

16 Digital Media Interventions for Adolescent Mental Health

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The majority of mental health problems first emerge during the adolescent years (Kessler et al., 2005). Thus, adolescence is a critical developmental window for both mental health prevention and intervention. Despite improvements in our understanding and ability to detect and treat youth mental health problems, there remains a persistent need for mental health services among youth, with the majority of youth untreated (Cummings et al., 2013; Merikangas et al., 2011). Among youth who do get treatment, there is often a long gap between the onset of symptoms and when youth first receive treatment (de Girolamo et al., 2012), as well as low treatment attendance and completion in this population. As rates of mental health problems such as depression and suicidality continue to rise during adolescence (Centers for Disease Control, 2018), the gap between those who need and receive mental health services will only continue to grow.

In this chapter, we review the potential for technology to advance our understanding and treatment of mental health problems among adolescents through digital mental health interventions (DMHIs). We first discuss existing barriers to mental health care among adolescents, followed by a discussion of how DMHIs can address these barriers to improve access to and quality of adolescent mental health services. We then review existing research on DMHIs and the digital frameworks that are used to collect and deliver psychoeducation, assessment, and interventions across different hardware (e.g., smartphones, computers) and modalities (e.g., online, text, apps). Finally, we conclude with a discussion of the current limitations of DMHIs and key directions for the field to improve adolescent mental health care using DMHIs.

Barriers to Existing Mental Health Services

Significant, and often systemic, barriers interfere with access and delivery of mental health services for adolescents, including barriers related to cost, geographic proximity, and time, among others. These barriers often

We would like to thank Woanjun Lee, BA for his contributions to the tables for this chapter. Jessica L. Hamilton was supported by funding from the National Institute of Mental Health (K01MH121584; L30MH117642).

result in long waitlists and travel times, as well as a shortage of professionals providing evidence-based care (Andrilla et al., 2018), particularly those who are trained to work with youth (American Psychological Association, 2016). Access to treatment is especially challenging for youth in rural regions (Andrilla et al., 2018) and for adolescents who are racial, ethnic, sexual, and/or gender minorities. These youth often face additional barriers to receive culturally sensitive care (Alegria et al., 2010). Inadequate education about mental illness, distrust of medical providers, and stigma about help-seeking behaviors (i.e., internalizing stigma) and mental health care (i.e., treatment stigma) also prevent adolescents from seeking help (Clement et al., 2015; Gulliver et al., 2010). Teens also often lack awareness and understanding of their symptoms as clinically significant, are uneducated about their treatment options, or are hesitant to share their symptoms with parents or other adults (Gulliver et al., 2010). Even when youth do access mental health care, treatment completion and compliance are often low due to these persistent barriers (e.g., cost, time, transportation, stigma). Thus, there is a critical need for services that are scalable, accessible, and developmentally appropriate for the prevention and intervention of adolescent mental health problems.

Potential Benefits of Digital Mental Health Interventions for Adolescents

Advancing technologies offer novel opportunities to improve the detection, prevention, and treatment of mental health problems. DMHIs have the potential to revolutionize mental health care by providing effective, accessible, scalable, and low-cost interventions. While adolescents are at heightened risk for mental health problems, they also may be uniquely positioned to benefit from DMHIs and novel digital tools (Wong et al., 2020).

DMHIs can overcome many of the aforementioned systemic and individual barriers for youth (e.g., availability, cost, transportation, stigma). There are several factors that suggest DMHIs may be promising for adolescent mental health care. First, certain technologies to deliver DMHIs are already widely in use. For example, smartphones have become nearly ubiquitous among youth, with over 95% of teens owning these regardless of gender, race/ethnicity, or sexual identity (Anderson & Jiang, 2018). Second, adolescents are early adopters of many digital technologies. They report high levels of comfort with and preference for online communication, particularly when discussing mental health (Bradford & Rickwood, 2015). Thus, DMHIs also promote help-seeking behaviors and can serve as a “gateway” to initiating mental health care (Kauer et al., 2014). Third, adolescents also commonly use the Internet for mental health information (Leanza & Alani, 2020; Park & Kwon, 2018), which is especially the case for adolescents who identify as racial/ethnic minorities or have parents that are less health literate (Park & Kwon, 2018).

Finally, as the first point of entry for many adolescents, DMHIs can facilitate treatment by reducing uncertainty about interactions with providers and ambiguity about treatment options (Boydell et al., 2014). Rather than being a passive participant, teens can gain a newfound understanding and agency over their mental health, which may promote treatment seeking and engagement.

