (e) the article is written in English. Conference proceedings were included, as limiting the search solely to peer-reviewed articles was not feasible given the infancy of the subject field. While definitions of “youth” and “adolescence” may vary from one context to another, MeSH and CINAHL headings both define “adolescent” as an individual aged 13–18 years, and “young adult” as aged 19–24 years. For this study, we followed MeSH and CINAHL standards and defined “adolescents and youth” as individuals aged between 13 and 24 years.

Data characterization and extraction

The full papers of selected abstracts were assessed by one reviewer (YS), and the following information was extracted and charted with Excel spreadsheets: purpose of study, study design and methodology, research location, study population, type of mobile phone technology (i.e., SMS, apps, phone), target mental health problem, main outcomes, and phone ownership (i.e., whether the study used participants' personal phone or lent them a study phone). After completion of data extraction, the second author (SK) independently reviewed a subsample of the articles to ensure the validity of the data characterization. Following Arskey and O'Malley's¹⁵ framework, a thematic content analysis approach¹⁶ was used for identifying advantages for implementing mobile phone technology to mental health intervention, as well as reported challenges and concerns associated with mobile phone use. Coding was done individually by two researchers (YS and SK) and then discussed by the team until consensus was achieved.

Results

Initial database searches yielded 669 citations. After removing duplicates, titles and abstracts of 500 unique citations were identified. We screened these articles and identified 57 citations based on broad relevance to the topic area. The 57 abstracts then went through a second round of scrutiny against the inclusion criteria, and 19 articles were selected for full-text review. Following further inspection, three study protocols were excluded, as they did not meet the inclusion criteria, while one study was added as a result of reference checking. The final set of 17 studies included 15 journal articles, one book chapter, and one conference proceeding (see Figure 1).

Table 1 displays a summary of the literature. The articles were published between 2006 and 2012, with the majority (82%) published since 2009. In terms of study location, articles emanated largely from researchers in Australia ($n=6$), Ireland ($n=4$), Italy ($n=3$), and the United States ($n=3$), with the remaining study based in New Zealand ($n=1$). Seven out of 17 studies were randomized controlled trials (RCTs), and two studies were content analyses of SMS interactions between patients and care providers. There were three pilot studies, one case-control study, one evaluation study, and three studies that took a mixed method approach, combining more than one method, such as a focus group and a clinical pilot study. Sample sizes ranged from six participants in a focus group to 855 students from 15 high schools. Application foci varied across studies, including mood charting ($n=9$), stress management ($n=3$), alcohol use self-assessment ($n=2$), patient–therapist interaction ($n=2$), and appointments at an outpatient clinic ($n=1$). In terms of target population, eight studies focused on preventative interventions for general populations, such as reducing stress and anxiety; six studies targeted young clients at mental health clinics with mental health issues of mild to moderate severity; and two studies targeted high-risk abusers of alcohol. One study aimed to provide interventions to young clinical population with Major Depressive Disorders (MDD). No study targeted psychosis or other severe mental illnesses.

Characteristics of studies

Of the 17 studies, 16 (94%) utilized asynchronous features of mobile phones (SMS, apps, or multimedia messaging

