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Digital mental health interventions in Chinese: a scoping review

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Digital mental health interventions (DMHIs) are playing an increasingly important role in supporting mental healthcare. Despite their widespread adoption during and after the COVID-19 pandemic, there has been a lack of review focused on DMHIs available in Chinese. This scoping review aims to enhance understanding of the landscape of DMHIs by examining the available evidence, assessing accessibility, and identifying gaps in both the research and implementation within the Greater China region. Searches across four English and four Chinese databases yielded 28 individual interventions reported across 32 trials in 31 publications. The majority of these interventions were mobile-based and trialed in economically developed regions. While most DMHIs showed significant improvements in reducing mental health symptoms, concerns persist regarding limited public access, high heterogeneity in study quality, and the lack of population-based early interventions. Future research is needed to address these issues within Chinese communities and the mental healthcare system.

Globally, mental disorders rank as top contributors to the total burden of disease¹. People living with mental illness often experience the burden of neglect, discrimination, societal stigma². A pronounced treatment gap exists worldwide due to a shortage of mental health providers relative to estimated demand³. This shortfall affects both the access to and quality of mental health services, exacerbating the challenges faced by those living with mental illness particularly in low-resource settings. In China, the overall prevalence of mental disorders has risen over the past decades, affecting ~130 million adults. Among these individuals, mood disorders, anxiety disorders, and substance use disorders are particularly prevalent⁴. Unfortunately, less than 30% of these individuals receive proper treatment due to various factors, including a lack of mental health literacy, mental health providers, stigma, financial concerns, and poor health care service quality^{5,6}.

Since 2010, the Chinese government has prioritized the development of mental health infrastructure to address the rising burden of mental illness, focusing investments on psychiatric hospitals⁷. Consequently, China's mental health care system is predominated by hospital-based care⁸. The vast majority of mental health professionals in China are psychiatric nurses, with relatively few psychiatrists, clinical psychologists, social workers, and occupational therapists⁹. In 2019, China had 6.8 licensed psychiatric nurses and 2.9 licensed psychiatrists per 100,000 population⁶, which is significantly lower than the national average of 12.9 psychiatrists per 100,000 population in the United States in 2018¹⁰. Progress has been made primarily in managing severe mental disorders within hospital settings, but common conditions such as depression and anxiety remain inadequately addressed. Mental health-seeking behavior

in China is also lower compared to other countries¹¹. Moreover, investment in the mental health workforce does not meet the growing demand, further exacerbating the barriers to effective mental health care⁷.

Given these challenges, the rise of digital mental health interventions (DMHIs) offers a promising solution by leveraging the internet's wide reach to support the overburdened mental healthcare system and provide resources to individuals with mental health symptoms. A mental health intervention is considered digital when it employs technology such as computers, mobile devices, text messaging services, or the Internet to deliver the intervention¹. DMHIs can be used for a variety of purposes, including promoting mental health, maintaining mental well-being, providing early intervention, and treating specific conditions. These interventions can be used as standalone solutions or complements to traditional treatments, enhancing current services while introducing innovative prevention and support methods¹². Additionally, they offer a layer of anonymity in a climate where mental health stigma is concerning. Within the Chinese context, where 96% of the population owns a smartphone and is proficient with technology⁸, digital intervention is a particularly promising strategy. These interventions are cost effective, efficacious, and offer a potentially destigmatizing alternative to traditional methods¹.

In 2021, Zhang et al. conducted a systematic review of DMHIs in China, reporting on 39 studies encompassing 32 distinct interventions, using various technologies ranging from virtual reality to smartphone applications⁸. The review reported generally favorable acceptance and use of digital health technologies among the Chinese population, drawing from

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both English and Chinese-language studies. Compared to their English counterparts, Chinese DMHI studies focused more prominently on schizophrenia, substance use disorder, and culturally specific presentations of social anxiety, reflecting the previous focus of the Chinese mental healthcare system. Notably, this review excluded studies from Hong Kong, Macao, and Taiwan due to differing healthcare systems and included only participants who met DSM or ICD diagnostic criteria. Since then, the field has evolved rapidly—particularly those emerging during the COVID-19 pandemic, a period marked by rapid growth in DMHIs and increased demand for digital mental health services¹³. In the current review, we expanded the scope to include these linguistically and culturally related regions and analyzed interventions developed since Zhang's 2021 review. Differing from the previous review, we focused on self-paced and automated interventions—those delivered by technology itself that can function without human support—which are likely to be more scalable, broadly applicable, and less constrained by regional healthcare contexts¹⁴. This type of intervention enhances accessibility, allowing individuals to use it at any time or place, without professional assistance, and while simultaneously maintaining their anonymity. To gain a deeper understanding of the current digital mental health landscape in the Greater China region (mainland China, Hong Kong, Macao, and Taiwan)¹⁵, identify sustainable intervention programs available for those in need, and build upon the current literature, it is essential to produce an updated review highlighting the current automatic digital interventions in the region.

Given the high heterogeneity of the studies and the broad scope of the research question, a scoping review is conducted to map the landscape of automated DMHIs in Greater China. The scoping review has three main objectives: (1) to identify the DMHIs available in the Chinese language (both simplified and traditional) within the Greater China region, (2) to assess the efficacy or effectiveness of these interventions, and (3) to determine the public availability of these interventions and their implementation.

Results

Study characteristics

Our literature search retrieved 3472 study records, which were reduced to 2116 after removing duplicates (see Fig. 1). After the title and abstract screening, 102 articles were retained for full-text review. Of these, 89 were excluded, and 13 met the inclusion criteria. Additionally, 18 studies from the previous review on digital mental health in China⁸ met the inclusion criteria. All full-text records were screened independently by two reviewers (Cohen's $\kappa = 0.90$). In total, 31 publications on 32 trials of 28 unique interventions were deemed eligible and included in the narrative synthesis. One of the included studies reports on three separate trials, two of which met the inclusion criteria¹⁶. The collection of included studies involved 24 English-language peer-reviewed studies and 7 Chinese-language peer-reviewed studies.

Table 1 provides an overview of the characteristics of studies included organized by intervention. All 32 trials were conducted in the Greater China region, including nine (28%) in Beijing, six (19%) in Hong Kong, four (13%) in Zhejiang, three (9%) in Guangdong, two (6%) in Shanghai, two in Macao (6%), one (3%) in Shandong, one (3%) in Chongqing, and four (13%) in multiple cities in China. Of the 28 interventions, 17 (61%) were in simplified Chinese, four (14%) were in traditional Chinese, one (4%) was in both simplified and traditional Chinese, and six (21%) were in unspecified Chinese (did not clearly indicate simplified or traditional Chinese usage). Twenty-two (79%) were locally developed for Chinese-speaking populations, six (21%) were originally developed internationally and translated into Chinese. Of the six internationally developed interventions, three (50%) were adapted for the Chinese context. Most interventions 22 (79%) were for adults, and six interventions (21%) were conducted amongst individuals less than 18 years old.

Online intervention modalities

A range of digital technologies were utilized for mental health interventions. Among the 28 identified interventions, 12 (43%) were application-based interventions delivered via mobile devices, highlighting the

increasing reliance on mobile technology for mental health support in the Greater China region^{16–27}. Of these, four interventions utilized existing applications as delivery vehicles: two through WeChat^{22,26}, a widely used social media platform in China, and two through WhatsApp¹⁶, a popular messaging application. Additionally, one intervention leveraged automated text messages to provide interventions²⁸. Web-based interventions were employed in seven interventions (25%), reflecting the accessibility and broad reach of internet-based programs^{29–38}. There is also a growing interest in immersive technologies for mental health treatment, as evidenced by the seven interventions (25%) that used virtual reality-based interventions^{39–45}. Zhu et al. developed a computer software program to deliver their intervention, demonstrating a unique approach among the reviewed studies⁴⁶.