Further, while stigma toward help-seeking and mental health care is prominent across age groups (Sharac et al., 2010), adolescents identify stigma as one of the greatest barriers to mental health care (Gulliver et al., 2010). DMHIs can be anonymous, private, and accessible to teens at any time of the day and in any location, thereby allowing teens to access and receive mental health care in the way that is most comfortable for them (Toscos et al., 2019). In this sense, DMHIs can reach diverse groups of adolescents efficiently by connecting with teens where they are (online) and in the digital spaces where they feel most comfortable. DMHIs have the potential to not only reduce the gap in mental health services and delivery, but also reduce mental health disparities that exist across youth who are marginalized or undeserved (Schueller et al., 2019). DMHIs can provide readily available, reliable, and accurate mental health information to adolescents, particularly youth who are traditionally underserved in mental health care. DMHIs may also be more readily adaptable or translated into other languages, which may help with the limited availability of multilingual mental health professionals. However, inequities in access to technology may actually create a digital divide in who has access to DMHIs (Odgers & Jensen, 2020). By collecting and delivering content in real time and in real-world contexts, DMHIs have the potential to inform and deliver timely, flexible, and personalized mental health care, thereby improving detection and treatment of mental health problems across risk stages and demographics (Price et al., 2014).

Modes of Delivery for Digital Health Interventions

As technology evolves, an abundance of novel digital platforms and tools have been developed to improve mental health among youth and adults. DMHIs provide online services for interventions through various hardware (e.g., computer, phone, tablet, wearable) and modalities. These modalities include online/web-based interventions, video conferencing, text messaging, smartphone applications (“apps”), social media sites, game-based approaches (e.g., “serious games”) (Lister et al., 2014), virtual reality, as well as emerging technologies like passive sensing (e.g., wearables, digital phenotyping) and artificial intelligence (e.g., chatbots). Yet, technology has far outpaced research on DMHIs. Most work examining DMHIs is heavily skewed toward modalities that have existed longer (e.g., telehealth, online/web-based interventions). Newer modalities of delivering mental health services, such as

Table 16.1 *Suggested readings for understanding DMHIs' effectiveness, implementation, and future directions*

Overall Reviews of DMHIs for Children and Adolescents	
Boydell et al., 2014	Scoping review of 126 studies on the use of technology (teleconferencing, telephone, internet, email, SMS/mobile phone, CD-ROM) to deliver mental health services to children and youth
Clarke et al., 2015	Systematic review of 28 studies on the effectiveness of online mental health promotion and prevention interventions, such as web-based support, for youth (12–25 years old)
Hollis et al., 2017	Meta review of 21 review articles and systematic review of 30 empirical articles on DMHIs (computer assisted therapy, smartphone apps, and wearable technologies) for youth mental health treatment across disorders (e.g., ADHD, autism, anxiety, depression)
Punukollu & Marques, 2019	Review of 4 studies of online mobile-based apps in the detection, management, and maintenance of youth mental health concerns
Reviews on DMHI Implementation and Dissemination	
Wozney et al., 2018	Review of DMHI implementation for anxiety disorders and depression in youth
Garrido et al., 2019	Systematic review, thematic analysis, narrative synthesis, and meta-analysis of DMHIs and their effectiveness in youth with depression and anxiety
Liverpool et al., 2020	Systematic review of 6 modes of DMHI for children and youth (websites, games/computer assisted programs, apps, robots and digital device, virtual reality, and text messages) and intervention-specific and person-specific barriers and facilitators to their implementation
Additional Articles for Understanding DMHIs for Youth and for Underserved Groups	
Schueller et al., 2019	Review of current DMHIs (smartphone apps, text messages, social media) for use in undeserved populations (e.g., individuals who are ethnic, racial, gender, or sexual minorities, live in rural areas, or are experiencing homelessness)
Wong et al., 2020	Affordances-based framework for understanding engagement in DMHIs in the context of adolescent development

Note: Full references are available in the References section.

mobile health (e.g., text messaging, apps), wearables, or games, are still in the earlier phases of testing for treatment effectiveness with youth. Nevertheless, given their promise for reducing the burden of mental health problems in adolescents, the field is rapidly expanding to empirically evaluate DMHIs for adolescent mental health problems. Below, we briefly discuss the potential benefits and effectiveness of a range of specific DMHI modes of delivery. Table 16.1 provides a review of suggested readings about DMHIs' effectiveness and implementation. Later in this chapter, we will discuss potential challenges of these technologies for mental health interventions.

Videoconferencing

Telehealth services (e.g., telephone and videoconferencing) most closely mirror traditional face-to-face assessment and treatment delivery, and also offer new opportunities. Videoconferencing provides synchronous communication between patients and providers, with the increased convenience for patients of eliminating travel. Being in one's natural environment has the potential to improve ecological validity of both assessment and treatment for youth with certain mental health problems (e.g., depression, psychosis, anxiety) compared to traditional treatment in an office or hospital setting. Specifically, videoconferencing may allow the clinician to observe the home environment to better assess a teen's home or provide opportunities to participate in more naturalistic exposures. Therapy conducted using videoconferencing has received empirical support to effectively treat a range of youth mental health problems (Myers et al., 2007, 2008; Nelson et al., 2017). Videoconferencing is now relatively common and accepted in mental health care among professionals, youth, and their caregivers (Boydell et al., 2014). Following the physical distancing practices of the COVID-19 pandemic (Gruber et al., 2021), videoconferencing will likely continue to increase in its use and acceptability as a means of providing mental health care to youth. Despite its more common use in mental health care compared to other DMHIs, empirical research is still underway to provide guidance for the use of videoconferencing (Nelson et al., 2017), including how to ethically navigate patient boundaries in their homes, which will be critical for delivering care using this modality.

