

# UC Irvine

## UC Irvine Previously Published Works

### Title

The Reach, Effectiveness, Adoption, Implementation, and Maintenance of Digital Mental Health Interventions for College Students: A Systematic Review.

### Permalink

<https://escholarship.org/uc/item/43t654rk>

### Authors

Taylor, Madison

Liu, Michelle

Abelson, Sara

et al.

### Publication Date

2024-10-11

### DOI

10.1007/s11920-024-01545-w

Peer reviewed



# The Reach, Effectiveness, Adoption, Implementation, and Maintenance of Digital Mental Health Interventions for College Students: A Systematic Review

Madison E. Taylor<sup>1</sup> · Michelle Liu<sup>1</sup> · Sara Abelson<sup>2</sup> · Daniel Eisenberg<sup>3</sup> · Sarah K. Lipson<sup>4</sup> · Stephen M. Schueller<sup>1</sup>

Accepted: 25 September 2024 / Published online: 11 October 2024  
© The Author(s) 2024

## Abstract

**Purpose of Review** We evaluated the impact of digital mental health interventions (DMHIs) for college students. We organized findings using the RE-AIM framework to include reach, effectiveness, adoption, implementation, and maintenance.

**Recent Findings** We conducted a systematic literature review of recent findings from 2019–2024. Our search identified 2,701 articles, of which 95 met inclusion criteria. In the reach domain, student samples were overwhelmingly female and White. In the effectiveness domain, over 80% of DMHIs were effective or partially effective at reducing their primary outcome. In the adoption domain, studies reported modest uptake for DMHIs. In the implementation and maintenance domains, studies reported high adherence rates to DMHI content. While recruitment methods were commonly reported, adaptations and costs of implementation and maintenance were rarely reported.

**Summary** DMHIs for college students are effective for many psychological outcomes. Future work should address diversifying samples and considering implementation in a variety of college settings.

**Keywords** College students · Mhealth · Universities · Digital mental health · Systematic review · Implementation science

## Introduction

Addressing student mental health is a major concern on college campuses. In 2023, the American College Health Association found that 45.9% of undergraduate students reported a history of at least one mental disorder diagnosis [1]. Additionally, many students experience considerable psychological distress (23.4%) and loneliness (53.3%) [1]. While college counseling centers have improved many aspects of treatment delivery (e.g., wait

times and hours of operation) to meet the demand for mental health services [2], colleges are still searching for other novel solutions. Options include contracting with third-party vendors for additional after-hours care, improving off-campus referral networks, investing in prevention and early intervention, and using digital mental health interventions (DMHIs) [3].

DMHIs are designed to teach and deliver skills to improve mental health and well-being through mobile apps, web-based programs, virtual reality (VR), wearable devices, and/or video games [4]. Although some DMHIs may include human support, either by a peer, paraprofessional, or professional, we use the term DMHI to disambiguate from the use of technology only to connect a licensed mental health provider with a client (i.e., teletherapy). DMHIs have potential to be a useful treatment option on college campuses. The asynchronous format and self-guided nature of many DMHIs can provide increased flexibility for students with hectic schedules, who see lack of time as a barrier to treatment [5]. Likewise, DMHIs may be easily deployed and scaled across college campuses [3], as students receive many resources online. Meta-analyses of randomized control trials (RCTs) of DMHIs among college students have found them to be effective with small to moderate effect sizes ( $d=0.52$ ) [6].

✉ Madison E. Taylor  
madisoet@uci.edu

<sup>1</sup> Department of Psychological Science, University of California, 214 Pereira Dr, Irvine, CA 92617, USA

<sup>2</sup> Department of Urban Health and Population Science, Lewis Katz School of Medicine, Temple University, Philadelphia, PA, USA

<sup>3</sup> Department of Health Policy and Management, Fielding School of Public Health, University of California at Los Angeles, Los Angeles, CA, USA

<sup>4</sup> Department of Health Law, Policy, and Management, School of Public Health, Boston University, Boston, MA, USA

Despite evidence supporting the effectiveness of DMHIs for college students, several open questions remain. A seminal review conducted by Lattie and colleagues [7••] examined the effectiveness, usability, acceptability, uptake, and adoption of DMHIs on college campuses across 89 studies. They found promising evidence of effectiveness, with 80% of the studies indicating that DMHI were effective or partially effective at reducing anxiety and/or depression in college student populations [7••]. However, only half of the studies assessed factors crucial for user engagement (e.g., acceptability and usability) [7••]. Even fewer studies explored factors related to implementing and maintaining DMHIs on campuses [7••]. These findings highlighted a need to expand research from considering only effectiveness towards evaluating how to best engage, implement, and sustain DMHI use among college students [7••].

Since these reviews were published [6, 7••], the mental health landscape on college campuses has changed considerably. The COVID-19 pandemic led to unprecedented disruptions and a notable increase in student mental health concerns [8]. Simultaneously, campus closures led to a greater interest in DMHIs from administrators [8]. The George Floyd protests and increases in Anti-Asian hate crimes in 2020 also drew additional attention to the mental health needs of BIPOC students [9, 10].

The aim of this study was to provide an overview of recent insights in the field by conducting a systematic review of the literature on DMHI for college students. Given the impact of the COVID-19 pandemic and presence of other reviews, we focused our review on the period after the Lattie and colleagues [7••] review, i.e., 2019 to 2024. We organized our findings within the RE-AIM framework to better identify gaps in our knowledge that may inhibit the dissemination and implementation of DMHI on college campuses. Finally, we provide suggestions for how DMHI research for college students should expand going forward.

## Methods

### Eligibility Criteria

Studies were eligible for inclusion in the review if they were empirical studies conducted between 2019–2024 that (1) reported results on DMHIs and (2) had college or other post-secondary education students (e.g., professional and trade) as the target population. DMHIs were defined as (1) having a technology-based intervention component (e.g., web-based platforms, apps, VR) and (2) delivering these intervention components to prevent and/or treat mental health conditions or increase well-being [11]. Studies were ineligible if they were not written in English and had no English translation, their results were not DMHI-related, the target population was unclear, or they did not present empirical data.