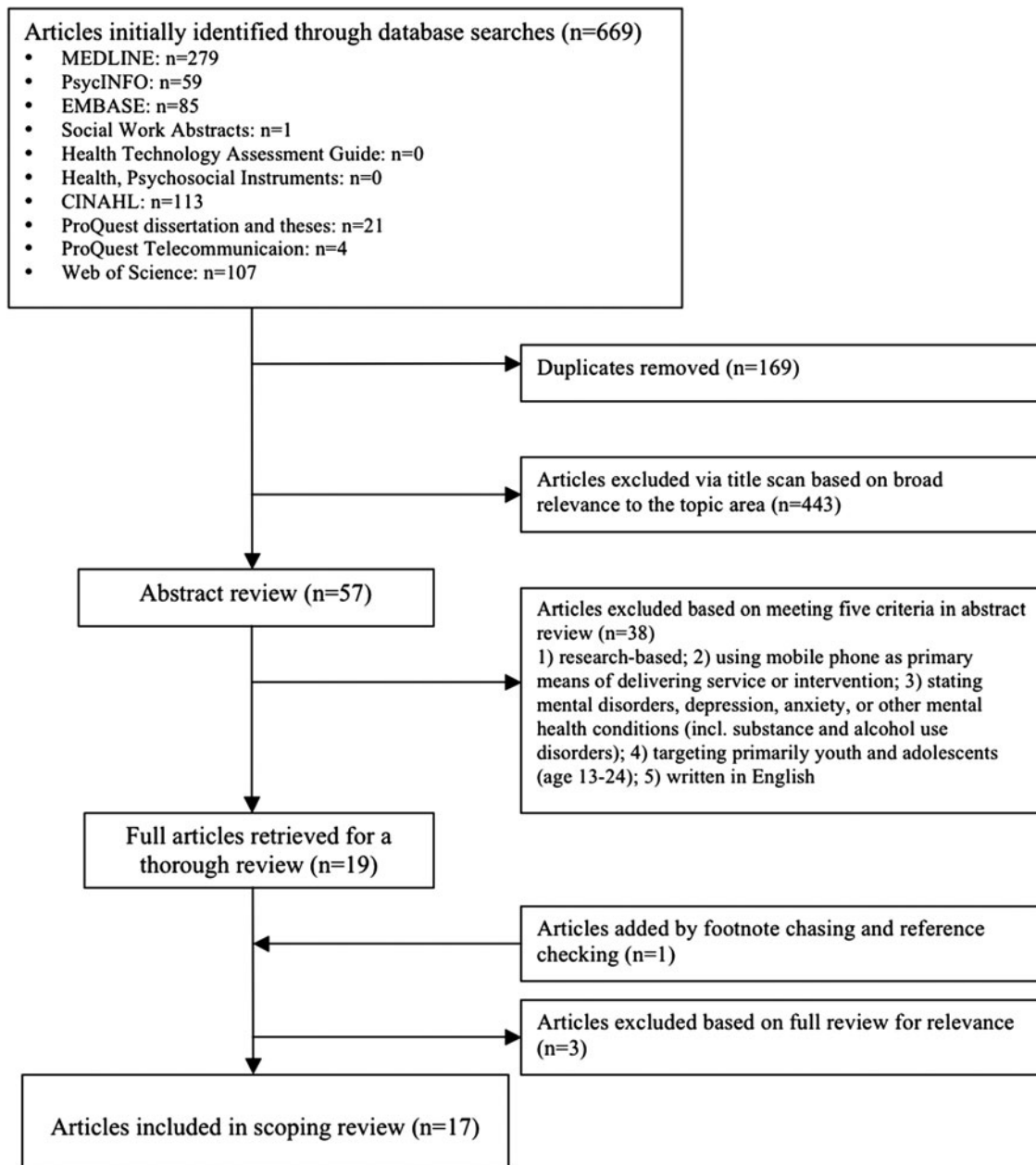


FIG. 1. Scoping review flow diagram.

system), instead of synchronous voice features. Of the four studies featuring SMS, two studies analyzed the content of text messages between patients and care providers^{18,24}; one study examined the efficacy of SMS reminders about appointments¹⁷; and one tested an SMS-based drinking self-assessment program.³² Eight studies reported the use of apps, among which five^{20,21,26-28} employed a self-monitoring program called MobileType (Mobile Tracking Young People's Experiences), and three²²⁻²⁴ used a mood-charting app called Mobile Mood Diary. Three studies reported the use of multimedia messaging to deliver relaxing audio and video content,^{19,29,30} and one tested the effect of CBT-based multimedia messages combining text, video, cartoon, and a mobile Web site.³³ One study involved calling participants and conducting ecological momentary assessment.³¹ With respect to phone ownership, 8 of the 17 studies^{17,18,22-25,32,33}

involved participants using their own cell phones to receive text messages, send data to researchers, or communicate with their therapists. In the remaining nine studies,^{19-21,26-31} participants were lent specifically designed study phones (i.e., answer only) for the duration of the research.

Study outcomes

Six studies reported statistically significant impacts of mobile interventions on youth mental health. Two RCTs using the MobileType app reported significant increases in emotional self-awareness²⁷ and positive impacts on mild depressive symptoms.²⁰ One trial of an SMS-based drinking intervention reported a significant reduction in self-reported heavy drinking days and the number of drinks per drinking day.³² Multimedia messages delivered via mobile phones

TABLE 1. SUMMARY OF THE LITERATURE

<i>Author/year</i>	<i>Study purpose</i>	<i>Research design</i>	<i>Intervention</i>	<i>Main findings</i>
Branson et al. (2011) ¹⁷	To examine the feasibility, acceptability, and preliminary efficacy of SMS appointment reminders	Design: Pilot study (quasi-experimental) Sample: 48 adolescent patients (age 13–17) Location: United States	Technology: SMS Format: SMS reminder the day before appointment Phone ownership: Participant	Higher attendance rate than control: SMS vs. control = 64.9% vs. 49.3%. High satisfaction: > 82% of participants favored SMS reminder; 88% of reminders were received.
Furber et al. (2011) ¹⁸	To analyze the content of SMS exchanges between therapists and young clients; to test the hypothesis that instances of inappropriate use of SMS are rare	Design: Content analysis Sample: 941 text messages between young patients and therapists Location: Australia	Technology: SMS Format: SMS conversation between patients and therapists Phone ownership: Participant	The majority of SMS sent to and received from clients aimed to coordinate face-to-face meetings (76% sent to clients and 61% received from clients). Only a small proportion of client use of SMS was classified as inappropriate (2%).
Grassi et al. (2009) ¹⁹	To investigate whether multimedia narratives delivered through mobile phone can induce a deep relaxation sensation and a significant anxiety sensation decrease	Design: RCT Sample: 120 college students commuting by train (age 20–25) Comparison group: No intervention Location: Italy	Technology: multimedia message Format: Participants were shown (a) video content of a virtual island associated with audio/relaxation content; (b) video content of a virtual island without audio; (c) audio relaxation content only; (d) control group Phone ownership: Researcher (participants used study phone during study)	Statistically significant decrease in anxiety level, and increase in relaxation level over time
Kauer et al. (2012) ²⁰	To examine the effectiveness of mobile phone-based self-monitoring tool on depressive symptoms	Design: RCT Sample: 114 clients (age 14–24) with mild or more severe mental health issues Comparison group: Used an abbreviated version of self-monitoring tool Location: Australia	Technology: app (mobile type) Format: Participants sent self-monitored data about mood, stress and coping strategies Phone ownership: Researcher (participants were lent mobile phone with the app)	Self-monitoring mood significantly increased emotional self-awareness (ESA). An increase in ESA predicted a decrease in depressive symptoms.
Kauer et al. (2009) ²¹	To test the feasibility and usefulness of a mobile phone-based self-monitoring program to capture data about alcohol use and related behaviors	Design: (a) school-based pilot study; (b) clinical study Sample: (a) 18 high school students (age 14–17); (b) 8 high-risk drinkers (age 16–24) Location: Australia	Technology: app (mobile type) Format: Participants sent data from self-assessment (alcohol use, daily experiences, mood and stress) Phone ownership: Researcher (participants were lent mobile phone with the app, and chose to use their own SIM card or use a study pre-paid SIM card)	(a) 69% of entries completed. The alcohol consumption data matched both participants' baseline Alcohol Use Disorder Identification Test responses and information reported in large cohort studies. (b) Though completion rate was low (30%), app captured the actual mood on drinking days in real time.