Online/Web-Based Interventions

Online or web-based platforms can provide a myriad of services. This includes: access to comprehensive mental health information (e.g., blogs, websites); scalable, affordable, and effective interventions to youth and their families for mental health problems; and translation of existing evidence-based treatments into computerized or online lessons, modules, or sessions accompanied by homework or tasks, among others. Systematic and meta-analytic reviews of randomized control trials (RCTs) support the effectiveness of online/web-based services for treating adolescent mental health problems (Clarke et al., 2015; Hollis et al., 2017). Most studies have been conducted with youth with subclinical or clinical levels of depression and anxiety (Grist et al., 2019; Khanna et al., 2017). To date, online interventions for these clinical problems have garnered the most support. Most online or web-based interventions are based on cognitive behavioral therapy (CBT) (Ebert et al., 2015). The majority of computerized and internet-based CBT programs were found to be of moderate to high quality (Clarke et al., 2015; Wozney et al., 2018). These programs included components of self-monitoring, interactive

content (e.g., videos, characters storytelling, games), and both online and offline support. However, online programs now include other treatment modalities and approaches for targeting youth mental health problems (Garrido et al., 2019), such as positive psychology, mindfulness (Ritvo et al., 2019), and problem-solving (Hoek et al., 2012).

Importantly, there is a need to better understand the level of human interaction (if any) needed for online or web-based interventions to be effective with youth mental health treatment, especially to counter low rates of engagement and adherence. Most online or web-based interventions are therapist-assisted, including a virtual or online therapist or to supplement in-person and face-to-face clinician visits. Meta-analytic reviews suggest online interventions that included therapists or clinicians performed better in reducing depression and anxiety symptoms than interventions that were self-guided (Clarke et al., 2015; Hollis et al., 2017). Indeed, some research suggests that self-guided online or web-based interventions were not effective for youth depression (Garrido et al., 2019). Alternatively, some studies indicate that minimal therapist involvement was better for youth anxiety than significant or more extensive therapist involvement (Podina et al., 2016).

Some of the largest barriers for self-guided online treatments for adolescents are low rates of treatment completion and adherence (Clarke et al., 2015; Garrido et al., 2019). To address these concerns, low-intensity web-based interventions have been developed to deliver skill-based interventions in single sessions (Schleider & Weisz, 2018). Self-administered online single-session interventions have demonstrated effectiveness in reducing adolescent depressive symptoms, as well as other core characteristics of depression (e.g., low perceived agency, self-worth, and hopelessness; Schleider & Weisz, 2018; Schleider, Dobias, Sung, & Mullarkey, 2020). One recent trial found that online single-session interventions demonstrate effectiveness in natural settings and also reach a large number of adolescents with one or more marginalized identities (Schleider, Dobias, Sung, Mumper, & Mullarkey, 2020). Thus, online single-session interventions may offer brief, low-intensity, accessible, and scalable mental health interventions for youth who may otherwise not engage in care, possibly serving as tools for universal or indicated prevention or during transitional periods of more intensive care. More research and diversification of these online brief interventions (e.g., length, type) is needed to evaluate the setting and context in which they are most effective (Schleider, Dobias, Sung, Mumper, & Mullarkey, 2020). Further, a recent RCT tested the effectiveness of a web-based decision aid to support young people in help-seeking for their self-harm (Rowe et al., 2018). Youth generally reported the online decision aid to be acceptable, easy to use, and informative for seeking help, which suggests another way in which online or web-based interventions can promote adolescent mental health.

Text Messaging

Text messaging can also be an affordable and effective way of providing interventions, monitoring symptoms, or prompting adolescents to engage in behaviors to promote mental health, such as coping skills during crisis. This type of platform can prompt adolescents to employ skills, as well as provide automated reminders for appointments and medication to improve treatment attendance (Branson et al., 2013). Texts can be personalized and tailored to the adolescent based on their needs and preferences by altering the message frequency, content, and customized interactions. Text-based services may be an especially accessible DMHI. Nearly all youth have mobile phones and smartphones and text messaging does not require internet for delivery. Further, text messaging interventions are not at risk for deletion, which is common for smartphone apps (Baumel et al., 2019), as text capabilities are embedded in phones. Text messaging interventions also may have lower upfront costs for development compared to apps that need to be adapted and delivered for both iOS and Android platforms. Importantly, there is some support for the effectiveness of text interventions for treating youth health problems (Loescher et al., 2018), including substance use and depression (Mason et al., 2015; Whitton et al., 2015). Further, a recent text messaging intervention also improved the mental health literacy of parents of adolescents (Chu et al., 2019), which may subsequently improve mental health care for teens by reducing one potential barrier to treatment.