### Database Search Strategy and Selection

To cover a variety of psychological and technology disciplines, the literature search used the PsycINFO, PubMed, and ACM Guide to Computer Learning databases. A comprehensive search strategy was developed using keywords to describe college/university students, mental health conditions (i.e., depression, anxiety, stress), technology, and digital mental health interventions (see Supplement 1 for a full list of keywords). Each database was searched from 2019 to 2024. This yielded a total of 2,701 articles. Research assistants did an initial screening of article abstracts according to eligibility criteria. The first two authors (MET and ML) reassessed the titles and abstracts for eligibility criteria. Following title and abstract screening, MET and ML independently reviewed the full-text of all articles to identify those that met inclusion criteria. Any discrepancies were identified and resolved by discussion until a consensus was reached.

### Data Synthesis

The content of eligible articles was mapped onto the RE-AIM framework [12••]. The first author (MET) developed a coding scheme based on the types of content that fall under each domain of RE-AIM (see Fig. 1). A notes category was used to code any aspects of the study found relevant but that did not fit neatly into the existing coding categories.



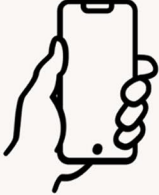


### Reach

Reach refers to the percentage and characteristics of those who receive an intervention, especially with respect to the target population [12••]. For this domain, eligible studies had the following information coded: the country where the study took place, the level of a college student (i.e., undergraduate, graduate, professional), college type (e.g., university, four-year liberal arts, community college), and sample demographics (e.g., gender/sexuality and race/ethnicity). We coded studies if they had majority ( $\geq 60\%$ ) female participants, majority ( $\geq 60\%$ ) male participants, or roughly equal female and male participants. For studies taking place in the United States and Canada, we also coded if the rates of race/ethnicity of participants matched the total enrollment rate for students of different race/ethnicities across college campuses [13].

### Effectiveness

Effectiveness refers to the impact of the program on target outcomes [12••]. In the case of DMHIs, this includes reductions in or prevention of mental disorder symptoms

# RE-AIM APPLIED TO COLLEGE STUDENT DMHI

 <p>Created by Sri Dewi from Noun Project</p>	<p><b>REACH</b></p> <p>The representativeness of college students willing to participate in the DMHI relative to the larger student population. Categories relevant to this domain include:</p> <ul style="list-style-type: none"> <li>• Location of study (e.g., country, college type)</li> <li>• Student level (e.g., undergraduate, graduate)</li> <li>• Demographics of participating students (e.g., gender, race/ethnicity, LGBTQ+)</li> <li>• Subgroups of students targeted (e.g., healthcare students, first-generation)</li> </ul>
	<p><b>EFFECTIVENESS</b></p> <p>The impact of the DMHI on outcomes of interest. Categories relevant to this domain include:</p> <ul style="list-style-type: none"> <li>• Study designs used for evaluation of effectiveness</li> <li>• Intervention characteristics (e.g., name, delivery format, therapeutic techniques)</li> <li>• Impact on psychological outcomes (e.g., symptoms and well-being facets targeted)</li> </ul>
 <p>Created by Rahmat Hidayat from Noun Project</p>	<p><b>ADOPTION (PERSON LEVEL)</b></p> <p>The extent to which students choose to uptake and initially use the DMHI. Categories relevant to this domain include:</p> <ul style="list-style-type: none"> <li>• Population-level adoption</li> <li>• Individual-level adoption</li> </ul>
	<p><b>IMPLEMENTATION</b></p> <p>The process of integrating a DMHI into college campuses. Categories relevant to this domain include:</p> <ul style="list-style-type: none"> <li>• Fidelity (e.g., adherence rates, time used metrics)</li> <li>• Implementation strategies (e.g., training, recruitment strategies)</li> <li>• Adaptations made to DMHI</li> <li>• Costs of implementation</li> </ul>
 <p>Created by Mario Aji from Noun Project</p>	<p><b>MAINTENANCE</b></p> <p>The extent to which a DMHI is sustained post-implementation. Categories relevant to this domain include:</p> <ul style="list-style-type: none"> <li>• Post-implementation adaptations to DMHI or delivery procedures</li> <li>• Costs to keep DMHI active for students</li> </ul>

**Fig. 1** Chart of RE-AIM domains and their application to DMHIs for college students. Note. “Demographics” icon by Sri Dewi, “Holding the Phone” icon by Rahmat Hidayat, and “Tools” icon by Mario Aji from thenounproject.com CC BY 3.0

or improvement in well-being [12••]. In the effectiveness domain, we coded the name of the DMHI used, primary and secondary outcomes, and the extent to which DMHI was successful in changing the outcomes of interest. We also coded the technology's delivery format, the therapeutic techniques used in the intervention, and the study's design, as these intervention and study characteristics provide further context to effectiveness findings.

### Adoption

Adoption refers to the proportion of people who are willing to initiate a program [12••]. For DMHIs, this is often conceptualized as uptake [12••]. Adoption can be considered from both a population- and individual-level. The population-level addresses what percent of students join a study among all those who are approached or recruited [14]. The individual-level is defined as the number of participants who, once enrolled in the study, download and use a DMHI at least once [15•]. We recorded the relevant population- and individual-level metrics for the eligible studies. This included doing additional computations if the relevant information was available but these metrics were not calculated in the original article (e.g., using participant flow charts from RCTs).

### Implementation

Implementation refers to the integration of a program into the deployment setting, including whether it is used as intended [12••]. Although the use of an intervention as intended is often determined by provider fidelity to the intervention protocol, this concept aligns with user engagement metrics such as adherence and usage time for DMHI as many are self-guided or direct-to-consumer. Adherence is measured as completion of an expected level of content and aligns with fidelity [15•]. To represent adherence, we recorded rates of content completion in DMHIs. We use the term usage time to refer to metrics that quantify how long students spent using the DMHI. This can include time spent on the platform overall, time spent on specific sessions, or sustained use (i.e., “remaining active in using the intervention for some period of time after downloading”; [15•]). As such, we recorded whatever usage time metrics were reported by the studies. For determining implementation activities related to integration into campus settings, we coded the implementation site, implementation strategies used, any adaptations made to the DMHI for implementation, and costs associated with DMHI implementation.

### Maintenance

Maintenance refers to the extent to which a program is sustained over time, including any implementation strategies or adaptations used to promote sustainment and maintenance costs [12••]. We coded maintenance strategies used, post-implementation adaptations, and costs associated with maintenance.