(continued)

TABLE 1. (CONTINUED)

<i>Author/year</i>	<i>Study purpose</i>	<i>Research design</i>	<i>Intervention</i>	<i>Main findings</i>
Matthews and Doherty (2011) ²²	To explore the general benefits, feasibility and limitations of using mobile phone for mood charting	Design: Pilot study Sample: 9 patients (age 10–17) in public mental health clinics Location: Ireland	Technology: app (mobile mood diary) Format: Participants sent self-monitored data about mood Phone ownership: Participant	Mean adherence rate across all participants (65%) and mean completion rate (89%) were higher than expected adherence for paper diary group. Both participants and therapists provided positive feedback.
Matthews et al. (2008a) ²³	To evaluate compliance and usability of mobile phone-based mood diary in comparison with paper diary	Design: (a) Focus group; (b) pilot study Sample: (a) 6 members of youth group (age 12–14); (b) 73 students (age 13–17) Location: Ireland	Technology: app (mobile mood diary) Format: Participants sent self-monitored data about mood Phone ownership: Participant	Positive feedback from participants regarding privacy and confidentiality, ease of use (based on self-report)
Matthews et al. (2008b) ²⁴	To examine the potential benefits of mobile phone for mood charting in comparison to existing methods	Design: Pilot study Sample: 73 students (age 13–17) Location: Ireland	Technology: app (mobile mood diary) Format: Participants sent self-monitored data about mood Phone ownership: Participant	High compliance rate. Mobile phone diary group (mean = 8.12) produced more entries than paper diary group (mean = 5.44); high satisfaction regarding data privacy; mobile vs. paper = 95% vs. 85%; perceived ease of use: mobile vs. paper = 88.7% vs. 11.3%
Nolan and MacCobb (2011) ²⁵	To investigate how text messaging on mobile phones was used by therapists and university students in a mental health support service (UNILINK)	Design: Content analysis Sample: 413 text messages between university students and therapists Location: Ireland	Technology: SMS Format: SMS conversation between patients and therapists Phone ownership: Participant	SMS offers means of maintaining ongoing therapeutic relationship between service users and staff
Reid et al. (2012) ²⁶	To evaluate utility, usability, and feasibility of mobile application in clinical settings with adolescents and adolescent psychiatrists	Design: Evaluation study Sample: 47 patients (age 14–19) and 6 psychiatrists Location: Australia	Technology: app (mobile type) Format: Participant sent self-monitored data about current activities, location, companions, mood, recent stressful events, responses to stressful events, alcohol and cannabis use, sleep, exercise, and diet Phone ownership: Researcher (participants were lent mobile phone with app, given a study pre-paid SIM card)	Participants reported data reflected their actual experiences (88%) and was accurate (85%), helpful (65%), and helped their psychiatrists understand them better (77%)

(continued)

TABLE 1. (CONTINUED)

<i>Author/year</i>	<i>Study purpose</i>	<i>Research design</i>	<i>Intervention</i>	<i>Main findings</i>
Reid et al. (2011) ²⁷	To conduct effectiveness trial to test utility of mobile type program in primary care setting and examine mental health outcomes	Design: RCT Sample: 114 patients (age 14–24) Comparison group: Used an abbreviated version of self-monitoring tool Location: Australia	Technology: app (mobile type) Format: Participant sent self-monitored data about current activities, location, companions mood, recent stressful events, responses to stressful events, alcohol and cannabis use, sleep, exercise, and diet Phone ownership: Researcher (participants were lent mobile phone with app, given a study pre-paid SIM card)	Intervention significantly increased emotional self-awareness (ESA). Medium to large significant main effect for time for depression, anxiety, or stress. Analyses suggested that participation in RCT enhanced mental healthcare at pretest and improved mental health outcomes.
Reid et al. (2009) ²⁸	To develop, pilot, and evaluate mobile phone program to monitor, in real time, young people's everyday experiences of mood, stress, and coping behaviors	Design: (a) focus group; (b) pilot study Sample: (a) 11 students (age 14–17); (b) 18 students (age 14–17) Location: Australia	Technology: app (mobile type) Format: Participant sent self-monitored data about moods, stresses, coping strategies, and alcohol and cannabis use Phone ownership: Researcher (participants were lent mobile phone with app, and chose to use their own SIM card or use a study prepaid SIM card)	In Study 2, 76% of entries completed. 83% of participants found app accessible; 94% of participants reported program adequately captures their moods.
Riva et al. (2007) ²⁹	To test if mobile audiovisual narratives help students manage exam stress	Design: RCT Sample: 30 female university students ($M=23.48$; $SD=1.24$) who were going to take an exam within a week Comparison group: No intervention prior to exams Location: Italy	Technology: multimedia message Format: Participants were shown (a) audio only narrative (CD at home); (b) audio only narrative (portable MP3); (c) audio and video narrative (DVD at home); (d) audio and video narrative (mobile phone based); 9e) control group Phone ownership: Researcher (participants used study phone during study)	Audio/video narratives induced reduction in exam anxiety in more than 80% of intervention group; all participants in intervention group were able to relax before the exam, against 50% of DVD users and 33% of audio-only users; negative correlation between level of anxiety and exam marks.
Riva et al. (2006) ³⁰	To examine if multimedia narratives delivered via mobile phones help commuters reduce stress	Design: RCT Sample: 33 young commuters on Italian local line (age 20–25) Comparison group: No intervention Location: Italy	Technology: multimedia message Format: Participants were shown (a) multimedia narratives of a trip to a desert tropical beach, (b) New Age music with an image of tropical beach Phone ownership: Researcher (participants were lent study phone during commute)	Significant reduction in anxiety level; increase in relaxation scale; anxiety reduction in intervention group significantly higher