Target population

The interventions included in this review targeted a variety of populations. Four (14%) interventions targeted a broad, non-specific universal sample from the public^{16,18,25}. One study specifically recruited participants from university settings, aiming to represent the academic community³². Additionally, one study recruited a healthy sample of seventh-grade Chinese middle school students²⁶. The remaining 27 trials of 22 unique interventions can be grouped into two categories based on the participants' health conditions: individuals with existing mental health symptoms and individuals with existing physical health symptoms.

Individuals with existing mental health symptoms

Nineteen interventions (68%) targeted individuals with mental health symptoms. Among these, seven (37%) interventions focused on participants with self-reported depressive symptoms or a formal diagnosis of depression^{20–22,24,34,36,39,41,46}. Three (16%) interventions derived from five studies addressed individuals with high social anxiety: one targeting adolescents¹⁹, one targeting adults²³, and one targeting university students^{29,31,37}. One intervention targeted individuals with situational insomnia³⁵, and another focused on those with generalized anxiety disorder⁴⁴. Additionally, three (16%) interventions derived from five studies included participants with obsessive-compulsive disorder (OCD)⁴⁵, attention deficit hyperactivity disorder (ADHD)³⁰, and post-traumatic stress disorder (PTSD)³⁸, respectively. Four (21%) interventions derived from five studies aimed at individuals looking to quit smoking or struggling with impulse control and substance use disorders, including one for tobacco users²⁸, one for internet addiction³³, and two for broader substance use issues^{17,27}. Of the 19 interventions, four (21%) were implemented to augment usual treatment, which included psychotropic medication use and psychological counseling^{27,39,41,46}.

Individuals with existing physical health symptoms

Three interventions (11%) focused on individuals with physical health symptoms who were undergoing medical treatments that could have mental health impacts. Mao et al. and Wong et al. tested the effects of VR-based interventions on cancer patients undergoing chemotherapy^{40,42}. Ran et al. applied a VR-based intervention to dental patients between the ages of four and eight to reduce anxiety and pain⁴³.

Target outcomes and intervention types

Depression and related symptoms. Among the 28 included interventions, ten (36%) assessed depression as the primary outcome^{20–22,24,25,32,34–36,39,41,42}, and another three (11%) included depression as the secondary outcome^{16,38}. Of these 13 interventions, six, originating from five studies, employed mindfulness-based techniques^{16,24,32,39,42}. Three interventions derived from four studies used internet-based cognitive behavioral therapy (iCBT)^{22,34–36}. Other interventions included attention training⁴¹, behavior activation^{20,21}, self-efficacy³⁸, and a lifestyle medicine approach that incorporated psychoeducation, physical activity, nutrition, stress, sleep management, and motivation components. The severity of depression was measured using scales, including the Hamilton Depression Scale^{35,39,41,42}, Beck Depression

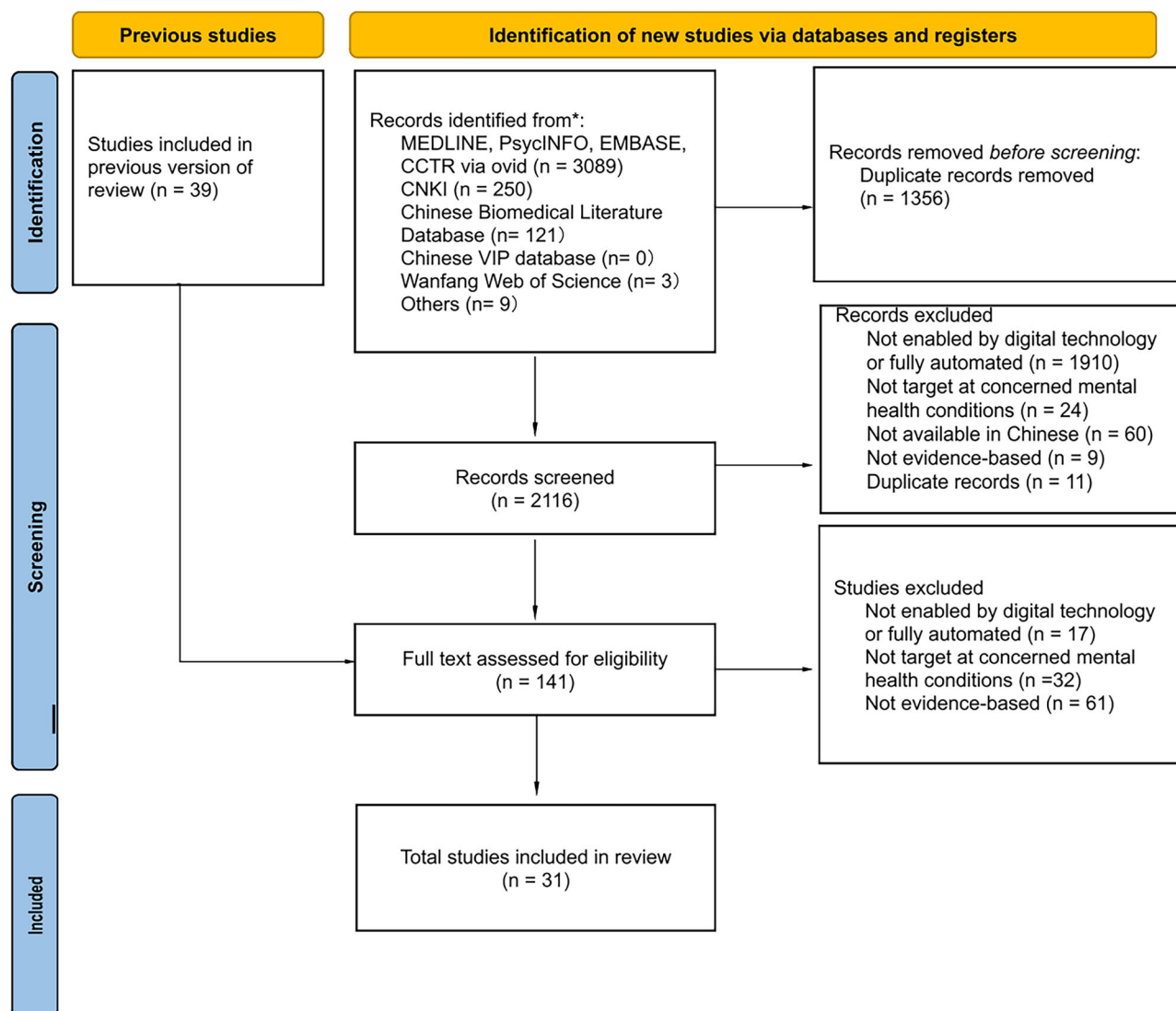


Fig. 1 | PRISMA flowchart of studies identified for inclusion in the review.

Inventory³⁹, Patient Health Questionnaire-9^{16,20–22}, Center for Epidemiologic Studies Depression Scale^{34,36}, Hospital Anxiety and Depression Scale^{35,42}, Symptom Checklist 90-Depression³⁸, and 21-Item Depression, Anxiety, and Stress Scale^{25,32}. Eleven interventions (85%) demonstrated significant improvements in reducing depression in the intervention group post intervention^{16,20–22,24,25,34–36,38,39,41,42}, with two demonstrating sustained significance beyond the immediate post-treatment period^{16,38}. Among the nine interventions that reported effect sizes, seven had small to medium effects^{16,22,24,25,32,38}. One behavioral activation-based digital intervention for depression “Step-by-step” showed a large effect in the pilot²⁰ but a moderate effect in the full trial²¹. One iCBT intervention underwent evaluation in trials conducted by Ren et al. and Yeung et al., where Ren et al.’s trial³⁶ exhibited large effect and Yeung et al.’s trial³⁴ found a moderate effect size for the intervention.