Smartphone Apps

The widespread ownership of mobile phones, particularly smartphones, provides unparalleled and unobtrusive access to adolescents in real time and in the “real world” to deliver scalable and low-cost mental health interventions. Current mental health apps can serve multiple purposes, including for psychoeducation, monitoring symptoms or behaviors, providing “just in time” or ecological momentary interventions, and as adjunctive or stand-alone treatments. There are many potential benefits to using apps to engage youth in mental health services, including heightened sense of privacy, accessibility, convenience, and integration in daily life. Importantly, apps can be more personalized and tailored to the individual, and can provide more developmentally appropriate and interactive material that engages adolescents (Bakker et al., 2016). For some youth, the very act of mental health monitoring may be beneficial in improving symptoms (Kauer et al., 2012), which can be delivered in a user-friendly manner and can be used as a preventive measure or adjunct to treatment. Monitoring apps that serve as an adjunct to treatment may increase engagement among youth, allowing adolescents to have an increased awareness and sense of agency over their own behavior and mental

health symptoms. However, most monitoring apps available for download have received limited empirical support. In general, relatively few apps have been empirically tested to determine their effectiveness in treating youth mental health problems (Melbye et al., 2020; Punukollu & Marques, 2019).

Although research is limited, apps designed to supplement other mental health treatment and aid care between sessions have demonstrated effectiveness, particularly for youth anxiety (Carper, 2017; Pramana et al., 2014; Silk et al., 2020). These apps enhance treatment exposures and skills-based practice, homework compliance, and symptom tracking between sessions. Apps also have the potential to provide adolescents with “just in time” adaptive interventions that are low-intensity and high-impact and when they most need it most, such as times of crisis. Indeed, specific suicide prevention apps have been developed (Martinengo et al., 2019), with preliminary evidence of positive treatment effects (Arshad et al., 2020). While not encouraged to be stand-alone treatments, digital safety planning and tools (Kennard et al., 2015, 2018) may help adolescents at risk for suicide while youth are in crisis or during high-risk periods by addressing the gap between hospital discharge and outpatient treatment.

Most evidence-based apps developed by researchers are not yet commercially available (Punukollu & Marques, 2019). In contrast, there are tens of thousands of commercially available apps for mental health, highlighting the large divide between apps developed for commercial use compared to those developed by researchers. Few of these available apps have been tested for effectiveness and most popular apps do not include therapeutic elements (Wasil et al., 2019), though empirical evaluation is currently underway for some commercial apps (Bry et al., 2018). There is also very little regulatory oversight of apps and limited available high-quality information on the effectiveness of commercially available apps (Boudreaux et al., 2014). This can leave adolescents vulnerable to mental health misinformation or using DMHIs that offer little therapeutic benefits (and some that could be harmful). Given that adolescents report difficulty distinguishing accurate from inaccurate information sources (Park & Kwon, 2018), user guidance is needed to inform teens, parents, and providers (Palmer & Burrows, 2021). There are several resources available that provide quantitative feedback, rubrics, and recommendations about mobile apps (Table 16.2). However, teens would likely benefit from a readily available tool, available in app stores, to provide information to them on which apps are research-based (Lagan et al., 2020) in a developmentally appropriate manner.

Game-Based Interventions

Another promising domain of DMHIs is video games, which includes those that are entirely focused on mental health (e.g., “serious games” or “mental health games”) and components of video games added to DMHIs for

Table 16.2 *Resources for evaluating mental health apps*

Resource	Description	Link
<i>PsyberGuide</i>	Comprehensive collection of reviews and ratings of various apps for mental health. Users can use filters to search through a list of apps.	onemindpsyberguide.org
<i>M-Health Index and Navigation Database (MIND)</i>	Searchable database of various apps for mental health that have been reviewed by trained app reviewers. Uses principles of the American Psychiatric Association's App Evaluation Model.	https://apps.digitalpsych.org/
<i>Mobile App Rating Scale (MARS)</i>	Multidimensional measure for classifying and assessing the quality of mobile health apps.	dx.doi.org/10.2196/mhealth.3422
<i>ENLIGHT</i>	Comprehensive suite of measures to evaluate mHealth interventions.	dx.doi.org/10.2196/jmir.7270
Professional Psychological Organizations		
<i>ABCT</i>	Expert reviews of multimedia resources for mental health published online and quarterly journal: <i>Cognitive and Behavioral Practice</i> .	abct.org
<i>ADAA</i>	List of apps that have been reviewed by ADAA members over the years.	adaa.org
<i>APA</i>	List of apps and websites that may be helpful for improving mental health. Aimed primarily at clinicians.	apa.org

Notes: ABCT = Association for Behavioral and Cognitive Therapies; ADAA = Anxiety and Depression Association of America; APA = American Psychological Association. Links are directed to the main organization website.

“gamification” of mental health (Fleming et al., 2016). With the components inherent in video games (e.g., levels, challenges, rewards), video games facilitate intrinsic motivation to incentivize adolescent engagement and adherence. Games have the potential to facilitate specific skills that also promote mental health and even improve treatment uptake, such as learning, memory, and coping skills. Games are also highly popular among adolescents (Rideout & Robb, 2019), which may encourage adolescent engagement. Video games can be played on familiar, low-cost platforms that are already integrated into the lives of youth (e.g., smartphones, web browsers, game systems, computers, etc). This may make these DMHIs more easily accessible compared to other cutting-edge platforms (e.g., virtual reality). Many research-based video games are still only available on computers, but gamification of mobile apps or other DMHIs offer promise (Lister et al., 2014).