(continued)

TABLE 1. (CONTINUED)

<i>Author/year</i>	<i>Study purpose</i>	<i>Research design</i>	<i>Intervention</i>	<i>Main findings</i>
Silk et al. (2011) ³¹	To investigate effectiveness of cell phone in investigating daily emotional dynamics of young clinical population with depression	Design: Case-control study Sample: 47 patients with Major Depressive Disorder (MDD) and 32 no psychopathology controls (CON), age 7–17 Location: United States	Technology: phone Format: Participants were phone-interviewed through ecological momentary assessment protocol Phone ownership: Researcher (participants were given modified, answer-only cell phones)	High completion rate (92%). Intervention group experienced more intense negative emotions (sadness, anger, nervousness, global negative affect) than control group.
Suffoletto et al. (2012) ³²	To develop SMS-based program, pilot test its feasibility, and provide variance in drinking-related outcomes to adequately power a clinical trial	Design: RCT Sample: 45 young drinkers (age 18–24) discharged from emergency department Intervention group: Weekly SMS feedback with goal setting Assessment group: weekly SMS drinking assessments without feedback Comparison group: No intervention Location: United States	Technology: SMS Format: Program sent weekly SMS-based queries about alcohol consumption with goal-specific prompts Phone ownership: Participant	88% of weekly SMS-based drinking assessments were answered, with 77% of participants responding throughout study duration. Goal setting was associated with fewer Heavy Drinking Days (HDD). At 3 months, intervention group had 3.4 ($SD = 5.4$) fewer HDDs in the last month and 2.1 ($SD = 1.5$) fewer drinks per drinking day.
Whittaker et al. (2012) ³³	To develop and test mobile phone delivery of CBT-based depression prevention intervention for adolescents	Design: RCT Sample: 855 students (age 13–17) Comparison group: Received placebo messages without CBT-based information Location: New Zealand	Technology: multimedia message Format: Program sent CBT-based multimedia message (text, video, cartoon, & mobile Web site) Phone ownership: Participant	90.7% (379/418) of intervention group favored the program, said intervention helped them be more positive (279/418; 66.7%) and get rid of negative thoughts (210/418; 50.2%)

appeared to be effective in reducing stress. In three studies that used audiovisual narratives, intervention groups receiving relaxation messages showed significant reductions in anxiety scores and increases in the relaxation scale.^{19,29,30}

Four studies reported a significant improvement in compliance with care and intervention. Branson et al.¹⁷ found that the intervention group that received SMS reminders for appointments showed significantly higher adherence rates to their appointment schedule compared with the control group. Similarly, participants who used mobile diaries showed a significantly higher adherence and completion rate compared with the paper-based diary group.^{22,24} Silk et al.³¹ reported a high completion rate of cell phone-based ecological momentary assessment. One study using the MobileType app for momentary sampling with young drinkers²¹ showed a low completion rate. However, the researchers concluded that the app was effective in capturing the actual mood of the high-risk drinkers in real time.

Participants tended to show positive attitudes toward mMental Health interventions. Matthews et al.²³ reported high satisfaction among participants regarding data privacy and user-friendliness. Participants of two MobileType studies had very favorable impressions of the program, reporting that the app accurately captured their moods²⁶ and adequately helped their pediatricians to understand them better.²⁸ Whittaker et al. noted that delivering CBT-based depression prevention via mobile phone was efficient, as 90.7% of participants (379 out of 418) in the intervention group favored the program.³³ Two studies that analyzed the content of patient-counselor SMS interactions^{18,25} found that SMS contributed positively to the rapport between patients and their health practitioners.

Advantages and challenges of mobile phone use

Our thematic analysis identified various strengths of mobile phone platforms (Table 2). The most commonly cited advantage was *ubiquity* of the device, with 13 out of 17

articles (77%) referring to the widespread ownership and use of cell phones among young people. The ubiquity of mobile phones was considered advantageous in extending service outreach and facilitating large-scale interventions³³ and in lowering the barrier to healthcare access.²⁴ Along with ubiquity, authors frequently mentioned **user-friendliness** of mobile phones as a strength (8/17; 47%). Matthews et al.²³ stated that using a device with which participants are already familiar enables researchers to build on the participants' existing knowledge without a major time investment.

Cost-efficiency was another common strength suggested by many articles (8/17; 47%), although few demonstrated this effectively with statistical data. For instance, Suffoletto et al.³² asserted that SMS-based interventions in the aftercare of alcohol use disorder could be a cost-effective supplement to traditional treatments, as the regularity and predictability of SMS feedback systems enables additional monitoring of clients. Similarly, Whittaker et al.³³ reported that delivering CBT messages via mobile phones was feasible and would enable large-scale interventions with minimal cost. Authors also suggested that mobile phones could provide a cheaper alternative to cost-prohibitive devices such as personal digital assistants (PDAs) for self-guided interventions.^{23,24,28}