Anxiety. Generalized, mixed, and situational (non-social) anxiety was assessed as the primary outcome in eight interventions (29%)^{25,26,32,35,40,42–44}, and five (18%) as the secondary outcome^{16,20–22,24}. Among the eight interventions that measured anxiety as the primary outcome, one used relaxation and physical activity²⁶, one employed mindfulness-based cognitive therapy (MBCT)⁴², one adopted mindfulness-based intervention³², two utilized distraction interventions^{40,43}, one implemented exposure therapy⁴⁴, one used iCBT³⁵,

and one took a lifestyle medicine approach²⁵. The severity of anxiety was assessed using the Spence Children’s Anxiety Scale²⁶, General Anxiety Disorder 7-item^{16,20–22,24}, Hamilton Anxiety Rating Scale⁴⁴, and the State Anxiety Scale for Children⁴⁰. Ran et al. assessed the application of a VR intervention to improve operative anxiety and behavior management during short-term dental procedures among children using the Children’s Fear Survey Schedule-Dental Subscale and Wong-Baker FACES Pain Rating Scale⁴³. Additionally, two studies utilized the Hospital Anxiety and Depression Scale to concurrently measure the severity of depression and anxiety^{35,42}, while two other studies^{25,32} utilized the anxiety subscale from the 21-item versions of the Depression, Anxiety, and Stress Scale. With one exception, all interventions that measured anxiety as the primary outcome reported significant improvements in anxiety levels post intervention. The exception was an internet-based mindfulness intervention that incorporated principles from the Health Action Process Approach and assessed anxiety using the short version of the Depression Anxiety Stress Scale³². Additionally, of the eight interventions reporting effect size, seven interventions showed small effects^{16,21,22,24,25,32}, while one had large effects⁴⁰. The Step-by-Step pilot²⁰ reported a large effect size while the full trial²¹ reported a small effect.

Social anxiety. Three of the included interventions (11%) focused on social anxiety^{19,23,29,31,37}. These studies used the Social Interaction Anxiety

Table 1 | Characteristics of the interventions grouped by online intervention modality

Citation [Publication Language]	Target Population [Number of participants]	Content of intervention [Intervention language] Duration of intervention	Research design [Control]	Trial site [Region of development (adaptation or translation)]	Primary outcome [Assessment measure; significance; effect size]	Secondary outcome [Assessment measure; significance; effect size]	Public availability
Mobile-based intervention							
Zhu et al. ²⁷ [EN]	Male patients with methamphetamine use disorder [N = 40, INT 20, CON 20]	Cognitive training and cognitive bias modification [Simplified CN] 4 weeks	RCT [Active control (TAU)]	Shanghai [China]	Cognitive function [CogState Battery, ISL, CPAL; sig] [Groton maze learning task; non sig], risk decision making [Iowa Gambling Task, balloon analog risk task, delay discounting task; sig], methamphetamine-related attentional bias [methamphetamine addiction Stroop task; non sig]	/	No
Mak et al. ¹⁸ [EN]	Hong Kong adults [N = 2161, INT mindfulness-based program (MBP) 703, self-compassion program (SCP) 705, cognitive behavioral psychoeducation program (CBP) 753]	Mindfulness-based intervention, cognitive behavioral therapy, acceptance-based therapy [Traditional CN] 4 weeks	RCT [Active control]	Hong Kong [Hong Kong]	Mental wellbeing [WHO-5; sig*; MBP <i>d</i> = 0.32, SCP <i>d</i> = 0.27, CBP <i>d</i> = 0.35], psychological distress [K6; sig*; MBP <i>d</i> = -0.28, SCP <i>d</i> = -0.35, CBP <i>d</i> = -0.31]	Mindful awareness [MAAS; sig; MBP <i>d</i> = -0.08, SCP <i>d</i> = -0.19, CBP <i>d</i> = -0.10], self-compassion [self-compassion scale; non sig; MBP <i>d</i> = 0.07] [self-compassion scale; sig; SCP <i>d</i> = 0.32, CBP <i>d</i> = 0.27]	Yes, the mobile app can be downloaded from Google Play
Liang et al. ¹⁷ [EN]	Chinese adults with substance use in the past 30 days [N = 74, INT 49, CON 25]	Cognitive behavioral therapy [Simplified and traditional CN] 4 weeks	RCT [Attention control]	Shanghai [China]	Drug use [urine test; non sig] [timeline follow-back survey on primary drug use; sig]	/	No
Sun et al. ²³ [EN]	College students with social anxiety [N = 41, INT 22, CON 19]	Cognitive bias modification for interpretation [Simplified CN] 4 weeks	RCT [Active control]	Beijing [United States (adapted)]	Social anxiety [LSAS, STAI; sig*]	/	No
Sun et al. ²⁴ [EN]	Pregnant women with depressive symptoms [N = 158, INT 74, CON 84]	Mindfulness-based cognitive therapy [Simplified CN] 8 weeks	RCT [Attention control]	Shandong [United States (translated)]	Depression [EPDS; sig; <i>d</i> = 0.47]	Anxiety [GAD-7; sig; <i>d</i> = 0.26], perceived stress [PSS, non sig; <i>d</i> = 0.27], positive affect, [PANAS; sig; <i>d</i> = -0.49], negative affect [PANAS; non sig; <i>d</i> = -0.01], sleep-related problem [PSQ], non sig; <i>d</i> = -0.04], fatigue [FSS; non sig; <i>d</i> = -0.02], prospective memory [PRMQ; non sig; <i>d</i> = -0.31], retrospective memory [PRMQ; non sig; <i>d</i> = -0.22], fear of childbirth [W-DEQ; non sig; <i>d</i> = 0.28]	No

Table 1 (continued) | Characteristics of the interventions grouped by online intervention modality

Citation [Publication Language]	Target Population [Number of participants]	Content of intervention [Intervention language] Duration of intervention	Research design [Control]	Trial site [Region of development (adaptation or translation)]	Primary outcome [Assessment measure; significance; effect size]	Secondary outcome [Assessment measure; significance; effect size]	Public availability
Zheng et al. ²⁰ [EN]	Middle school students under home confinement during COVID-19 [N = 954, INT 485, CON 469]	Relaxation and physical activity [Simplified CN] 2 weeks	RCT [Attention control]	Guangdong [China]	Anxiety [Chinese SCAS; sig]	Sleep quality [PROMIS; non sig]	No
Song et al. ²² [EN]	Adults with depression symptoms [N = 314, INT 194, CON 120]	Cognitive behavior therapy [Simplified CN] 1 week	QE [Waitlist control]	China [China]	Depression [PHQ-9; sig; <i>d</i> = 0.51]	Anxiety [GAD-7; non sig; <i>d</i> = 0.36], insomnia [ISI; sig; <i>d</i> = 0.53]	No
1. Sit et al. ²⁰ [EN] 2. Li et al. ²¹ [EN]	1. Chinese university students in Macao with depressive symptoms [N = 39] 2. Chinese college students in Macao with depressive symptoms [N = 371, INT = 187, CON = 184]	Behavioral activation [CN] 8 weeks	1. QE [No control] 2. RCT [Active control (ETAU)]	Macao [Switzerland (adapted)]	1. Depression [PHQ-9; sig; <i>d</i> = 1.24] 2. Depression [PHQ-9; sig; <i>g</i> = 0.35]	1. Anxiety [GAD-7; sig; <i>d</i> = 0.75], well-being [WHO-5; non sig; <i>d</i> = 0.39], client-defined stress [PSYCHLOPS; sig; <i>d</i> = 0.99] 2. Anxiety [GAD-7; sig; <i>g</i> = 0.26], well-being [WHO-5; sig*; <i>g</i> = 0.31], self-defined psychosocial problems [PSYCHLOPS; sig*, <i>g</i> = 0.21]	No
Li et al. ¹⁶ [EN]	Adults [N = 333, INT 167, CON 166]	Mindfulness-based intervention [Traditional CN] 3 weeks	RCT [Waitlist control]	Hong Kong [China]	Insomnia [ISI; sig*; <i>d</i> = 1.11], presleep arousal – somatic [PSAS; sig*; <i>d</i> = 0.34], presleep arousal – cognitive [PSAS; sig*; <i>d</i> = 0.49], dysfunctional beliefs and attitude about sleep [DBAS; sig*; <i>d</i> = 0.43]	Mindfulness [MAAS; sig*; <i>d</i> = 0.23], depression [PHQ-9; sig*; <i>d</i> = 0.43], anxiety [GAD-7; sig*; <i>d</i> = 0.38], mental well-being [WHO-5; sig*; <i>d</i> = 0.36], functional impairment [WSAS; non sig; <i>d</i> = 0.21]	No
Li et al. ¹⁶ [EN]	Adults [N = 351, INT 177, CON 174]	Mindfulness-based intervention [Traditional CN] 3 weeks	RCT [Waitlist control]	Hong Kong [China]	Eating behavior [TFEQ-R18; sig*; uncontrolled eating <i>d</i> = 0.36] [TFEQ-R18; non sig; cognitive restraint <i>d</i> = 0.13] [TFEQ-R18; sig*; emotional eating <i>d</i> = 0.33], reactivity to food cue [PFS; non sig; <i>d</i> = 0.30]	Mindfulness [MAAS; sig*; <i>d</i> = 0.27], depression [PHQ-9; non sig; <i>d</i> = 0.17], anxiety [GAD-7; non sig; <i>d</i> = 0.21], mental well-being [WHO-5; sig*; <i>d</i> = 0.33]	No
Mao et al. ¹⁹ [EN]	Adolescents with high social anxiety [N = 30, INT 15, CON 15]	Cognitive bias modification for interpretation [CN] 4 weeks	RCT [Waitlist control]	Beijing [China]	Social anxiety [SAS-A; sig], fear of negative evaluation [BFNE; sig]	/	No