The majority of research on video games has been conducted on internalizing disorders and demonstrated some effectiveness (Lau et al., 2016; Li et al., 2014), especially in conjunction with other treatments (Merry et al., 2012; Schoneveld et al., 2018). Studies indicate that video games may be especially effective at increasing motivation, teaching cognitive restructuring, imparting relaxation techniques, and providing psychoeducation to ameliorate these types of disorders (Knox et al., 2011; Pramana et al., 2014). These rewarding elements (e.g., levels, positive feedback) also draw on adolescents' cognitive and motivational development (Somerville & Casey, 2010), which may motivate adolescents to participate and engage in treatment. Some recent programs also integrate biofeedback techniques to teach breathing, meditation, and relaxation exercises (Pramana et al., 2014). The use of avatars in gaming also provide a higher level of personalization and engagement, as well as reduce stigma toward mental health (Ferchaud et al., 2020). Personalization may also have the potential to aid youth in identity development, as teens can experiment with different ways of presenting themselves. This may be particularly important for youth who identify as sexual and/or gender minorities, providing safe spaces to anonymously explore and discuss difficult topics related to their identities and mental health (DeHaan et al., 2013). Video games and gamification may be particularly compelling for adolescents with autism spectrum disorder (ASD) or those with attention deficit-hyperactivity disorder (ADHD) due to the existing popularity of video games in these populations (Yerys et al., 2019). Future RCTs and reviews are needed to fully capture the benefits and evaluate the effectiveness of gaming for adolescent mental health.

Virtual and Augmented Realities

Virtual and augmented realities create new opportunities for delivering and enhancing treatments. Virtual reality provides an immersive experience that virtually transports individuals into a real or imaged physical environment. In contrast, augmented realities overlay image and video content on top of reality, enhancing a person's in-person physical environment. Virtual and augmented realities can deliver services in an interactive manner while still remaining under the control of the adolescent and provider (Li et al., 2017). Virtual and augmented reality may be promising for youth with ASD (Berenguer et al., 2020; Vahabzadeh et al., 2018) and for youth with anxiety disorders (Barnes & Prescott, 2018), where sensory input can be tailored to the individual need. For example, virtual realities can simulate experiences found in everyday life or expose youth to fears or situations that may not otherwise be possible in daily life (e.g., fear of flying) or the clinical setting (e.g., public speaking in large crowds). Augmented realities can further extend youth's natural environment to simulate real-world experiences, such as specific phobias (e.g., spiders) and social interactions with peers. To date, virtual reality is more regularly used and examined with adults (Cieslik et al., 2020);

there is still limited empirical support on the effectiveness of virtual and augmented realities for youth mental health treatment (Grist et al., 2019). Despite its initial development nearly two decades ago, there continues to be a lag in the adoption of virtual reality for clinical interventions or in clinical practice, potentially due to its high cost and complex development. However, research may surge in virtual and augmented reality systems as they become more mobile and available on smartphones, commercially available, and as design becomes more centered on its potential clinical utility (Bell et al., 2020).

Social Media

Given the increasing presence of social media in the daily lives of adolescents, researchers have sought to employ social media as novel tools for mental illness detection, prevention, and intervention. Adolescence is a unique developmental period during which individuals are more sensitive to social feedback, peer relationships, and peer influence (Prinstein & Dodge, 2008). Social media provides adolescents with a range of social affordances, including social support, sense of belonging, and access to a network of known and unknown peers (Nesi et al., 2018). Thus, social media-based DMHIs have the power to reduce stigma, increase help-seeking behaviors, connect peers, and provide support and psychoeducation about the benefits of mental health problems (Betton et al., 2015). Social media can also connect adolescents with needed support and information that aids in treatment engagement, symptom reduction, and even as a form of suicide prevention (Robinson et al., 2016). Indeed, social media campaigns targeting mental health awareness and stigma reduction have demonstrated effectiveness in reducing stigma and increasing adolescent treatment engagement (Booth et al., 2018).

Research is still in its nascency for employing existing social media platforms to deliver interventions, with most systematic reviews identifying a need for high-quality studies examining online peer-to-peer support (Ali et al., 2015) or social networking sites (Ridout & Campbell, 2018). Thus far, social media-based interventions that include social networking or peer support components have been found to be acceptable, feasible, and safe for youth across a range of mental health problems (Ridout & Campbell, 2018), including depression (Radovic et al., 2018; Rice et al., 2014) and first-episode psychosis (Alvarez-Jimenez et al., 2013; McEnery et al., 2021). These interventions are professionally mediated to ensure networks remain supportive and informational, while also training some youth to be leaders in these peer networks.