## Results

The search retrieved 2,701 articles that were screened at the title and abstract stage. The full text of 123 articles were reviewed for inclusion, resulting in 95 articles that met the inclusion criteria (See Fig. 2 for the flow diagram and Supplemental 2 for a table of all articles).

### Reach

Of the 95 studies, most 60.0% occurred in the United States or Canada (see Table 1). Undergraduate students were the population for 47.9% of the studies, 30.2% of the studies had a combination of graduate and undergraduate students, and 5.2% focused specifically on graduate students. Just over half of the studies (56.2%) took place at large or mid-sized universities. Only one study took place at a liberal arts college and two at community colleges.

Women were more likely to enroll in the studies with 80.0% of the studies reporting over 60% of the sample as female. Only 12.6% of the studies reported demographic data on participants' sexuality; students who identify as non-heterosexual comprised 5%–35.9% of their samples. One study reported that 62.5% of the students in the sample identified as non-heterosexual, but it had a sample size of 8 participants [16]. 29.5% of studies reported demographic data on non-cisgender students.

For the 57 studies conducted in the United States and Canada, Hispanic/Latine students were represented at rates at or above their national enrollment rate in colleges (i.e., 16%) in 24% of studies [13]. Black/African American students were represented at rates at or above their national enrollment rate in colleges (i.e., 10%) in 29% of studies [13]. Asian students were represented at rates at or above their national enrollment rate in colleges (i.e., 6%) in 57% of studies [13]. American Indian and Alaskan Native students were represented at rates at or above their national enrollment rate in colleges (i.e., 0.6%) in 24% of studies [13]. Native Hawaiian or Other Pacific Islander students were represented at rates at or above their national enrollment rate in colleges (i.e., 0.2%) in 17% of studies [13].

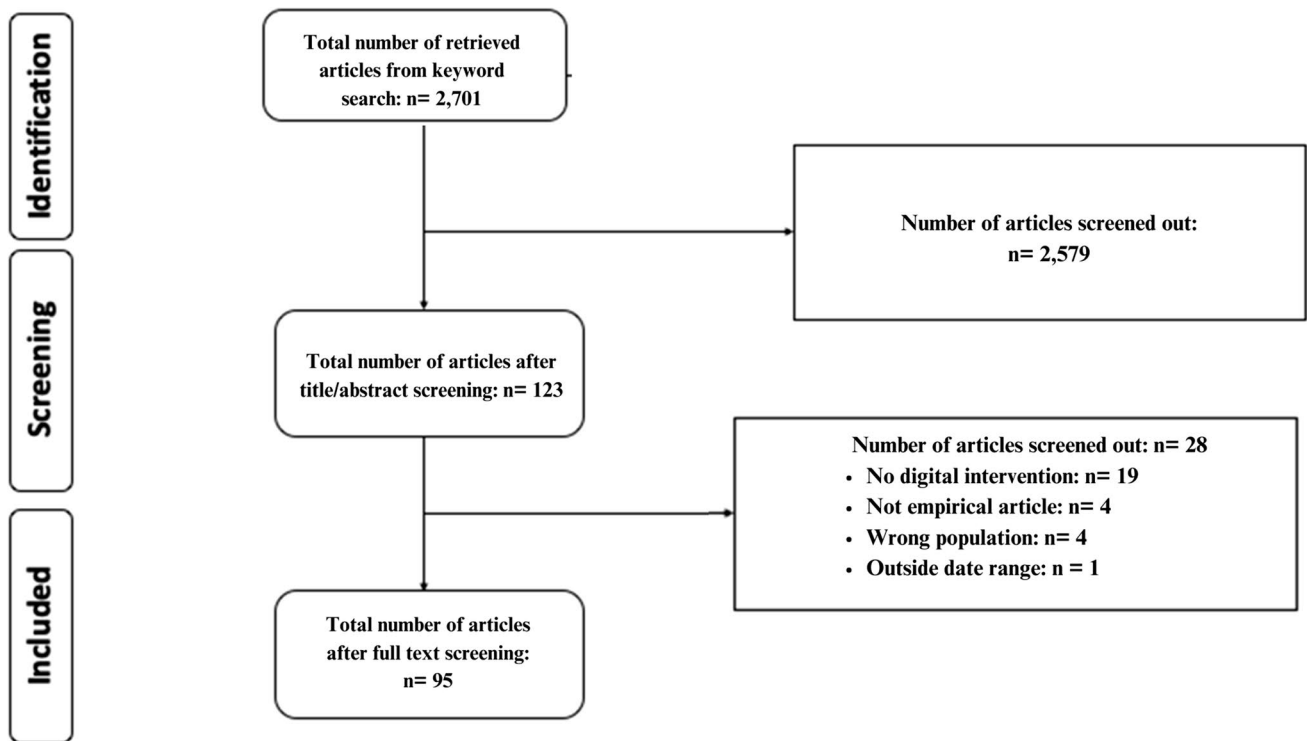


Fig. 2 Preferred reporting items for systematic reviews and meta-analyses (PRISM) flow diagram

Table 1 Sample demographics across studies

		N (Studies)	%
Study Location	US/Canada	57	60.0
	Other	38	40.0
College Level	Undergraduate	49	51.6
	Graduate/Professional	13	13.7
	Community College	1	1.1
	Combo	32	33.7
Gender Distribution	Female (greater or equal to 60%)	76	80.0
	Male (greater or equal to 60%)	3	3.2
	Equal distribution	12	12.6
	Not reported	4	4.2
LGBTQ+ Reported*	Sexuality	12	12.6
	Non-Cisgender	28	29.5

\*Note. N for this category will not add up to 95

Some studies targeted specific demographics of students during recruitment. Studies that specifically developed interventions for students in healthcare made up 6.3% of the studies surveyed [17–22]. Three other studies recruited specialized samples: students who experienced IPV [23], first-year students [24], and veteran students [25].

## Effectiveness

### Study Designs

68 of the 95 studies evaluated the effectiveness of the DMHI on psychological outcomes. RCTs were 72% of these studies. Of the RCTs, 40.8% had a waitlist control, 38.8% had an active control, and 20.4% had multiple comparison conditions (e.g., treatment as usual and a waitlist). Pre-post designs were used in 24% of these studies and the final 2% of studies used other quasi-experimental designs. 32.4% of studies only recruited participants with mental health concerns, including those with clinically-elevated mental health symptoms or identified risk factors.