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Citation [Publication Language]	Target Population [Number of participants]	Content of intervention [Intervention language] Duration of intervention	Research design [Control]	Trial site [Region of development (adaptation or translation)]	Primary outcome [Assessment measure; significance; effect size]	Secondary outcome [Assessment measure; significance; effect size]	Public availability
Wong et al. ⁴⁵ [EN]	Adults [N = 106, INT 53, CON 53]	Lifestyle medicine approach (psychoeducation, physical activity, nutrition, stress and sleep management, motivation) [Traditional CN] 8 weeks	RCT [Waitlist control]	Hong Kong [China]	Overall mental health [DASS-21; sig; <i>d</i> = 0.52], depression [DASS-21; sig; <i>d</i> = 0.56], anxiety [DASS-21; sig; <i>d</i> = 0.33], stress [DASS-21; sig; <i>d</i> = 0.44]	Insomnia [ISI; sig; <i>d</i> = 0.29], functional disability [SDS; non sig; <i>d</i> = 0.34], HRQOL [SF-6D; non sig; <i>d</i> = 0.49], HPBs [HPLP-II; sig; <i>d</i> = 0.31]	No but plan to make publicly available soon
Virtual reality-based intervention							
Zhang et al. ⁴⁴ [EN]	Patients with COVID-19 infection anxiety [N = 3]	Exposure therapy [CN] 1 session	CS [No control]	Guangdong [China]	Anxiety [HAM-A; sig], fear of COVID-19 infection [FCV-19S; non sig]	/	No
Ran et al. ⁴³ [EN]	Children aged 4–8 receiving dental treatments [N = 104, INT 55, CON 49]	Distraction therapy [CN] 1 session	RCT [No treatment control]	Chongqing [China]	Anxiety and pain [CFSS-DS, WBFS, FBRS; sig]	/	No
Feng et al. ³⁹ [CN]	In-patient adult Parkinson's patients with depression [N = 68, INT 34, CON 34]	Mindfulness-based cognitive therapy, music therapy, relaxation [Simplified CN] 12 weeks	RCT [Active control (TAU)]	Zhejiang [China]	Depression [HAMD, BDI; sig]	/	No
Wong et al. ⁴⁰ [EN]	Pediatric patients receiving their first intravenous chemotherapy [N = 19, INT 9, CON 10]	Distraction therapy [CN] 3 sessions	RCT [No treatment control]	Hong Kong [Hong Kong]	Anxiety [CSAS-C; sig; <i>g</i> = 1.87]	/	No
Li et al. ⁴¹ [CN]	Pediatric patients with depressive episodes [N = 86, INT 43, CON 43 CON]	Attention training [Simplified CN] 24 weeks	RCT [Active control (TAU)]	Zhejiang [China]	Depression [HAMD; sig], cognitive function [MMSE; sig]	/	No
Zhu et al. ⁴⁵ [CN]	Adult female patients with OCD [N = 80, INT 40, CON 40]	Exposure and response prevention therapy [Simplified CN] 8 weeks	QE [Active control]	Zhejiang [China]	/	OCD [Y-BOCS; sig], Cognitive function [MOCA-B; sig]	No
Mao et al. ⁴² [EN]	In-patient adult ovarian cancer patients undergoing chemotherapy [N = 48]	Mindfulness-based cognitive therapy and mindfulness stress reduction therapy [Simplified CN] 4 weeks	QE [No control]	Beijing [China]	Anxiety and depression [HADS; sig]	/	No
Web-based intervention							
Su et al. ³³ [EN]	College students with internet addiction [N = 65, INT lab environment 17, natural environment 16, non-interactivity system 16, CON 16]	Expert system intervention [Simplified CN] 4 weeks	RCT [Waitlist control]	Beijing [China]	Internet addiction symptoms [self-reported online hours per week; sig; lab environment <i>d</i> = -0.88, natural environment <i>d</i> = -0.92, non-interactivity system <i>d</i> = -0.75] [YDQ; sig; lab environment <i>d</i> = -0.82, natural environment <i>d</i> = -0.80, non-interactivity system <i>d</i> = -0.72]	/	No
Wang et al. ³⁸ [EN]	PTSD patient [N = 90, INT 46, CON 44] ^a	Self-efficacy intervention [Simplified CN] 4 weeks	RCT [Waitlist control]	China [United States (translated)]	Posttraumatic symptoms [PDS; sig*; <i>d</i> = -0.44],	Depression [SCL-D; sig*, <i>d</i> = -0.44], post-traumatic cognitive changes [PCC; sig*; <i>d</i> = -0.61], social functioning [SFI; sig*; <i>d</i> = -0.48], trauma coping self-efficacy [CSE; non sig; <i>d</i> = 0.19]	No