Emerging Digital Tools

There are several new and emerging digital tools, such as passive sensing and artificial intelligence, that may further revolutionize how and in what ways

DMHIs promote adolescent mental health. One exciting avenue for DMHIs is the use of passive sensing from wearables or digital phenotyping of individuals' online or mobile footprints. With the integration of passive sensors from smartphones or wearables, ecological momentary interventions can be developed that provide just-in-time and adaptive treatments (Russell & Gajos, 2020). As smartphones are nearly always with adolescents (Anderson & Jiang, 2018), the rich data collected by smartphone sensors can yield information about location, activity levels, light exposure, social networking activity, and social connection (e.g., calls/messages). This information can be synthesized into clinically meaningful metrics of sleep, physical activity, emotional distress, and upstream clinical presentations (Huckvale et al., 2019; Vaidyam et al., 2019). This field is rapidly evolving for youth (Russell & Gajos, 2020), particularly to address the rising mental health concerns and suicide crisis in this population (Allen et al., 2019; Torous, Larsen, et al., 2018). To date, few apps have been developed that operationalize digital phenotyping data in actual interventions (Wong et al., 2020), though some are currently being developed and tested.

Artificial intelligence has also progressed in recent years, including the development of fully automated conversational agents (e.g., chatbots). Chatbots are able to process text and emojis entered by a participant and provide personalized responses that aim to mimic human conversation. Unlike other DMHIs that are fully automated, chatbots offer a level of direct and synchronous interaction that may motivate users to continue participation and even provide empathic support (Morris et al., 2018). Chatbots can provide daily check-ins for participants' symptoms and behaviors. They can also be readily integrated with other passive sensing metrics to increase awareness and individualization. Since some individuals are more willing to disclose to a machine than other individuals (Lucas et al., 2014), chatbots can serve as moderators or agents when real human interactions are not available. While preliminary studies indicate symptom reduction for adults with the use of chatbots (Fitzpatrick et al., 2017), particularly for psychoeducation and self-guided treatment, there is still much work needed to understand the risks and benefits of using this mode of delivery for DMHIs (Vaidyam et al., 2019). Nevertheless, integrating components of artificial intelligence like chatbots into other DMHIs may enhance connectedness and engagement in care for adolescents.

Challenges and Future Directions to Digital Mental Health Research and Treatment

Although DMHIs demonstrate great potential for delivering scalable and low-cost mental health services to adolescents, many obstacles remain. Simply stated, there is a significant divide between research and technology

development. Commercially available technology is far outpacing research on the effectiveness and implementation of DMHIs for youth, as well as the enforcement of data privacy and security measures. The scalability of DMHIs also remains in question to determine whether these tools are actually as cost-effective, accessible, and effective in reaching underserved youth as initially promised. This section outlines the current challenges of the field and critical directions for growth to improve our understanding and use of DMHIs for adolescent mental health care.

Effectiveness of DMHIs: For Whom and in What Contexts?

There is a dearth of research investigating the effectiveness of DMHIs across modalities in adolescents, particularly newer and currently popular modes of delivery (e.g., smartphone apps). While most research has been conducted on web-based/online interventions, more rigorous research is needed to examine the effectiveness of DMHIs delivered via mobile applications, social media, and gaming platforms. These DMHI modalities represent areas of potential high engagement for teens. To date, most research also has focused on DMHIs for youth depression and anxiety. High-quality research is needed to examine DMHIs for specific mental health conditions beyond internalizing disorders (Hollis et al., 2017), such as youth with ASD (Yerys et al., 2019), psychosis (Reilly et al., 2019), and eating disorders (Loucas et al., 2014). Most research is also limited to short-term outcomes, and research on the long-term effects of DMHIs is needed. It also is critical to understand which youth may benefit from DMHIs and in what contexts, such as different stages of clinical severity or treatment progression. For instance, certain modalities may be most appropriate as a gateway to care, during waitlist or transitions to care, or “booster” sessions to supplement prior treatment and prevent relapse. Certain DMHI modalities also may pair better with certain conditions, such as using virtual or augmented realities with youth who have ASD and ADHD (Yerys et al., 2019). While there are concerns noted about using DMHIs clinically with high-risk adolescents (Palmer & Burrows, 2021), recent research suggests DMHIs may be effective in reducing suicidality (Hetrick et al., 2017) and for use in screening, prevention, and intervention with psychosis (Reilly et al., 2019). This research points to the potential utility of DMHIs for higher-risk adolescents as well. However, research would benefit from more systematic examination of how the effectiveness of DMHIs varies across clinical presentations, symptoms, and severity. Research is also needed to evaluate effectiveness of DMHIs by intervention stage (e.g., prevention, intervention) and type (e.g., skill building, CBT, exposure). Further, the active ingredients of DMHIs and fidelity to evidence-based approaches remain to be specified (Hollis et al., 2017). More details about DMHI design and implementation would help isolate the most effective elements, such as short motivational messages, gamification features, or symptom monitoring (Whitton et al., 2015). Research on

the dose of clinical/human interaction needed (if at all) to engage and treat adolescents also is imperative, particularly since level of clinician involvement affects both cost-effectiveness and scalability.