Eight articles (47%) identified the *flexibility* of mobile communication as beneficial for young patients. In particular, asynchronous features (e.g., SMS, apps) were favored over synchronous telephone functions, as they are seen as being less intrusive and granting autonomy to the young user. For instance, Nolan and MacCobb²⁵ argued that SMS enables university students to access their therapists directly for coordinating appointments. This ability is viewed as "empowering" the students to arrange healthcare service according to their own needs. Suffoletto et al.^{32(p553)} also noted that SMS-based interventions are more acceptable for young people "who prefer unassisted, self-directed program(s)," as they ensure relative autonomy and independence. Flexibility of mobile communication was also seen as facilitating unobtrusive interventions. Branson et al.¹⁷ found SMS reminders to be

TABLE 2. REPORTED ADVANTAGES AND CHALLENGES OF MOBILE PHONE USE

	<i>Descriptions</i>	<i>No.</i>	<i>%^a</i>
<i>Advantages</i>			
Ubiquity/popularity	Mobile phones are popular and ubiquitous among youth	13	76.5
User-friendly	Mobile phones are easy to use/user-friendly	8	47.1
Cost-effective	Mobile phones are a cost-effective means	8	47.1
Flexibility	Mobile phones allow users flexible use beyond time and geographical constraints and give greater control over the time and pace of interactions	8	47.1
Rapid/real-time response	Mobile phones enable quick and timely communication	6	35.3
Interactivity	Mobile phones are an interactive medium that builds patient-caregiver rapport	6	35.3
Personal nature	Mobile phones are personal devices	5	29.4
<i>Challenges</i>			
Confidentiality/privacy	Patient and data privacy needed to be protected	5	29.4
Technical issues/difficulties	Sufficient skills and technical knowledge needed to be effective	4	23.5
Cost	Mobile tools (e.g., smartphones, apps) may be expensive to implement and use	2	11.8
Data validity/reliability	Potential for invalid data	1	5.9
Design	Small display screen	1	5.9
Digital divide	Mobile tools may widen the gap between haves and have-nots	1	5.9

^aIndividual articles could contain multiple categories; total percentages do not equal 100%.

effective in improving patient adherence to appointments, since they allow patients to read the message at their convenience.

Six articles (35%) indicated that *rapid and timely communication* is a feature of mobile phones that makes them efficient in gathering patient-generated data in situ,^{20,21} increasing treatment compliance^{22,24,32} and, if necessary, offering some interventions on the spot.³¹ Suffoletto et al.³² demonstrated that automated SMS interventions can provide real-time assessment and feedback to young drinkers that increase the likelihood of success in intervention. Silk et al.^{31(p14)} noted that cell phones allowed researchers to “explain things to youth immediately when they were confused or unclear” and to “prompt for more information.”

Interactivity of mobile phones was identified in six articles (35%) as a potential prompt for a therapeutic relationship between young patients and healthcare professionals. Raid et al.²⁶ argued that their mobile self-monitoring app can help to establish a rapport between pediatricians and clients by helping clinicians overcome difficulties engaging young clients who are reluctant to share sensitive information about their mental health. Even in a study that did not use two-way communication, participants indicated a desire for two-way communication with their therapists rather than simply receiving one-way reminders.¹⁷ Interactive and multimedia functionalities of the mobile phone interface were also evaluated as creating a feeling of presence and encouraging patient engagement.^{19,23}

Five articles (29%) mentioned the *personal nature* of the cell phone as a strength. Matthews and Doherty^{22(p2948)} argued that using personal cell phones in public spaces is a widely accepted activity. This function provides users with “sufficient privacy to support sensitive therapeutic activities,” such as documenting their mood in a public environment. The ability of mobile phones to offer personal space is also considered to increase levels of perceived autonomy, control, and self-esteem in young users. Given this personal nature, cell phones may be well suited for promoting self-monitoring strategies that assist young people to become aware of their mental health and to learn coping strategies.²⁰

While reporting several advantages, some authors also pointed out challenges associated with mobile phone use. Ensuring *confidentiality and privacy* was the most commonly stated concern (5/17 studies; 29%). mMental Health data generated by young patients are often personal and sensitive, and this raises concerns about how these data are handled, transmitted, and stored. In addition, the potential loss of the mobile device was another commonly identified privacy concern. To avoid potential breaches of privacy, Branson et al.¹⁷ used an abbreviation technique: when sending an SMS reminder to young patients, they simply stated the day and time of the next session without revealing the nature of the appointment (e.g., “C u Wed @8”). Matthews and Doherty²² also pointed out that whether participants use their own phones would warrant careful discussion. They argued that a situation in which participants have to carry two devices for the duration of a study may attract unwanted attention and hinder therapeutic potential.

Another challenge mentioned by four articles (24%) related to *technical difficulties* pertaining to program implementation and operation. Whittaker et al.³³ faced technical issues setting up an Internet connection on participants’

phones. Matthews and Doherty²² also documented therapists’ lack of technical confidence as one of the greatest barriers to the implementation of their mood-monitoring app.

Discussion

This scoping review draws together the current evidence about mobile phone use in the context of adolescent and youth mental health. A total of 17 articles met inclusion criteria. This low yield of research activity appears to reflect the paucity of programs focusing primarily on young populations, despite the growing number of mHealth and mMental Health interventions for adults.³⁴ Nonetheless, all 17 studies indicated that mobile phones are potentially effective platforms for enhancing treatment and improving mental health interventions among young people.