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Citation [Publication Language]	Target Population [Number of participants]	Content of intervention [Intervention language] Duration of intervention	Research design [Control]	Trial site [Region of development (adaptation or translation)]	Primary outcome [Assessment measure; significance; effect size]	Secondary outcome [Assessment measure; significance; effect size]	Public availability
Mak et al. ³² [EN]	University students and staffs [N = 288, INT Health Action Process Approach (HAPA) 105, Basic Mindfulness 104, CON 79]	Mindfulness-based intervention [Simplified CN] 8 weeks	RCT [Waitlist control]	Hong Kong [Hong Kong]	Mindfulness [FFMQ; non sig; basic mindfulness <i>d</i> = 0.08] [FFMQ; sig*; HAPA <i>d</i> = 0.25], mental wellbeing [WHO-5; sig*; basic mindfulness <i>d</i> = 0.35, HAPA <i>d</i> = 0.24], life satisfaction [SWLS; non sig; basic mindfulness <i>d</i> = 0.18, HAPA <i>d</i> = 0.22], perceived stress [PSS; non sig; basic mindfulness <i>d</i> = -0.09, HAPA <i>d</i> = -0.20], depression [DASS-21; non sig; basic mindfulness <i>d</i> = -0.04, HAPA <i>d</i> = -0.09], anxiety [DASS-21; non sig; basic mindfulness <i>d</i> = 0.00, HAPA <i>d</i> = -0.20], stress [DASS-21; non sig; basic mindfulness <i>d</i> = -0.64, HAPA <i>d</i> = -0.77]	/	No
1.Ren et al. ³⁶ [CN] 2.Yeung et al. ³⁴ [EN]	1. University students with depressive symptoms [N = 58, INT 43, CON 15] 2. Out-patient adult depression patients [N = 75, INT 37, CON 38]	1.Cognitive behavioral therapy [CN] 3 weeks 2. Cognitive behavioral therapy [CN] 5 weeks	RCT [Waitlist control]	1.China (non-specific) [Australia (translated)] 2. Beijing [Australia (translated)]	1.Depression [CES-D; sig; <i>g</i> = 0.93] [PHQ-9; sig; <i>g</i> = 0.79] 2.Depression [CES-D; sig; <i>d</i> = 0.6]	/	English version is available
Li et al. ³⁰ [CN]	Pediatric ADHD patients [N = 34, INT 17, CON 17]	Executive function training [Simplified CN] 12 weeks	RCT [Active control]	Beijing [China]	ADHD [CDIS, ADHD RS-IV, SNAP-IV; sig], intelligence [WISC-IV-Chinese; sig], executive function [objective evaluation; non sig]	/	No
1.Chen et al. ²⁹ [EN] 2.Wang et al. ³⁷ [EN] 3.Lin et al. ³¹ [EN]	1. Adults with social anxiety symptoms [N = 255, Self-help 72, Therapist guided 183] 2. Adults with social anxiety symptoms [N = 210, INT self-help 70, INT therapist guided 70, CON 70] 3. Adults with social anxiety and different levels of Taijin Kyofusho [N = 80, INT 55, CON 25, then divided into subgroups based on TKS scores]	Cognitive behavioral therapy [Simplified CN] 8 weeks	1. QE [no control] 2. RCT [Waitlist control] 3. RCT [No treatment control]	Beijing [Switzerland (adapted)]	1. social anxiety [SPS, SIAS; NA] 2. Shame proneness [ESS; sig; self-help <i>d</i> = 0.80, therapist-guided <i>d</i> = 0.88] 3. Social anxiety, TKS-level [TKSS; sig; <i>d</i> = 0.92] [SIAS; sig; <i>d</i> = 0.80] [SPS; sig; <i>d</i> = 0.48]	2. Social anxiety [SIAS; sig; self-help <i>d</i> = 1.01, therapist-guided <i>d</i> = 1.20] [SPS; sig; self-help <i>d</i> = 0.89, therapist-guided <i>d</i> = 0.96]	No
Zhang et al. ³⁵ [EN]	Adults with symptoms of situational insomnia [N = 194]	Cognitive behavioral therapy [Simplified CN] 1 week	QE [No control]	Guangdong [China]	Somatic and cognitive arousal before sleep [PSAS; sig], insomnia, sleep satisfaction [ISI; sig], depression and anxiety [HADS; sig]	/	No
Text message-based intervention							
Liao et al. ²⁸ [EN]	Adults who want to quit smoking [N = 1369, INT high-frequency messaging intervention 674, low-frequency messaging intervention 284, CON 411]	Cognitive behavioral intervention [Simplified CN] 12 weeks	RCT [Attention control]	China (non-specific) [China]	Biochemically verified continuous smoking abstinence [sig; high frequency messaging intervention OR = 3.51, low frequency messaging intervention OR = 3.21]	Self-reported prevalence of abstinence [sig*; high frequency messaging intervention OR = 4.05, low frequency messaging intervention OR = 3.02], continued abstinence [sig*; high frequency	No

Table 1 (continued) | Characteristics of the interventions grouped by online intervention modality

Citation [Publication Language]	Target Population [Number of participants]	Content of intervention [Intervention language] Duration of intervention	Research design [Control]	Trial site [Region of development (adaptation or translation)]	Primary outcome [Assessment measure; significance; effect size]	Secondary outcome [Assessment measure; significance; effect size]	Public availability
						messaging intervention OR = 3.52, low frequency messaging intervention OR = 3.36]	
Computer software							
Zhu et al. ⁴⁶ [CN]	Adult patients with depressive disorder [N = 67, INT 35, CON 32]	Cognitive remediation therapy [Simplified CN] 8 weeks	RCT [Active control (TAU)]	Zhejiang [China]	Cognitive function [WCST; sig] [trail making test TMT, Stroop; non sig]	/	No

Table 1 summarizes the characteristics of each publication included in the review identified from the electronic search, organized by intervention. Publications related to the same intervention are combined into a single row. For interventions with multiple trials, characteristics specific to each trial are reported within the same row. If the information for multiple trials is identical, only one set of characteristics is listed in the table cell. Li et al.¹⁶ reported results from three trials on three different interventions; two of these trials met the inclusion criteria and are listed separately (in two rows) in the result table.

Language, language of publication. EN = English, CN = Chinese.

Number of participants, N = total number of participants who completed pre-assessment, INT = number in intervention group, CON = number in control group.

Intervention language, simplified CN = simplified Chinese, traditional CN = traditional Chinese, CN = Chinese, not further specified.

Research design, RCT randomized controlled trial, QE quasi-experimental study, CS case series.

Control, control condition. TAU treatment as usual, ETAU enhanced treatment as usual.

Trial site, the province, city, or region where the trial was conducted. For trials that were conducted in various cities or across China, China is listed.

Adaptation or translation, whether an intervention originally developed internationally was either directly translated into Chinese or culturally adapted to fit local contexts.

Assessment measure, ISL International Shopping List task, CPAL Continuous Paired Association Learning task, K6 Kessler Psychological Distress Scale, MAAS Mindful Attention and Awareness Scale, ASI Addiction Severity Index, LSAS Liebowitz Social Anxiety Scale, STAI State-Trait Anxiety Inventory, SCAS Spence Children's Anxiety Scale, PROMIS Patient-reported Outcomes Measurement Information System, PHQ-9 Patient Health Questionnaire, GAD-7 Generalized Anxiety Disorder Assessment, ISI Insomnia Severity Index, CFSS-DS Cognitive Functioning Self-Assessment Scale Dental Subscale, WBFS Wong-Baker Faces Scale, FBRF Frankl Behavior Rating Scale, HAM-D Hamilton Depression Scale, BDI Beck Depression Inventory, CSAS-C Chinese Version of the State Anxiety Scale for Children, WHO-5 WHO Five Well-Being Index, MMSE Mini-mental State Examination, SAS-A Social Anxiety Scale for Adolescents, BFNE Brief Fear of Negative Evaluation Scale, Y-BOCS Yale-Brown Obsessive Compulsive Scale, MOCA-B Montreal Cognitive Assessment Basic, HADS Hospital Anxiety and Depression Scale, DASS-21 Depression Anxiety Stress Scale-21, SDS Sheehan Disability Scale, SF-6D Short Form (Six-Dimension) Health Survey, HPLP-II Health-Promoting Lifestyle Profile, YDQ Young Diagnostic Questionnaire, PDS Posttraumatic Diagnostic Scale, DTQ Disclosure of Trauma Questionnaire, FFMQ Five Facets Mindfulness Questionnaire, SWLS Satisfaction with Life Scale, PSS=Perceived Stress Scale, CES-D Center for Epidemiologic Studies Depression Scale, CDIS Clinical Diagnostic Interview Scale, ADHD-RS-IV ADHD Rating Scale-IV, SNAP-IV Swanson Nolan and Pelham, Version IV Scale- parent form, WISC-IV-Chinese Chinese-Wechsler Intelligence Scale for Children, WCST Wisconsin Card Sorting Test, SPS Social Phobia Scale, SIAS Social Interaction Anxiety Scale, ESS Experience of Shame Scale, TKSS Tajjin-Kyofusho Scale, SAS Social Anxiety Scale, FCV-19S Fear of COVID-19 Scale, HAM-A Hamilton Anxiety Rating Scale, PSAS Pre-sleep Arousal Scale, EPDS Edinburgh Postnatal Depression Scale, PANAS Positive and Negative Affect Schedule, PSQI Pittsburgh Sleep Quality Index Questionnaire, FSS Fatigue Severity Scale, PRMQ Prospective and Retrospective Memory Scale, W-DEQ Wijma Delivery Expectancy Questionnaire, DBAS Dysfunctional Beliefs and Attitude about Sleep Scale, WSAS Work and Social Adjustment Scale, TFEQ-R18 Three-Factor Eating Questionnaire revised, PFS Power of Food Scale, SCL-D Symptom Checklist 90-Depression, PCC Post-traumatic Cognitive Changes, SFI Social Functioning Impairment, CSE Trauma Coping Self-Efficacy Scale, PSYCHLOPS Psychological Outcomes Profile.