Gap between Research and Commercial Technology

The fast pace at which technology is developed presents a major obstacle for the academic and research community. In contrast to commercial technology, research is typically produced at a much slower pace. RCTs are the “gold-standard” approach for determining efficacy and effectiveness. However, RCTs can take 5–7 years from initiation to dissemination (Hollis et al., 2017), and even longer for broader implementation. This length of time may render a DMHI modality irrelevant by the time it is deemed effective. Timing may be particularly important to consider in the context of DMHI research for adolescents, who rapidly adopt new platforms and technology. DMHIs that are specific to a single platform or modality may quickly become obsolete or outgrow their functionality. For instance, text-based interventions may be effective, but it remains unclear to what extent teens will use texting platforms as social media messaging continues to become more common. Thus, revised or alternate approaches to developing and testing DMHIs are needed that balance the need for rigorous testing with the need for evaluations that are timely and relevant (Murray et al., 2016; Pham et al., 2016). One such approach may be reducing the need for reevaluation for revised iterations of DMHIs that do not alter the core therapeutic principles (Torous et al., 2019). Another option to bridge the research-commercial gap is to partner with existing apps that are already popular with teens and test their effectiveness or incorporate evidence-based approaches as needed. This may be a particularly effective method given that teens report that brand familiarity helps with app engagement (Liverpool et al., 2020). Furthermore, systematic and consensus guidelines on DMHIs are needed (Torous et al., 2019), which may help close the gap between commercial and research digital tools and ensure high-quality mental health services for adolescents.

Privacy and Security

One major challenge at the forefront of DMHI research is the privacy and safety of digital spaces (Wong et al., 2020). Indeed, most teens are unaware of who has access to their data or how it is being used. Teen privacy and data security present concerns for providers with recommending or implementing DMHIs with adolescents. While privacy policies may exist for some apps, a recent review of apps targeting teens found that most data privacy statements were written at or above a 12th-grade reading level (Das et al., 2018), which is problematic for adolescents and their parents. Without knowing how their data will be used, adolescents may agree to have their private information sold

and marketed to third-party companies. Violations of teens' privacy directly conflict with adolescents' strong preference for mental health privacy in engagement with DMHIs (Park & Kwon, 2018). Uncertainty regarding teens' data privacy also presents ethical concerns for clinicians in recommending or using commercially available digital tools with patients (Kerst et al., 2020; Palmer & Burrows, 2021). Thus, it is critical that researchers take special consideration in ensuring that adolescents are aware of how their digital data will be stored and secured (Torous, 2019). One potential avenue for addressing these concerns could be increasing digital health literacy among adolescents, such as through school-based curricula in childhood and throughout adolescence (see Chapter 15 of this volume). Directly addressing digital mental health literacy with teens may help them navigate the overabundance of digital tools and select DMHIs that are private, safe, and from reliable sources (Park & Kwon, 2018). However, it is also important for researchers to take a more active role in disseminating tools (Lagan et al., 2020) or advocating for policies that will aid teens, providers, and parents in understanding and identifying evidence-based DMHIs as they develop. Research on whether these approaches improve teens' perceived and actual privacy, as well as the reach and engagement of DMHIs, would further inform future directions in this area.

Youth-Centered DMHIs

Most DMHIs are plagued by low rates of adherence from participants (Fleming et al., 2018; Hollis et al., 2017). Programs that are self-guided or that include minimal human (especially clinician) contact suffer the most from low engagement across modalities compared to interventions that include more human and clinician contact. Indeed, most teens stop using mental health apps within days to weeks (Baumel et al., 2019), do not complete all modules of online interventions (Christensen et al., 2009), and do not use video games created by researchers in their daily lives (Fleming et al., 2018). This suggests a large difference between clinical trials in which adolescents are incentivized, which still struggle from lower adherence rates (Clarke et al., 2015), and real-world application.

While there are many factors that contribute to adolescents' poor engagement in DMHIs (Torous, Nicholas, et al., 2018), poor usability and the absence of adolescent-specific design may be key components. Collaborating with experts across disciplines (e.g., design, engineering) is critical in designing DMHIs that are more user-friendly and that integrate components well-received by adolescents, such as the inclusion of graphics, video, personalization, and elements that facilitate social connection (Liverpool et al., 2020). Adolescents' input and preferences, particularly from those with lived experience of mental illness, are especially important in the development of DMHIs (Scholten & Granic, 2019). Furthermore, leveraging developmental science to

inform the development, design, and implementation of DMHIs may be particularly effective for adolescents (Giovannelli et al., 2020). For instance, adolescents are highly sensitive to social contexts and, perhaps unsurprisingly, DMHIs that are conducted without any provider interaction are less effective (Hollis et al., 2017). Though social media interventions hold particular promise, there are major challenges for developing DMHIs via social media (Pagoto et al., 2016). For instance there is a need to adapt content to fit specific social media platforms and to stay abreast of evolving norms of the targeted population (Pagoto et al., 2016). This is particularly challenging for teens given the relatively quick adoption and extinction of platforms and norms, which suggests that DMHIs using social media may be best developed across platforms rather than relying on a single medium. However, researchers should also consider the unique affordances of social media, including its social, cognitive, identity, and emotional affordances, in designing mental health interventions for social media that best fit the needs and goals of targeted youth (Moreno & D'Angelo, 2019). However, research is needed to examine the affordances of DMHIs that are most important to adolescents (Wong et al., 2020).