### Intervention Characteristics

Few DMHIs were evaluated in multiple studies. The most commonly tested DMHIs were Studicare (6.0%), the ACT Online Program (4.0%), and Headspace (3.0%). Apps and other mobile platforms were the most common delivery format, used in 44.2% of studies. Another 38.2% of the DMHI in these studies used web-based delivery. Other delivery formats included online courses, videos, and ecological momentary interventions (EMIs). Of the DMHI tested, 5.9% had an in-person adjunct component (e.g., workshop).



The DMHI in these studies used a variety of therapeutic techniques and addressed many different mental health issues. CBT (36.7%), ACT (25.0%), and mindfulness (30.9%) were the most common therapeutic techniques.

### Impact on Psychological Outcomes

The most common clinical outcomes assessed were depressive symptoms (50.0%), anxiety symptoms (44.1%), and stress (41.2%). Trait mindfulness (e.g., Freiburg Mindfulness Inventory; [26]) was also a common outcome measure, being featured in a quarter of studies (25%). Other outcome measures assessed include quality of life, flourishing, adjustment, student performance, well-being, sleep disturbance, experiential avoidance, eating disorder symptoms, self-efficacy, negative affect, and knowledge of mental health care.

DMHI were effective for the primary outcome(s) measured in 47% of the studies. An additional 34% studies found that their DMHI was partially effective (i.e., a significant change in the desired direction observed in some but not all of the primary outcome(s) measures or were effective for only a subset of students). Only 19% of studies found the DMHI had no effect (e.g., no desired change over time or greater change in DMHI compared to control) on the primary psychological outcome(s) measured. Of the 30 studies that had anxiety symptoms and/or diagnoses as a primary outcome measure, 60% found that the DMHI was effective at reducing the anxiety at the highest level of control offered. For the 23 studies that had depression symptoms and/or diagnoses as a primary outcome measure, 83% showed effectiveness in reducing depression symptoms at the highest level of control offered.

### Adoption

#### Population-Level

20 studies reported on adoption at the population level (see supplemental 2). Between 0.5% to 93.7% of students responded to study participation invitations in the 10 studies that had sufficient data to determine this metric (median = 13.9%). Between 3.1–91.4% of students consented to participate in study after the eligibility was determined in the 16 studies that reported this metric (median = 48.8%).

#### Individual-Level

16 studies reported adoption rates for the DMHI on the individual-level (see supplemental 2). For the 12 studies using “traditional” recruitment strategies (e.g., participant pools, study advertisements), uptake rates were generally high, ranging from 65% to 100% [17, 18, 27–29, 30•, 31–36]. Six out of 12 of these studies reported compensating participants monetarily or with course credit [28, 29, 31, 33, 35,

36]. Adoption rates were higher on average for the non-paid samples ( $M=92\%$ ) than the paid samples ( $M=77.6\%$ ). For the 4 studies that reported uptake for DMHIs implemented into college campuses, uptake varied more greatly. These rates ranged from 26.7% to 90.5% [37•, 38, 39•, 40].

### Implementation and Maintenance

#### Usage Time

See supplemental 2 for a full list of usage time metrics. For 3 studies using single-session intervention (SSI) DMHIs, students spent between 30–40 min on average completing the SSI [29, 41, 42•]. For apps, 3 studies that reported on session duration found that users spent 3–13 minutes on average per session [43–45]. Students who were given access to modular web-based treatments or apps over several weeks generally spent hours of time on their DMHI. Time spent ranged from 37.9 min [46] to 120 min [47] on average each week, and 3 h and 18 min [32] to 48 h [48] over the whole study duration. In terms of sustained use, studies generally found that students used their DMHI less towards the end of the multi-week period than at the beginning [49, 50]. One study reported consistently high use over a 6-month period and that study used an ecological momentary intervention (EMI) [36].

#### Adherence

Adherence rates were reported in 28 studies (see Supplemental 2), which were generally high. For 17 studies that reported the percentage of content completed, 71% had students complete over 50% of the DMHI's content on average and 53% had students complete over 70% of content available. For 13 studies that reported the percentage of participants that met a specific criterion of expected use, 77% had over half of participants meet their criterion.

#### Integration Factors

Of the 95 studies reviewed, only 11 studies reported on implementation activities (see supplemental 2). An additional 4 feasibility and effectiveness studies used DMHI that were already integrated into existing structures on college campuses. Three studies involved the implementation of DMHI across multiple universities [37•, 38, 51]. The most common recruitment strategy involved using university listservs to advertise the DMHI and educating staff and faculty on the availability of the DMHI. Two studies reported having an onsite coordinator or representative for the DMHI [38, 40].

Outside of recruitment strategies, studies largely did not report other implementation activities. Four studies reported on adaptation processes to modify the DMHI for use among the intended college student population. Wasil and colleagues

[42•] made adaptations to the vignettes and activities in their pre-existing COMET SSI to make it more applicable to the challenges college students were facing during COVID-19. Chung and colleagues [51] replaced the American psychologist voice-over for mindfulness exercises with a British psychologist voice-over to suit the context of delivery in UK colleges. Benjet and colleagues [27] culturally adapted SilverCloud for Mexican and Colombian college students. Pankow and colleagues [50] adapted the symptom monitoring and care planning platform iSpero into a self-guided and therapy adjunct tool for students through biweekly meetings with community stakeholders, but did not describe specific adaptations made. Two studies reported on the potential costs of implementing and maintaining a DMHI [30•, 52•]. Gatto and colleagues [30•] reported that their DMHI BERT took a research team member 1–2 hours a day to manage data and send email reminders and additional materials. Davis and colleagues [52•] estimated that their DMHI ACT Online Guide would need 20 hours a week of support to conduct technical upkeep and continued recruitment efforts.

## Discussion

In recent years, many studies have evaluated DMHIs on college campuses. We found that a majority of these studies were conducted at four-year universities in the United States and Canada. Most studies recruited White and female students and few matched the demographics and diversity of college students nationally. The DMHIs evaluated had a wide range of delivery formats and incorporated skills from various treatment modalities. DMHIs appeared to be effective, with over 80% of studies finding the DMHIs effective or partially effective in improving psychological outcomes. Although RCTs demonstrated high rates of adoption and adherence, these rates were lower in studies that used pre-post designs or implementation-effectiveness methodologies. Implementation and maintenance factors were seldom reported. When they were, the focus was primarily on recruitment sites and strategies. Based on these insights, we offer the following observations and recommendations for research going forward.