Primary outcome and secondary outcome only report mental health-related outcomes.

Significance, significance post-intervention, sig significant, non sig not significant.

Significance* = significance of pre-intervention compared to follow-up, defined as a period occurring some time after the intervention. Marked if the outcome measure is not only significant post-intervention, but also significant at follow-up.

NA, not applicable. The study did not report the group x time effect for the outcome measures.

Effect sizes are presented only when they were reported in the original publication; cells are left blank when an article did not include an effect-size statistic.

Some studies report Cohen's (d), while others provide Hedges' (g) or odds ratios (OR). Each cell specifies the name of the measure used to ensure clarity and accuracy in interpretation.

*Wang et al.³⁷ conducted their intervention testing on two distinct samples: one urban/unsupported sample and one rural/supported sample separately. Notably, while the urban sample fulfilled the inclusion criteria, the rural sample did not. Therefore, all results reported in the table are specific to the urban sample.

Scale^{29,31,37}, Social Phobia Scale^{29,31,37}, Social Anxiety Scale¹⁹, Liebowitz Social Anxiety Scale²³, and State-Trait Anxiety Inventory²³. All three interventions—one web-based cognitive behavioral therapy (CBT)^{31,37} and two mobile-based cognitive bias modification for interpretation^{19,23}—significantly reduced social anxiety. However, one of the three trials examining the web-based CBT treatment only investigated the predictors of treatment adherence and outcomes but did not report the effects on outcomes²⁹. Another one of these three trials reported large effect sizes³⁷. Lin et al. also measured the level of Tajjin Kyofusho (TKS), a culturally specific form of social anxiety common in Eastern cultures where individuals worry that their behaviors, expressions, or physical characteristics might offend or discomfort others³¹, as the primary outcome measure using the 31-item Tajjin Kyofusho Scale (TKSS). The study found that participants in the intervention group with higher pretreatment TKS levels showed significant reductions in TKSS scores posttreatment.

Mental wellbeing. Four mindfulness-based interventions (MBI) (14%) assessed general mental health and well-being, two as the primary outcome^{18,32} and two as the secondary outcome¹⁶. All four interventions

used the World Health Organization Five Well-Being Scale (WHO-5), a short, self-administered, and positively worded scale that measures subjective well-being over the past two weeks. Wong et al. investigated an intervention based on the lifestyle medicine approach, using the Depression, Anxiety, and Stress Scale – 21 Items to assess overall mental health as the primary outcome measure²⁵. Additionally, the Step-by-step intervention trials conducted by Sit et al.²⁰ and Li G et al.²¹ measured subjective wellbeing as the secondary outcome using WHO-5. Six interventions^{16,18,21,25,32} significantly improved mental well-being following the interventions and reported small to moderate effect sizes.

Cognitive function. Four of the included interventions (14%) measured cognitive function as the primary outcome^{27,30,41,46} and one measured it as the secondary outcome⁴⁵. These studies evaluated the efficacy of different interventions: a VR-based exposure and response prevention intervention for female OCD patients⁴⁵, a computer-assisted cognitive remediation intervention for adult patients with major depression⁴⁶, a web-based executive function training intervention for pediatric ADHD patients³⁰, a mobile-based attention training intervention for pediatric patients with

depressive episodes⁴¹, and a cognitive training and cognitive bias modification-based intervention for males with methamphetamine use disorder²⁷. Cognitive function was assessed using screening tests including Montreal Cognitive Assessment-Basic⁴⁵, Wisconsin Card Sorting Test⁴⁶, Trail Making Test, Stroop Color and Word Test, the CogState Battery²⁷, objective evaluation³⁰, and the Mini Mental State Evaluation Scale⁴¹. Four interventions^{27,41,45,46} significantly improved cognitive function and performance for participants in the intervention group, but no effect sizes were reported in the original articles. Additionally, the web-based executive function training intervention for pediatric ADHD patients did not demonstrate significant effects on executive function based on objective evaluations³⁰.

Sleep. Two interventions, one utilizing CBT³⁵ and one a MBI¹⁶, measured sleep-related indicators as primary outcome measures. Four other interventions, one employing relaxation and physical activity²⁶, one using MBCT²⁴, one implementing CBT²², and one adopting a lifestyle-medicine approach²⁵, measured sleep-related indicators as secondary measures. The assessment measures included the Insomnia Severity Index^{16,22,25,35}, Pre-sleep Arousal Scale^{16,35}, Dysfunctional Beliefs and Attitudes about Sleep Scale¹⁶, Pittsburgh Sleep Quality Index²⁴, and the Patient-Reported Outcomes Measurement Information System²⁶. Both interventions that targeted sleep-related concerns as the primary outcome reported significant improvements in the intervention group post-intervention^{16,35}; of these one reported large effect size¹⁶.

COVID-19 related outcomes. Four of the included studies directly addressed pandemic-related mental health challenges. Among these, one CBT-based intervention measured the severity of situational insomnia³⁵, three other interventions examined COVID-19 related depression or anxiety symptoms as the outcome measures^{22,26,44}. Zhang et al. documented three cases of patients with generalized anxiety disorder, who were primarily concerned with COVID-19 infection anxiety and reported that exposure therapy significantly reduced their anxiety levels⁴⁴. Zheng et al. used an intervention promoting relaxation and physical activity and significantly reduced anxiety and eye strain among Chinese middle school students under home confinement²⁶. Song et al. tested the efficacy of an iCBT intervention on reducing COVID-19 related mental health problems and reported medium effect sizes²².

Others. An expert system intervention for college students with internet addiction found a significant decrease in self-reported hours spent online per week and online satisfaction after the intervention. The intervention was found to have large effect sizes³³. Two CBT-based interventions for substance use—one targeting smoking cessation²⁸ and the other for adults with recent substance use¹⁷—reported significant improvements in addiction levels following smartphone-based interventions using measures including self-reported cigarette consumption and the timeline follow-back survey on primary drug use. Li A et al. measured eating behaviors with the Three-Factor Eating Questionnaire and the Power of Food Scale after a mindfulness-based intervention with eating-specific exercises and found significant improvements¹⁶.

Public availability

Of the 28 interventions reviewed, only one (4%) remained publicly available after the conclusion of the study¹⁸. Mak et al. designed the “Living with Heart” intervention, a mobile-based intervention in Hong Kong that offers mindfulness, self-compassion, and cognitive behavioral psychoeducation training for the general public¹⁸. The Android mobile version of this intervention is publicly accessible⁴⁷.

The effective web-based CBT intervention for Chinese depression patients, MoodGYM, was reported by Yeung et al. and Ren et al.^{34,36}. Although originally developed in Australia and translated into Chinese for the studies, only the English and the German version are currently available⁴⁸. Additionally, the smartphone-based lifestyle medicine

intervention developed by Wong et al., to address overall mental health for the general public in Hong Kong is expected to become available later this year²⁵. All other interventions (86%) reported in the reviewed studies are not publicly available.

Study design

According to the Oxford Centre for Evidence-Based Medicine levels of evidence⁴⁹, this review included 25 (78%) randomized controlled trials (RCTs), six (19%) quasi-experimental designs, and one case series.

Randomized controlled trials

Six RCTs used an active control group, including four trials with “treatment as usual”^{27,39,41,46} and two trials as “enhanced treatment as usual”^{18,21}. Three trials used a “no treatment”^{31,40,43} group. Four trials used attention control by adding components such as mental health education or basic counseling^{17,24,26,28}. Ten trials utilized a waitlisted control group, granting participants in the control group access to the intervention after the trial’s completion^{16,19,25,32–34,36–38}. Two trials used a mock intervention like the experimental intervention^{23,30}. Among all RCT trials, two employed a three-arm design^{18,32}.

Quasi-experimental designs

Of the six trials that adopted a quasi-experimental design, three employed a non-randomized approach. One trial evaluated cognitive behavioral therapy for COVID-19-related mental health problems, demonstrating its impact on reducing symptoms associated with the pandemic²². The other trials focused on treating social anxiety²⁹ and OCD⁴⁵ respectively. Additionally, three trials utilized a single group, pre-post uncontrolled design to evaluate the effectiveness of interventions^{20,35,42}.