The reviewed articles suggested a trend in mMental Health toward self-guided interventions. Nine out of 17 articles (53%) utilized apps and SMS as a means of facilitating mental self-monitoring among young users.^{20–24,26–28,32} The authors argued that self-monitoring can be a mental health intervention in itself, as it not only contributes to mitigating psychological distress and improving perceived self-efficacy,^{20,27} but also increases treatment adherence.^{22–24} Moreover, the data generated by self-monitoring programs were considered helpful for use by treating clinicians to monitor closely patients’ emotional patterns and how they deal with daily problems and life events. Particularly, ecological momentary assessment, a method for collecting real-time self-report data, was found to be deployable on mobile phones.^{21,28,31}

In terms of technological functions, the majority of the reviewed studies (12/17; 70%) preferred technologically advanced functions such as apps and multimedia messaging over SMS and voice features. As the new generation of cell phones (i.e., smartphones) combine advanced computing functionalities with wireless Internet features, more and more mMental Health tools will harness advanced multimedia technologies such as gaming, virtual reality, and social networking services attractive to youth. For instance, one study protocol found in the process of this scoping review proposes the use of smartphones for delivering a CBT-based 3D game for the assessment and training of emotional regulation.³⁴ Such media-rich programs offer a very different user experience than SMS and voice call, introducing a significant change in therapeutic possibilities of mobile platforms. Future mMental Health researchers should carefully select the appropriate mobile tools that fit their intervention goals, aligning their strategy with target users, their device choice, and bandwidth.

Research gaps

Consideration of the recommendations for future research in the reviewed papers, as well as the identification of gaps in current state of knowledge as illuminated by our descriptive synthesis of the literature, suggest four areas that deserve further work.

One conspicuous gap is the lack of research in low and middle income countries. All 17 studies in our review were conducted in high income OECD countries, targeting youth from a homogeneous socioeconomic background. This result echoes a recent systematic review on mHealth interventions³⁵

that revealed the sheer lack of trials in low and middle income countries, despite the high penetration of mobile technologies in these settings. Given that mobile phone use in developing countries surpassed that of developed areas by 2012,³⁶ future studies should pay more attention toward the possibility of mMental Health for young populations in developing countries.

There is also a gap in knowledge about the real-life feasibility of mobile tools, especially the mental health apps whose effectiveness depends greatly on those who use them. While some of the reviewed articles examined feasibility of the apps in clinical settings with young patients and care providers,^{26,27} it is not yet known whether youth who need or might benefit from the apps would actually download and use them in their everyday lives. In particular, there is little discussion regarding what makes the apps attractive and competitive in an open market context and how health professionals can actually implement mMental Health tools in their clinical practice. Further research is needed on user engagement with apps (i.e., how often young users use the mental health apps, whether they follow the protocols), along with the potential health impact of the apps.

The issue of health and technical literacy was also found not to be discussed sufficiently in the literature. Although authors often took for granted a high level of technical proficiency among young users, being tech-savvy does not equal being information literate. In order to ensure that young users understand the potential impact of interventions, future mMental Health tools should combine psychoeducation and health promotion components to build mental health literacy. As recommend by Matthews et al.,²³ it is important for developers to incorporate youth input in the design and development of interventions and to set up a recurrent feedback loop between users, researchers, and program implementers. In addition, as Matthews and Doherty²² pointed out, a major barrier to the adaptation of mMental Health is the lack of technical literacy on the part of healthcare providers. Future research should provide adequate training to healthcare providers in a way that enables them to take advantage of their existing skills and integrate the new technologies into their practice.

Furthermore, little attention has been devoted to the wide-ranging ethical issues that emerge with mMental Health. Although some authors implemented strategies to ensure data and participant privacy, mMental Health researchers should not limit their ethical scope to confidentiality concerns. For example, while self-monitoring tools allow for constant monitoring of patient treatment and immediate feedback to practitioners, too frequent patient-practitioner interactions may force healthcare providers to face an excessive amount of user-generated health information. This may add to their workload and place them under pressure to monitor patients' mental states constantly and offer personalized services beyond their capacity. Future research should consider how to prevent information overload for clinicians while still encouraging the use of mMental Health tools to develop a strong patient-practitioner rapport.

The quality of mMental Health tools also deserves critical attention. Between 2010 and 2012, the number of apps for mental health almost tripled,⁹ a rate that is clearly outpacing evidence-based research into the effectiveness of such tools. To date, no universal standards for mMental Health tools

exist, and research is still lacking on the content quality of commercially developed programs.³⁷ Thus, it is possible that these tools contain inaccurate information or provide interventions that do not adhere to the evidence-based literature and, as a result, inadvertently introduce patient safety risks. In fact, researchers who conducted a content analysis of iPhone apps for smoking cessation reported that few of the apps followed established guidelines.³⁸ mMental Health researchers should ensure that an evidence base exists for proposed interventions and should inform participants about quality and efficacy of the programs. Likewise, professionals aiming to implement mobile phone technologies, given the limited evidence base in this area, would be well advised to monitor their use and clinical impacts closely.

Finally, critical discussion is needed regarding the logic of self-surveillance. Recent sociologists of medicine point out a tendency among the medical literature on mHealth technologies to shift responsibility for care from clinician to patient, representing patients as willing to promote their health using these technology-enhanced interventions.³⁹⁻⁴³ The persistent and compulsive nature of self-monitoring tools also warrants particular caution, as it may put youth under too much pressure to monitor their own mental health constantly. As Lupton⁴³ pointed out, being unable to adhere to the monitoring routine may also contribute to feelings of shame and guilt, which could reduce control users have over the ways they interact with interventions. Even worse, the individualistic and targeted approach manifested in self-management technologies may reduce health problems to the personal level, while drawing attention away from the larger, sociocultural dimensions of health. The sheer absence of mMental Health tools for key supporters of young users, such as family and caregivers, may also indicate this tendency to confine mental health to a realm of its own, independent from all other social spheres. To avoid disregarding the sociocultural perspective in favor of technology, these ethical issues should warrant further attention in future mMental Health research.