Scalability of DMHIs

Relatedly, research on the scalability and implementation of DMHIs in real-world contexts is sorely needed (Liverpool et al., 2020). Most research has focused on acceptability, adoption, and appropriateness, but the cost and sustainability of DMHIs remain understudied (Wozney et al., 2018). Although there is potential for improving mental health outcomes for adolescents, DMHIs are still not widely employed in clinical practice or within health systems. Thus, research efforts should assess both provider and patient acceptability and intention to use DMHIs. It is also critical to address potential barriers to their implementation, such as comfort level, privacy, and safety concerns (Kerst et al., 2020). Further, the costs of development and maintenance for DMHIs, including long-term maintenance (Hollis et al., 2017), is important for scalability and integration in clinical care (Liverpool et al., 2020). One approach to overcoming barriers in long-term maintenance DMHIs is to increase the use of open-access methods and resource-sharing to ensure DMHIs are accessible and free. Using open-access methods might also increase the reach of DMHIs to underserved populations. Interdisciplinary research teams that include various stakeholders may be most effective in troubleshooting these barriers and improving the implementation and scalability of DMHIs (Torous et al., 2019; Torous, Wisniewski, et al., 2018). Thus, research and development of DMHIs should collaborate across disciplines, including medicine, computer science, engineering, public health, schools, education, policy-makers, and clinical care. Most, importantly, adolescents and their families should play an integral part in improving the scalability of DMHIs.

Culturally Sensitive and Equitable DMHIs

While DMHIs may be able to reduce health disparities through their reach and accessibility, it is important to develop and implement interventions that are equitable and inclusive, and that engage diverse communities in DMHI design and implementation. For instance, most research with DMHIs in youth has been done in developed countries, and consequently, there is much less access to DMHIs in lower- and middle-income countries (Liverpool et al., 2020). Even within developed countries, disparities exist both in access to high-quality mental health services and for adolescents who are racial, ethnic, sexual, or gender minorities. There is a dire need to customize interventions to these minority and historically underserved populations (Schueller et al., 2019). Yet, it is critical that DMHIs engage in participatory designs that reflect the diverse and evolving needs of these populations (Schueller et al., 2019), as some online resources may inadvertently increase feelings of marginalization and misinformation (Steinke et al., 2017). For instance, DMHIs that “group together” all sexual and gender minority youth or all Latinx/Hispanic youth may further alienate individuals from mental health services given the large heterogeneity that exists within these populations (Schueller et al., 2019; Steinke et al., 2017). Further, few to no DMHIs have been specifically designed or implemented that target the unique needs of youth with marginalized and intersecting identities. Thus, DMHIs may have the potential to increase access and delivery of equitable and effective mental health services to youth across demographics; however, research on culturally sensitive DMHIs remains a high-priority area.

Double-Edged Sword of Digital Media

There is a potential irony in using DMHIs with adolescents amid general concerns about adolescents’ use of and reliance on digital technology. Using DMHIs for mental health may be especially concerning for youth who may use or experience digital media in ways that further exacerbate their symptoms (Radovic et al., 2017). Thus, a critical future direction will be the development and tailoring of interventions or programs that help youth, particularly those with mental illness, use digital media in a way that promotes mental health. One such example is #chatsafe, which is an international program that helps teens communicate safely online with others about suicide (Robinson et al., 2018). Preliminary results suggest that individuals who participated in #chatsafe felt better equipped to communicate safely about suicide online, as well as to identify and support others who may be at risk for suicide (Robinson et al., 2020; Thorn et al., 2020). To date, there is still limited research on interventions that target media use and behaviors among youth with mental health problems. However, there are several emerging interventions that use mindfulness (Weaver & Swank, 2019) and daily reflection (Hou et al., 2019) as

a means to improve mindless scrolling and reduce unwanted use. Further, a recent values-alignment intervention focused on adolescents' own motivations to self-regulate their social media use (Galla et al., 2021), finding that adolescents who participated in the intervention experienced more motivation to self-regulate and independently changed their social media behaviors to be consistent with their values. Thus, it is important to consider the potential for conflicting messages regarding the risks and benefits of digital media when using DMHIs with adolescents. Further, it will be critical to continue designing and implementing interventions, offered both digitally and in other formats, that help adolescents use media in a way that promotes their mental health.

Conclusion

Given the large gap between the need and delivery of mental health services for adolescents, DMHIs have received considerable attention among researchers and providers. The current state of research with youth suggests only preliminary effectiveness of most DMHIs, with the most support for online/web-based interventions for depression and anxiety (Hollis et al., 2017). However, the field is rapidly expanding to evaluate DMHIs and to address the current challenges in research on DMHIs' effectiveness and implementation. Thus, DMHIs continue to hold great promise in delivering accessible, developmentally informed, and scalable interventions for the detection, monitoring, prevention, and treatment of adolescent mental health problems.

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