Case series

One case series study explored the role of virtual reality exposure therapy in treating psychiatric illness in three patients who had chief complaints of fear of COVID-19 infection⁴⁴.

Quality assessment and acceptance

Quality assessments were conducted using the JBI critical appraisal tools. Results for the 31 publications included in Tables 2–4. While the review includes 32 trials, the quality assessment for the two RCTs from Li A et al., was based on that publication as a whole, resulting in 31 quality assessments¹⁶. Among the 24 RCTs reviewed, five (21%) had a low risk of bias^{21,24–27}, 16 (67%) had a moderate risk of bias^{16,18,19,23,28,30–32,34,40,41,43,46}, three (13%) had a high risk of bias^{17,33,39}. Studies with moderate or high bias risk often showed weaknesses in selection, allocation, intervention administration, and outcome assessment methods, primarily due to unspecified randomization procedures or lack of participant and outcome assessor blinding. Due to the nature of psychotherapy interventions, double-blind designs were rarely feasible, with only two studies^{24,28} employing them. If the blinding of the participants and personnel rating were removed from the assessment, the risk of bias for these eight trials would be reduced significantly^{16,18,25,32,36,38,40,43}. Of the six quasi-experimental studies reviewed, two (33%) had low risk of bias^{29,45}, two (33%) had moderate risks^{20,22}, and two (33%) had high risks^{35,42}, primarily due to issues in selection and allocation, particularly the absence of a control group. The case series study had a high risk of bias as it lacked information regarding inclusion criteria and demographics of the patients.

Additionally, seven interventions (25%) reported the acceptability or satisfaction levels of participants using a combination of questionnaires²⁵, self-designed surveys^{17,34,38,40,42}, and qualitative interviews^{20,21,40}. All seven interventions reported high levels of acceptability and satisfaction among participants, indicating a positive reception and perceived value of the interventions.

Discussion

This review systematically examined 31 publications that reported 28 unique DMHIs in Chinese. The interventions tackled a wide range of mental

Table 2 | Quality assessments for randomized controlled trials included in the review

Citation	Domain	Internal validity bias related to:										Statistical conclusion validity			Risk of Bias
		Selection and allocation			Administration of intervention/exposure			Assessment, deduction, and measurement of the outcome			Participant retention	11	12	13	
Item	1	2	3	4	5	6	7	8	9	10	11	12	13		
Su, W., et al., 2011	Online hours per week	Y	U	N	Y	U	Y	U	Y	U	U	Y	U	N	HIGH
	Online satisfaction							U	Y	U	U	Y	U		
	Internet addiction							U	Y	Y	U	N	U		
Wang, Z., et al., 2013	PTSD	Y	U	Y	U	U	Y	U	Y	Y	Y	Y	Y	Y	MODERATE
	Disclosure of trauma							U	Y	Y	Y	Y	Y		
Mak, W., et al., 2015	Mindfulness	Y	U	Y	U	U	Y	U	Y	Y	Y	Y	Y	Y	MODERATE
	Mental wellbeing							U	Y	Y	Y	Y	Y		
	Life satisfaction							U	Y	Y	Y	Y	Y		
	Perceived stress							U	Y	Y	Y	Y	Y		
	Psychological symptoms							U	Y	Y	Y	Y	Y		
Ren, Z., et al., 2016	Depression	Y	U	Y	U	U	Y	U	Y	Y	Y	Y	Y	Y	MODERATE
	Mediators (negative thoughts, dissonance, interpretation bias)							U	Y	Y	Y	Y	Y		
Li, Y., et al., 2017	ADHD	Y	U	Y	U	U	Y	U	Y	Y	Y	Y	Y	Y	MODERATE
	Executive function					U	Y	Y	Y	Y	Y	Y	Y		
Liang, D., et al., 2018	Urine test	U	N	Y	N	N	N	N	N	Y	Y	Y	Y	Y	HIGH
	Addiction severity							N	N	N	Y	Y	Y		
	Intervention usability							N	N	Y	Y	Y	Y		
Liao, Y., et al., 2018	Biochemically verified continuous smoking abstinence	Y	Y	U	Y	Y	Y	U	Y	Y	Y	Y	Y	Y	MODERATE
	Self-reported 7-day point prevalence of abstinence							U	Y	Y	Y	Y	Y		
	Self-reported continuous abstinence at 4, 12, 24 weeks							U	Y	Y	Y	Y	Y		

Citation	Domain	Internal validity bias related to:										Statistical conclusion validity			Risk of Bias
		Selection and allocation			Administration of intervention/exposure			Assessment, deduction, and measurement of the outcome			Participant retention	11	12	13	
	Item	1	2	3	4	5	6	7	8	9	10				
	Average number of cigarettes smoked per day							U	Y	Y	Y	Y	Y		
Mak, W., et al., 2018	Mental wellbeing	Y	N	Y	N	N	Y	N	Y	Y	Y	Y	Y	Y	MODERATE
	Psychological distress							N	Y	Y	Y	Y	Y		
	Mindful awareness							N	Y	Y	Y	Y	Y		
	Self-compassion							N	Y	Y	Y	Y	Y		
Yeung, A., et al., 2018	Depression	Y	U	Y	U	U	Y	U	Y	Y	Y	Y	Y	Y	MODERATE
Zhu, Y., et al., 2018	Social cognition	Y	Y	Y	Y	N	Y	N	Y	Y	Y	Y	Y	Y	LOW
Sun, X., et al., 2019	Social anxiety	Y	N	Y	U	U	Y	U	Y	Y	Y	Y	U	Y	MODERATE
	State anxiety							U	Y	Y	Y	Y	U		
	Trait anxiety							U	Y	Y	Y	Y	U		
Lin, Y., et al., 2020	Social anxiety without TKS	U	U	Y	U	U	Y	U	Y	Y	Y	Y	U	U	MODERATE
	Social anxiety with TKS							U	Y	Y	Y	Y	U		
Zhu, C., et al., 2020	Cognitive function	Y	U	Y	U	U	Y	U	Y	Y	U	U	Y	Y	MODERATE
Wang, H., et al., 2020	Shame proneness	U	U	Y	U	U	Y	U	Y	Y	Y	Y	Y	Y	MODERATE
	Shame level							U	Y	Y	Y	Y	Y		
	Social anxiety							U	Y	Y	Y	Y	Y		
	Children's Fear Survey Schedule-Dental Subscale							U	Y	Y	Y	Y	Y		
Ran, L., et al., 2021	Children's Fear Survey Schedule-Dental Subscale	Y	N	Y	N	N	Y	N	Y	Y	Y	Y	Y	U	MODERATE
	Wong Baker FACES Pain Rating Scale							N	Y	Y	Y	Y	Y		
	Depression	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	LOW

Citation	Domain	Internal validity bias related to:										Statistical conclusion validity			Risk of Bias
		Selection and allocation			Administration of intervention/exposure			Assessment, deduction, and measurement of the outcome			Participant retention	11	12	13	
Item	1	2	3	4	5	6	7	8	9	10	11	12	13		
Sun, Y., et al., 2021	Anxiety							Y	Y	Y	Y	Y	Y		
	Stress							U	Y	Y	Y	Y	Y		
	Affect							Y	Y	Y	Y	Y	Y		
	Sleep							Y	Y	Y	Y	Y	Y		
	Fatigue							Y	Y	Y	Y	Y	Y		
	Memory							Y	Y	Y	Y	Y	Y		
Zheng, Y., et al., 2021	Self-reported anxiety	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	
	Eye strain							Y	Y	Y	Y	Y	Y		
	Sleep quality							Y	Y	Y	Y	Y	Y		
Li, A. et al., 2022	Insomnia	Y	N	Y	N	N	Y	N	N	Y	Y	Y	Y		
	Dysregulated eating							N	N	Y	Y	Y	Y		
	Mental wellbeing							N	N	Y	Y	Y	Y		
Wong, L., et al., 2022	Anxiety	Y	N	Y	N	N	Y	N	Y	Y	Y	Y	Y		
Feng, X., et al., 2022	Depression	U	U	Y	U	U	Y	U	Y	Y	U	U	Y	U	
Mao, N., et al., 2023	Social anxiety	U	U	Y	U	U	Y	N	Y	Y	Y	Y	Y	Y	
	Negative evaluation							N	Y	Y	Y	Y	Y		
Li, B., et al., 2023	Depression	Y	U	Y	U	U	Y	U	Y	Y	U	U	Y	Y	
	Mental wellbeing							U	Y	Y	Y	Y	Y		
Wong, V., et al., 2024	Overall mental health condition	Y	N	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y	
	Depressive symptoms							Y	Y	Y	Y	Y	Y		