Limitations

Scoping studies, by definition, are not meant to be exhaustive; they intend to map the literature in a particular field of interest quickly and identify gaps in current research.¹⁵ Although we searched 10 electronic databases for peer-reviewed and gray literature sources, it is likely that other relevant publications were not included. Also, we did not include literature written in languages other than English, which may constitute a significant source for information. Given the widespread use of mobile phones in developing countries, future research would benefit from including non-English sources. Beyond the inclusion criteria, we did not assess the quality of the existing literature because it is not an expectation in the scoping review framework. However, as the number of research studies grows, the quality appraisal of design principles and practices for mMental Health tools will become increasingly important in assessing the significance of research findings.

Conclusion

mMental Health for young people is hailed as a way forward for services to connect with their young consumers. Advanced mobile technologies can contribute to improve

patient-centered care for youth growing up in our increasingly tech-savvy society. More research is needed to fill the gaps in the current state of knowledge and to provide an evidence base for the implementation of mobile phone technologies. Developing mobile tools for young users with mental health problems requires careful consideration regarding stigma associated with mental illness and the potentially detrimental effect of overmedicalization. To maximize the benefits while minimizing potential harm, health researchers and clinicians should carefully consider and further examine ethical, methodological, and technological issues pertaining to mMental Health.

Acknowledgments

This study was supported by the Social Aetiology of Mental Illness (SAMI) Training Program, a Strategic Training Initiative in Health Research funded by the Canadian Institutes of Health Research (CIHR) at the Centre for Addiction and Mental Health (CAMH). We gratefully thank Sarah Bonato, a health science librarian at CAMH, for her advice on search strategies in databases, and Hema Zbogor at CAMH for editing the manuscript.

Author Disclosure Statement

No competing financial interests exist.

References

- Rodgers A, Corbett T, Bramley D, et al. Do u smoke after txt? Results of a randomised trial of smoking cessation using mobile phone text messaging. *Tobacco Control* 2005; 14:255–261.
- Franklin VL, Waller A, Pagliari C, et al. A randomized controlled trial of Sweet Talk, a text-messaging system to support young people with diabetes. *Diabetic Medicine: A Journal of the British Diabetic Association* 2006; 23:1332–1338.
- Huckvale K, Car M, Morrison C, et al. Apps for asthma self-management: a systematic assessment of content and tools. *BMC Medicine* 2012; 10:144.
- Joo N-S, Kim B-T. Mobile phone short message service messaging for behaviour modification in a community-based weight control programme in Korea. *Journal of Telemedicine & Telecare* 2007; 13:416–420.
- Bauer S, Percevic R, Okon E, et al. Use of text messaging in the aftercare of patients with bulimia nervosa. *European Eating Disorders Review* 2003; 11:279–290.
- Robinson S, Perkins S, Bauer S, et al. Aftercare intervention through text messaging in the treatment of bulimia nervosa—feasibility pilot. *International Journal of Eating Disorders* 2006; 633–638.
- Harrison V, Proudfoot J, Wee PP, et al. Mobile mental health: review of the emerging field and proof of concept study. *Journal of Mental Health* 2011; 20:509–524.
- Morris ME, Kathawala Q, Leen TK, et al. Mobile therapy: case study evaluations of a cell phone application for emotional Self-awareness. *Journal of Medical Internet Research* 2010; 12:e10.
- Sarasohn-Kahn J. (2012) The online couch: mental health care on the web. www.chcf.org/publications/2012/06/online-couch-mental-health (accessed Mar. 14, 2013).
- Koivusilta LK, Lintonen TP, Rimpelä AH. Orientations in adolescent use of information and communication technology: a digital divide by sociodemographic background, educational career, and health. *Scandinavian Journal of Public Health* 2007; 35:95–103.
- Thomas S, Heinrich S, Kühnlein A, et al. The association between socioeconomic status and exposure to mobile telecommunication networks in children and adolescents. *Bioelectromagnetics* 2010; 31:20–27.
- Kessler RC, Amminger P, Aguilar-Gaxiola S, et al. Age of onset of mental disorders: a review of recent literature. *Current Opinion in Psychiatry* 2007; 20:359–364.
- Kessler RC, Berglund P, Demler O, et al. Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the National Comorbidity Survey replication. *Archives of General Psychiatry* 2005; 62:593–602.
- Rickwood D, Deane FP, Wilson CJ, et al. Young people's help-seeking for mental health problems. *Australian e-Journal for the Advancement of Mental Health* 2005; 4:1–34.
- Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *International Journal of Social Research Methodology* 2005; 8:19–32.
- Mayring P. Qualitative content analysis. *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research* 2000; 1:1–8.
- Branson CE, Clemmey P, Mukherjee P. Text message reminders to improve outpatient therapy attendance among adolescents: a pilot study. *Psychological Services* 2013; 10:298–303.
- Furber GV, Crago AE, Meehan K, et al. How adolescents use SMS (short message service) to micro-coordinate contact with youth mental health outreach services. *Journal of Adolescent Health: Official publication of the Society for Adolescent Medicine* 2011; 48:113–115.
- Grassi A, Gaggioli A, Riva G. The green valley: the use of mobile narratives for reducing stress in commuters. *Cyberpsychology & Behavior* 2009; 12:155–161.
- Kauer SD, Reid SC, Crooke AHD, et al. Self-monitoring using mobile phones in the early stages of adolescent depression: randomized controlled trial. *Journal of Medical Internet Research* 2012; 14:e67.
- Kauer SD, Reid SC, Sanci L, et al. Investigating the utility of mobile phones for collecting data about adolescent alcohol use and related mood, stress and coping behaviours: lessons and recommendations. *Drug & Alcohol Review* 2009; 28:25–30.
- Matthews M, Doherty G. In the mood: engaging teenagers in psychotherapy using mobile phones. *Proceedings of the 2011 Annual Conference on Human Factors in Computing Systems* 2011; 2947–2956.
- Matthews M, Doherty G, Coyle D, et al. (2008) Designing mobile applications to support mental health interventions. In Lumsden J, ed. *Handbook of research on user interface design and evaluation for mobile technology*. Vols 1 and 2. Hershey, PA: Information Science Reference/IGI Global, pp. 635–656.
- Matthews M, Doherty G, Sharry J, et al. Mobile phone mood charting for adolescents. *British Journal of Guidance Counselling* 2008; 36:113–129.
- Nolan C, Quinn S, MacCobb S. Use of text messaging in a mental health service for university students. *Occupational Therapy in Mental Health* 2011; 27:103–125.
- Reid SC, Kauer SD, Khor AS, et al. Using a mobile phone application in youth mental health. *Australian Family Physician* 2012; 41:711–714.
- Reid SC, Kauer SD, Hearps SJC, et al. A mobile phone application for the assessment and management of youth