### Diversify the "" of DMHI

Our findings demonstrate a notable lack of diversity among the college students included in DMHI studies. The majority of DMHI studies took place on four-year university campuses with large student populations. Concentrating DMHI research in large universities neglects college students who could greatly benefit from these interventions. Community college students experience mental health issues more frequently than their peers in four-year universities and are less likely to use mental health services due to barriers like cost [53]. Additionally, many community college students are

receptive to internet-delivered mental health interventions [54]. Establishing partnerships to test DMHI at smaller four-year schools and community colleges, like the STAND project (<https://stand.ucla.edu/>), could enhance the reach of DMHI to students with limited access to other treatments.

The samples in these studies were rather homogeneous, consisting mostly of female and non-Hispanic White students. This aligns with general trends in DMHI and traditional mental health treatment [55, 56], but is disappointing given the calls to expand recruitment to marginalized groups and cisgender men [57, 58]. Cisgender male students and students from traditionally marginalized groups are less likely to seek traditional therapy on college campuses due to stigma and concerns over culturally competent care [59, 60]. Attention to sexual and gender minorities was even rarer than racial and ethnic diversity, with only one-fifth of studies reporting on LGBTQ+ students. LGBTQ+ students in particular experience higher prevalence of mental health concerns relative to their heterosexual and cisgender peers [61]. To address the homogeneity of samples, active efforts must be made to include these students in DMHI initiatives. This includes tailoring intervention content, recruitment strategies [62], and human support to address fit with cultural/identity groups and personalization for each user [63].

### Move Beyond "Basic" Effectiveness Studies

Over two-thirds of the studies evaluated the effectiveness of specific DMHIs for mental health concerns, particularly anxiety and depression. Similar to past reviews [7••, 64], we found that most studies demonstrated that DMHIs were effective or partially effective at improving mental health, even when compared to waitlist or active controls. This consistent evidence underscores the effectiveness of DMHIs for college students in improving mental health concerns, especially for common issues such as depression and anxiety, and for promoting well-being and positive mental health.

Despite this, researchers frequently develop and test new DMHIs. The most studied DMHI was used in only 6% of studies, with most DMHI assessed in only one study. While it is important to assess these interventions, studies should also advance the field by evaluating DMHI with previously established effectiveness among college students in more diverse samples, and evaluating DMHI in the context of implementation on college campuses allowing consideration of practical implementation activities, long-term effectiveness, and sustainment. When novel DMHIs need to be evaluated, hybrid effectiveness-implementation designs can simultaneously provide information both about their impact as well as the necessary strategies and resources to support their implementation [12••, 65]. Studies should also be of sufficient size to consider moderator analyses such as demographic characteristics of students or their use patterns.



Efforts to harmonize baseline measures and outcomes across studies could also support combined analyses and drive approaches to personalize care.

## Record and Publish Implementation and Maintenance Metrics

Implementation and maintenance were the least covered domains. Our review found that less than a fifth of studies mentioned implementing the DMHI within college campus structures and less than one-tenth reported on implementation activities. For research on DMHIs to translate to real-world contexts, proper attention needs to be given to these aspects to guide implementation attempts. This information is especially important for decisionmakers on college campuses, especially consideration of costs and maintenance [66, 67]. This work will require researchers to partner with organizations and administrators on campus and consider how to continue to collect data beyond the period of the traditional research study.

## Conclusions

We must acknowledge some limitations in our findings. First, we only used data presented within published articles; some research teams may have collected additional data relevant to RE-AIM that was not published. Second, our broad inclusion criteria led to significant heterogeneity in study methodologies, DMHI delivery formats, and psychological outcomes assessed. While this approach allowed us to provide a comprehensive overview of recent progress, it makes direct comparisons between studies difficult. Finally, we did not assess the quality and potential bias of the studies.

Our review offers several key strengths. As a systematic review, we could provide a comprehensive overview of the DMHI landscape for college students over the past five years. The RE-AIM framework was useful for identifying gaps in the literature to consider to improve DMHI dissemination and implementation.

Due to the growing concerns around student mental health, DMHIs offer an attractive option for college campuses to consider. However, the current research does not address questions that will be crucial to answer in order to integrate DMHI into practice. Therefore, although found effective in existing research, to realize their potential we need to improve DMHI and their delivery to reach and benefit a diverse range of students. This review highlights the advances seen in the past five years and demonstrates effectiveness in the studies undertaken thus far.

**Supplementary Information** The online version contains supplementary material available at <https://doi.org/10.1007/s11920-024-01545-w>.

**Acknowledgements** The systematic literature review was supported by the efforts of research assistants Hana Nip, Ashley Jane Tolorio Pagador, and Ranelle Rigor.

**Author Contributions** M.E.T. led the systematic review, wrote the main manuscript text, and developed Fig. 1. M.L. facilitated the systematic review, contributed to writing the main manuscript, and prepared Tables 1, 2 and Fig. 2. S.M.S. provided guidance to M.E.T. on conducting the systematic review. S.M.S., S.A., D.E., and S.L. reviewed and provided feedback on manuscript outline and drafts.

**Data Availability** No datasets were generated or analysed during the current study.

## Declarations

**Competing Interests** SMM reports personal fees from Headspace, personal fees from Otsuka Pharmaceuticals, and personal fees from Boehringer Ingelheim outside the submitted work. The remaining authors have no competing interests to declare that are relevant to the content of this article. No funding was received to assist with the preparation of this manuscript.

**Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

## References

Papers of Particular Interest, Published Recently, Have Been Highlighted as:

- of Importance
- of Major Importance

1. American College Health Association. American College Health Association-National College Health Assessment III: Undergraduate Student Reference Group Data Report Spring 2023. Silver Spring, MD: American College Health Association; 2023.
2. Center for Collegiate Mental Health. Annual reports. Pennsylvania State University. <https://ccmh.psu.edu/annual-reports> Accessed 17 Jul 2024.
3. Abelson S, Eisenberg D, Johnston A, et al. Digital mental health interventions at colleges and universities: understanding the need, assessing the evidence, and identifying steps forward. The Hope Center, Temple University. May 2024. <https://hope.temple.edu/digital-mental-health-interventions-highered> Accessed 3 Sep 2024.
4. Schueller SM, Torous J. Scaling evidence-based treatments through digital mental health. *Am Psychol*. 2020;75(8):1093. <https://doi.org/10.1037/amp0000654>.
5. Moghimi E, Stephenson C, Gutierrez G, et al. Mental health challenges, treatment experiences, and care needs of post-secondary students:

- a cross-sectional mixed-methods study. *BMC Public Health*. 2023;23(1):655. <https://doi.org/10.1186/s12889-023-15452-x>.
6. Harrer M, Adam SH, Baumeister H, et al. Internet interventions for mental health in university students: a systematic review and meta-analysis. *Int J Methods Psychiatr Res*. 2019;28(2):e1759. <https://doi.org/10.1002/mpr.1759>.
  7. ●● Lattie EG, Adkins EC, Winquist N, et al. Digital mental health interventions for depression, anxiety, and enhancement of psychological well-being among college students: systematic review. *J Med Internet Res*. 2019;21(7):e12869. <https://doi.org/10.2196/12869>. **(This is a seminal systematic review that found a majority of DMHI tested among college students were effective or partially effective at treating anxiety, depression, and psychological well-being.)**
  8. Pandya A, Lodha P. Mental health consequences of COVID-19 pandemic among college students and coping approaches adapted by higher education institutions: A scoping review. *SSM - Mental Health*. 2022;2:100122. <https://doi.org/10.1016/j.ssmmh.2022.100122>.
  9. Brown N, Johnson R, Strayhorn T, et al. Psychosocial impacts of #BlackLivesMatter protests and police killings on undergraduate students in STEM. *Teach Coll Rec*. 2022. Accessed from: <https://www.researchgate.net/publication/362184388>
  10. Huynh J, Chien J, Nguyen AT, et al. The mental health of Asian American adolescents and young adults amid the rise of anti-Asian racism. *Front Public Health*. 2023;10:958517. <https://doi.org/10.3389/fpubh.2022.958517>.
  11. Mohr DC, Weingardt KR, Reddy M, et al. Three problems with current digital mental health research... and three things we can do about them. *Psychiatr Serv*. 2017;68(5):427–9. <https://doi.org/10.1176/appi.ps.201600541>.
  12. ●● Glasgow RE, Vogt TM, Boles SM. Evaluating the public health impact of health promotion interventions: the RE-AIM framework. *Am J Public Health*. 1999;89(9):1322–7. <https://doi.org/10.2105/AJPH.89.9.1322>. **(This article outlines the domains in the RE-AIM framework and the content that fall within each of the domains.)**
  13. National Student Clearinghouse Research Center. Stay informed. National Student Clearinghouse. 2023. [https://nscresearchcenter.org/stay-informed/?gad\\_source=1&gclid=Cj0KCQjwz7C2BhDKARisAA\\_SZKa3YycWwgNhE14g\\_LeRkybvVw4Exi1\\_S--JKPvvB63dCI7J9Ldyea0aAp\\_KEALw\\_wcB](https://nscresearchcenter.org/stay-informed/?gad_source=1&gclid=Cj0KCQjwz7C2BhDKARisAA_SZKa3YycWwgNhE14g_LeRkybvVw4Exi1_S--JKPvvB63dCI7J9Ldyea0aAp_KEALw_wcB) Accessed 3 Sep 2024.
  14. Wasfi R, Poirier Stephens Z, Sones M, et al. Recruiting participants for population health intervention research: effectiveness and costs of recruitment methods for a cohort study. *J Med Internet Res*. 2021;23(11):e21142. <https://doi.org/10.2196/21142>.
  15. ● Lipschitz JM, Pike CK, Hogan TP, et al. The engagement problem: a review of engagement with digital mental health interventions and recommendations for a path forward. *Curr Treat Options Psychiatry*. 2023;10(3):119–35. <https://doi.org/10.1007/s40501-023-00297-3>. **(This article provides a comprehensive overview of different ways to measure engagement for DMHI.)**
  16. Bohrer BK, Chen Y, Christensen KA, et al. A pilot multiple-baseline study of a mobile cognitive behavioral therapy for the treatment of eating disorders in university students. *Int J Eat Disord*. 2023;56(8):1623–36. <https://doi.org/10.1002/eat.23987>.
  17. Dai Z, Jing S, Wang H, et al. Mindfulness-based online intervention on mental health among undergraduate nursing students during coronavirus disease 2019 pandemic in Beijing, China: a randomized controlled trial. *Front Psychiatry*. 2022;13:949477. <https://doi.org/10.3389/fpsy.2022.949477>.
  18. Ditton E, Knott B, Hodyl N, et al. Evaluation of an app-delivered psychological flexibility skill training intervention for medical student burnout and well-being: randomized controlled trial. *JMIR Ment Health*. 2023;10:e42566. <https://doi.org/10.2196/42566>.
  19. Holden S, O’Connell KA. Using meditation to reduce stress, anxiety, and depression in nursing students. *J Nurs Educ*. 2023;62(8):443–9. <https://doi.org/10.3928/01484834-20230612-02>.
  20. Krifa I, Hallez Q, Van Zyl LE, et al. Effectiveness of an online positive psychology intervention among Tunisian health-care students on mental health and study engagement during the Covid-19 pandemic. *Appl Psychol Health Well Being*. 2022;14(4):1228–54. <https://doi.org/10.1111/aphw.12332>.
  21. O’Driscoll M, Byrne S, Byrne H, et al. An online mindfulness-based intervention for undergraduate pharmacy students: results of a mixed methods feasibility study. *Curr Pharm Teach Learn*. 2019;11(9):858–75. <https://doi.org/10.1016/j.cptl.2019.05.013>.
  22. Wang L, Guo Y, Liu Y, et al. The effects of a mobile phone-based psychological intervention program on stress, anxiety and self-efficacy among undergraduate nursing students during clinical practice: a randomized controlled trial. *J Prof Nurs*. 2022;42:219–24. <https://doi.org/10.1016/j.profnurs.2022.07.016>.
  23. Glass NE, Clough A, Messing JT, et al. Longitudinal impact of the myPlan app on health and safety among college women experiencing partner violence. *J Interpers Violence*. 2022;37(13–14):NP11436–59. <https://doi.org/10.1177/0886260521991880>.
  24. Kim SY, Suh H, Oh W, et al. Daily change patterns in mindfulness and psychological health: a pilot intervention. *J Clin Psychol*. 2021;77(3):496–515. <https://doi.org/10.1002/jclp.23043>.
  25. Son C, Hegde S, Markert C, et al. Use of a mobile biofeedback app to provide health coaching for stress self-management: pilot quasi-experiment. *JMIR Form Res*. 2023;7:e41018. <https://doi.org/10.2196/41018>.
  26. Walach H, Buchheld N, Bütünmüller V, et al. Measuring mindfulness—the Freiburg mindfulness inventory (FMI). *Pers Individ Dif*. 2006;40(8):1543–55. <https://doi.org/10.1016/j.paid.2005.11.025>.
  27. Benjet C, Albor Y, Alvis-Barranco LC, et al. Internet-delivered cognitive behavior therapy versus treatment as usual for anxiety and depression among Latin American university students: a randomized clinical trial. *J Consult Clin Psychol*. 2023;91(12):694.
  28. Bruehlman-Senecal E, Hook CJ, Pfeifer JH, et al. Smartphone app to address loneliness among college students: pilot randomized controlled trial. *JMIR Ment Health*. 2020;7(10):e21496. <https://doi.org/10.2196/21496>.
  29. Crosby ES, Witte TK. A pilot study of Sleep Scholar: a single-session, internet-based insomnia intervention for college students with a history of suicide ideation. *J Am Coll Health*. 2021;71(7):1984–98. <https://doi.org/10.1080/07448481.2021.1953028>.
  30. ● Gatto AJ, Elliott TJ, Briganti JS, et al. Development and feasibility of an online brief emotion regulation training (BERT) program for emerging adults. *Front Public Health*. 2022;10:858370. <https://doi.org/10.3389/fpubh.2022.858370>. **(This article serves as a model for how to use the RE-AIM framework to develop and evaluate a DMHI for college students.)**
  31. Ponzio S, Morelli D, Kawadler JM, et al. Efficacy of the digital therapeutic mobile app BioBase to reduce stress and improve mental well-being among university students: randomized controlled trial. *JMIR Mhealth Uhealth*. 2020;8(4):e17767. <https://doi.org/10.2196/17767>.
  32. Salamanca-Sanabria A, Richards D, Timulak L, et al. A culturally adapted cognitive behavioral internet-delivered intervention for depressive symptoms: randomized controlled trial. *JMIR Ment Health*. 2020;7(1):e13392. <https://doi.org/10.2196/13392>.
  33. Sauer-Zavala S, Tirpak JW, Eustis EH, et al. Unified protocol for the transdiagnostic prevention of emotional disorders:

- evaluation of a brief, online course for college freshmen. *Behav Ther.* 2021;52(1):64–76. <https://doi.org/10.1016/j.beth.2020.01.010>.
34. Sturgill R, Martinasek M, Schmidt T, et al. A novel artificial intelligence-powered emotional intelligence and mindfulness app (Ajivar) for the college student population during the COVID-19 pandemic: quantitative questionnaire study. *JMIR Form Res.* 2021;5(1):e25372. <https://doi.org/10.2196/25372>.
  35. Vereschagin M, Wang AY, Richardson CG, et al. Effectiveness of the Minder mobile mental health and substance use intervention for university students: randomized controlled trial. *J Med Internet Res.* 2024;26:e54287. <https://doi.org/10.2196/54287>.
  36. Wiljer D, Shi J, Lo B, et al. Effects of a mobile and web app (Thought Spot) on mental health help seeking among college and university students: randomized controlled trial. *J Med Internet Res.* 2020;22(10):e20790. <https://doi.org/10.2196/20790>.
  37. • Fitzsimmons-Craft EE, Firebaugh M-L, Graham AK, et al. State-wide university implementation of an online platform for eating disorders screening and intervention. *Psychol Serv.* 2019;16(2):239–49. <https://doi.org/10.1037/ser0000264>. **(This study details outcomes for one of the largest DMHI implementation projects undertaken at universities over the past 5 years.)**
  38. King CA, Eisenberg D, Pistorello J, et al. Electronic bridge to mental health for college students: a randomized controlled intervention trial. *J Consult Clin Psychol.* 2022;90(2):172–83. <https://doi.org/10.1037/ccp0000709>.
  39. • Lattie EG, Cohen KA, Hersch ED, et al. Uptake and effectiveness of a self-guided mobile app platform for college student mental health. *Internet Interv.* 2022;27:100493. <https://doi.org/10.1016/j.invent.2021.100493>. **(This article models how to evaluate uptake of a DMHI on college campuses post-implementation.)**
  40. Shih C, Pudipeddi R, Uthayakumar A, et al. A local community-based social network for mental health and well-being (Quokka): exploratory feasibility study. *JMIRx Med.* 2021;2(4):e24972. <https://doi.org/10.2196/24972>.
  41. Ghosh A, Cohen KA, Jans L, et al. A digital single-session intervention (Project Engage) to address fear of negative evaluation among college students: Pilot randomized controlled trial. *JMIR Ment Health.* 2023;10:e48926. <https://doi.org/10.2196/48926>.
  42. • Wasil AR, Taylor ME, Franzen RE, Steinberg JS, DeRubeis RJ. Promoting graduate student mental health during COVID-19: Acceptability, feasibility, and perceived utility of an online single-session intervention. *Front Psychol.* 2021;12:569785. <https://doi.org/10.3389/fpsyg.2021.569785>. **(This study provides a good example of how DMHI can be adapted for use with college students.)**
  43. Purkayastha S, Addepally SA, Bucher S. Engagement and usability of a cognitive behavioral therapy mobile app compared with web-based cognitive behavioral therapy among college students: Randomized heuristic trial. *JMIR Hum Factors.* 2020;7(1):e14146. <https://doi.org/10.2196/14146>.
  44. Kajitani K, Higashijima I, Kaneko K, et al. Short-term effect of a smartphone application on the mental health of university students: A pilot study using a user-centered design self-monitoring application for mental health. *PLoS ONE.* 2020;15(9):e0239592. <https://doi.org/10.1371/journal.pone.0239592>.
  45. Oliveira C, Maia M, Vairinhos M, et al. A social anxiety mobile intervention for college students attending therapy: A usability and acceptability study. *Int J Hum Comput Interact.* 2022;38(14):1333–44. <https://doi.org/10.1080/10447318.2021.2002042>.
  46. Huberty J, Green J, Glissmann C, et al. Efficacy of the mindfulness meditation mobile app “Calm” to reduce stress among college students: Randomized controlled trial. *JMIR Mhealth Uhealth.* 2019;7(6):e14273. <https://doi.org/10.2196/14273>.
  47. Räsänen P, Muotka J, Lappalainen R. Examining coaches’ asynchronous written feedback in two blended ACT-based interventions for enhancing university students’ wellbeing and reducing psychological distress: A randomized study. *J Contextual Behav Sci.* 2023;29:98–108. <https://doi.org/10.1016/j.jcbs.2023.06.006>.
  48. Strehli I, Burns RD, Bai Y, et al. Development of an online mind-body physical activity intervention for young adults during COVID-19: A pilot study. *Int J Environ Res Public Health.* 2023;20(5):4562. <https://doi.org/10.3390/ijerph20054562>.
  49. Kleiman EM, Bentley KH, Wacha-Montes A, et al. A pilot implementation-effectiveness trial of a single-session telehealth workshop and smartphone-based cognitive behavioral intervention for managing emotions among college students. *Behav Ther.* 2022;53(5):1024–36. <https://doi.org/10.1016/j.beth.2022.04.008>.
  50. Pankow K, King N, Li M, et al. Acceptability and utility of digital well-being and mental health support for university students: A pilot study. *Early Interv Psychiatry.* 2024;18(3):226–36. <https://doi.org/10.1111/eip.13458>.
  51. Chung J, Mundy ME, Hunt I, et al. An evaluation of an online brief mindfulness-based intervention in higher education: A pilot conducted at an Australian university and a British university. *Front Psychol.* 2021;12:752060. <https://doi.org/10.3389/fpsyg.2021.752060>.
  52. • Davis CH, Klimczak K, Aller TB, et al. Reach, adoption, and maintenance of online acceptance and commitment therapy at a university: An implementation case study. *Psychol Serv.* 2024. <https://doi.org/10.1037/ser0000834>. **(This study is one of the only DMHI implementation studies to consider maintenance factors post-DMHI implementation.)**
  53. Lipson SK, Phillips MV, Winquist N, et al. Mental health conditions among community college students: A national study of prevalence and use of treatment services. *Psychiatr Serv.* 2021;72(10):1126–33. <https://doi.org/10.1176/appi.ps.20180332>.
  54. Borghouts J, Eikev EV, Mark G, et al. Understanding mental health app use among community college students: Web-based survey study. *J Med Internet Res.* 2021;23(9):e27745. <https://doi.org/10.2196/27745>.
  55. Adu-Brimpong J, Pugh J, Darko DA, et al. Examining diversity in digital therapeutics clinical trials: Descriptive analysis. *J Med Internet Res.* 2023;25:e37447. <https://doi.org/10.2196/37447>.
  56. Chou T, Bry LJ, Comer JS. Overcoming traditional barriers only to encounter new ones: Doses of caution and direction as technology-enhanced treatments begin to “go live.” *Clin Psychol Sci Pract.* 2017;24:241–4. <https://doi.org/10.1111/cpsp.12196>.
  57. Schueller SM, Hunter JF, Figueroa C, Aguilera A. Use of digital mental health for marginalized and underserved populations. *Curr Treat Options Psych.* 2019;6:243–55. <https://doi.org/10.1007/s40501-019-00181-z>.
  58. Garrido S, Millington C, Cheers D, et al. What works and what doesn’t work? A systematic review of digital mental health interventions for depression and anxiety in young people. *Front Psychiatry.* 2019;10:759. <https://doi.org/10.3389/fpsyg.2019.00759>.
  59. Rafal G, Gatto A, DeBate R. Mental health literacy, stigma, and help-seeking behaviors among male college students. *J Am Coll Health.* 2018;66(4):284–91. <https://doi.org/10.1080/07448481.2018.1434780>.
  60. Lipson SK, Zhou S, Abelson S, et al. Trends in college student mental health and help-seeking by race/ethnicity: Findings from the national healthy minds study, 2013–2021. *J Affect Disord.* 2022;306:138–47. <https://doi.org/10.1016/j.jad.2022.03.038>.
  61. Lipson SK, Lattie EG, Eisenberg D. Increased rates of mental health service utilization by U.S. college students:

- 10-year population-level trends (2007–2017). *Psychiatr Serv.* 2019;70(1):60–3. <https://doi.org/10.1176/appi.ps.201800332>.
62. Kodish T, Schueller SM, Lau AS. Barriers and strategies to improve digital mental health intervention uptake among college students of color: A modified Delphi study. *J Behav Cogn Ther.* 2023;33(1):10–23. <https://doi.org/10.1016/j.jbct.2022.12.002>.
63. Ramos G, Chavira DA. Use of technology to provide mental health care for racial and ethnic minorities: Evidence, promise, and challenges. *Cogn Behav Pract.* 2022;29(1):15–40. <https://doi.org/10.1016/j.cbpra.2019.10.004>.
64. Davies EB, Morriss R, Glazebrook C. Computer-delivered and web-based interventions to improve depression, anxiety, and psychological well-being of university students: A systematic review and meta-analysis. *J Med Internet Res.* 2014;16(5):e130. <https://doi.org/10.2196/jmir.3142>.
65. Beidas RS, Saldana L, Shelton RC. Testing psychosocial interventions in the contexts they are meant to be delivered. *J Consult Clin Psychol.* 2023;91(4):189. <https://doi.org/10.1037/ccp0000797>.
66. Graham AK, Lattie EG, Powell BJ, et al. Implementation strategies for digital mental health interventions in healthcare settings. *Am Psychol.* 2020;75(8):1080. <https://doi.org/10.1037/amp0000686>.
67. Liu M, Schueller SM. Moving evidence-based mental health interventions into practice: Implementation of digital mental health interventions. *Curr Treat Options Psychiatry.* 2023;10:333–45. <https://doi.org/10.1007/s40501-023-00298-2>.

**Publisher's Note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.