- mental health problems in primary care: a randomised controlled trial. *BMC Family Practice* 2011; 12:131.
28. Reid SC, Kauer SD, Dudgeon P, et al. A mobile phone program to track young people's experiences of mood, stress and coping. Development and testing of the mobilitytype program. *Social Psychiatry & Psychiatric Epidemiology* 2009; 44:501–507.
 29. Riva G, Grassi A, Villani D, et al. Managing exam stress using UMTS phones: the advantage of portable audio/video support. *Studies in Health Technology & Informatics* 2007; 125:406–408.
 30. Riva G, Preziosa A, Grassi A, et al. Stress management using UMTS cellular phones: a controlled trial. *Studies in Health Technology & Informatics* 2006; 119:461–463.
 31. Silk JS, Forbes EE, Whalen DJ, et al. Daily emotional dynamics in depressed youth: a cell phone ecological momentary assessment study. *Journal of Experimental Child Psychology* 2011; 110:241–257.
 32. Suffoletto B, Callaway C, Kristan J, et al. Text-message-based drinking assessments and brief interventions for young adults discharged from the emergency department. *Alcoholism, Clinical & Experimental Research* 2012; 36: 552–560.
 33. Whittaker R, Merry S, Stasiak K, et al. MEMO—a mobile phone depression prevention intervention for adolescents: development process and postprogram findings on acceptability from a randomized controlled trial. *Journal of Medical Internet Research* 2012; 14:e13.
 34. Rodriguez A, Rey B, Alcaniz M, et al. GameTeen: new tools for evaluating and training emotional regulation strategies. *Studies in Health Technology & Informatics* 2012; 181:334–338.
 35. Free C, Phillips G, Galli L, et al. The effectiveness of mobile-health technology-based health behaviour change or disease management interventions for health care consumers: a systematic review. *PLoS Medicine* 2013; 10: e1001362.
 36. World Bank. Information and communications for development 2012: maximizing mobile. <https://openknowledge.worldbank.org/handle/10986/11958> (accessed Aug. 21, 2013).
 37. Luxton DD, McCann RA, Bush NE, et al. mHealth for mental health: Integrating smartphone technology in behavioral healthcare. *Professional Psychology Research & Practice* 2011; 42:505–512.
 38. Abroms LC, Padmanabhan N, Thaweethai L, et al. iPhone apps for smoking cessation: a content analysis. *American Journal of Preventive Medicine* 2011; 40:279–285.
 39. Conrad P. (2007) The medicalization of society: on the transformation of human conditions into treatable disorders. Baltimore: Johns Hopkins University Press.
 40. Mort M, Finch T, May C. Making and unmaking telepatients: identity and governance in new health technologies. *Science, Technology & Human Values* 2007; 34:9–33.
 41. Andreassen HK. What does an e-mail address add? Doing health and technology at home. *Social Science & Medicine* 2011; 72:521–528.
 42. Lupton D. Quantifying the body: monitoring and measuring health in the age of mHealth technologies. *Critical Public Health* 2013; 1–11.
 43. Lupton D. M-health and health promotion: The digital cyborg and surveillance society. *Social Theory & Health* 2012; 10:229–244.

Address correspondence to:

*Dr. Sean Kidd
Centre for Addiction & Mental Health (CAMH)
1001 Queen Street West, Unit 2-1 Room 161
Toronto
Ontario, M6J1H1
Canada*

E-mail: sean.kidd@camh.ca

Appendix

Appendix 1: List of Search Terms

Group 1:

Cellular Phone (MeSH); Text Messaging (MeSH); cell* phone*; cell* telephone*; phone* cell*; telephone* cell*; mobile phone*; mobile telephone*; phone* mobile*; telephone* mobile*; smart phone*; smartphone*; blackberr*; iPhone*; android*; mobile app*; phone app*; text messag*; SMS*; short messag*; short messag* service*; message* text*; texting*

Group 2:

Mental Health (MeSH); Mental Health Services (MeSH); Mental Disorders (MeSH); Behavioral Symptoms (MeSH);

Adolescent Psychiatry (MeSH); mental health*; mental health* service*; mental disorder*; behavi* symptom*; adolesc* psychiatry*; Cognit* Behavi* Therap*; CBT; Dialecti* Behavi* Therap*; DBT; mood* track*; mood* chart*; mood* monitor*; emotion* regulat*; mental health assess*; mental health manag*

Group 3:

Adolescent (MeSH); asolescen*; youth*; young adult*