Citation	Domain	Internal validity bias related to:										Statistical conclusion validity			Risk of Bias
		Selection and allocation			Administration of intervention/exposure			Assessment, deduction, and measurement of the outcome			Participant retention	11	12	13	
	Item	1	2	3	4	5	6	7	8	9	10				
	Anxiety symptoms							Y	Y	Y	Y	Y	Y		
	Stress							Y	Y	Y	Y	Y	Y		
	Insomnia							Y	Y	Y	Y	Y	Y		
Li, G., et al., 2024	Depression	Y	Y	Y	N	U	Y	Y	Y	Y	Y	Y	Y	Y	LOW
	Anxiety							Y	Y	Y	Y	Y	Y		
	Well-being							Y	Y	Y	Y	Y	Y		
	Self-defined psychosocial problem							Y	Y	Y	Y	Y	Y		

Cells are color-coded to indicate the results of the critical appraisal based on the JBI critical appraisal tools.
 Green cells with (Y) = criterion was met.
 Yellow cells with (U) = unclear criteria.
 Red cells with (N) = criterion was not met.
 Unlabeled and uncolored cells = not applicable.

Table 3 | Quality assessments of quasi-experimental trials included in the review

Citation	Domain	Internal validity bias related to:								Statistical conclusion validity	Risk of bias
		Temporal precedence	Selection and allocation	Confounding factors	Administration of intervention/exposure	Assessment detection and measurement of the outcome			Participant retention		
	Item	1	2	3	4	5	6	7	8	9	
Chen, H., et al., 2020	Social anxiety disorder	Y	Y	N	Y	Y	Y	Y	Y	Y	LOW
	Intervention adherence					N	Y	Y			
Zhang, C., et al., 2021	Sleep	Y	N	Y	N	Y	U	Y	U	U	HIGH
	Insomnia					Y	U	Y	U	U	
	Depression					N	U	Y	U	U	
	Anxiety					N	U	Y	U	U	
Song, J., et al., 2021	Depression	Y	Y	Y	N	Y	Y	Y	U	Y	MODERATE
	Anxiety					Y	Y	Y	U	Y	
	Insomnia					Y	Y	Y	U	Y	
	Psychological resilience					Y	Y	Y	U	Y	
	Self-rated anxiety					Y	Y	Y	U	Y	
Sit, H., et al., 2022	Depression	Y	N	N	N	Y	N	Y	Y	Y	MODERATE
	Anxiety					Y	N	Y	Y	Y	
Zhu, J., et al., 2023	Treatment compliance	Y	Y	Y	Y	N	Y	Y	Y	Y	LOW
	OCD					N	Y	Y	Y	Y	
	Cognitive function					N	Y	Y	Y	Y	
Mao, W., et al., 2024	Anxiety	Y	N	N	N	N		Y	Y	Y	HIGH
	Depression					N		Y	Y	Y	
	Cancer-related fatigue					N		U	Y	Y	

Note. cells are color-coded to indicate the results of the critical appraisal based on the JBI critical appraisal tools.
 Green cells with (Y) = criterion was met.
 Yellow cells with (U) = unclear criteria.
 Red cells with (N) = criterion was not met.
 Unlabeled and uncolored cells = not applicable.

Table 4 | Quality assessment of the case series trial included in the review

Citation	Item	Appraisal	Risk of bias
Zhang, W., et al., 2024	Clear inclusion criteria	U	HIGH
	Standardized, reliable measurement of condition	Y	
	Valid methods for condition identification	N	
	Consecutive inclusion of participants	U	
	Complete inclusion of participants	U	
	Clear reporting of participant demographics	N	
	Clear reporting of participants' clinical information	N	
	Clear reporting of outcomes or follow-up results	Y	
	Clear reporting of presenting site(s)/clinic(s) demographic information	N	
	Appropriate statistical analysis	Y	

Note. cells are color-coded to indicate the results of the critical appraisal based on the JBI critical appraisal tools. Green cells with (Y) = criterion was met. Yellow cells with (U) = unclear criteria. Red cells with (N) = criterion was not met. Unlabeled and uncolored cells = not applicable.

health issues including depression, anxiety, cognitive function, mental well-being, insomnia, substance-related addictive disorders, and COVID-19-related symptoms. Most interventions (19/28) were either mobile or internet-based, and about one-third utilized virtual reality technology, underscoring an area of growing research interest. Predominantly, examined studies employed randomized controlled trials (25/32). Seven interventions that examined acceptability reported high levels. Most interventions (27/28) demonstrated significant improvements in at least one primary mental health outcome post-intervention. Effect-size statistics were provided for 14 interventions with most laying in the small to moderate range. The results on sustained effectiveness of the interventions over time were mixed, only eight interventions reported follow-up data, and four showed sustained post-treatment gains across all primary mental health outcomes. Only one intervention remained publicly available and fully functional after the study conclusion.

Research on DMHIs for children is gaining traction. Among the six interventions that targeted children, three addressed anxiety, one targeted depression, one focused on ADHD, and one was aimed at social anxiety. Although studies on children and adolescents included in this review remain less common compared to adults, their representation has notably increased since the previous review in 2021⁸. This rising interest can be attributed to several key factors. First, digital interventions are inherently aligned with the younger generation's proficiency in technology, making these tools especially engaging and practical for children and adolescents. Second, the privacy and confidentiality provided by these interventions can be valuable for adolescents who may be more sensitive to stigma and peer perception

when dealing with mental health issues. For instance, Mao et al.¹⁹ demonstrated the effectiveness of a mobile-based intervention for adolescents with social anxiety, highlighting the importance of reducing stigma in this context. Third, digital interventions can be seamlessly integrated into school systems, offering direct support within educational settings. Zheng et al.'s online streaming intervention, implemented as a course for grade seven students during COVID-19 home confinement, displayed how such resources can be utilized within schools to address mental health needs²⁶.

There were relatively few interventions (5/28) targeting the general adult population, which highlights a gap in the application of DMHIs for broader population-based detection and early prevention in the Greater China region. Most interventions (19/28) targeted individuals with specific mental health conditions, with six designed to augment traditional psychotropic medication and psychological counseling. This indicates that DMHIs are often used to enhance rather than replace existing treatment methods. The integration of DMHIs alongside traditional care emphasizes their role as complementary tools that can expand upon current mental health services. By enhancing traditional approaches and providing additional support, DMHIs offer new avenues for improving mental health care delivery and accessibility, rather than substituting existing systems. While designing, rolling out and evaluating DMHIs for the general adult population are important next steps, developing targeted interventions for vulnerable groups such as the elderly, migrants, and the LGBTQ community should also be priorities for future research. The use of DMHIs can break down major barriers faced by these populations in accessing mental health services including privacy and confidentiality, filling a critical gap in care by

significantly enhancing the inclusivity and effectiveness of the digital mental health landscape.

This review showed that while DMHIs are increasingly employed to address specific mental health outcomes, there is limited information on whether participants utilized other interventions concurrently. This points to an opportunity for developing a poly-digital ecosystem, where individuals can personalize their use of various digital interventions to optimize their mental health outcomes¹². In considering the effectiveness of DMHIs, while there is variability in the effect of different interventions on individual users, most studies included in this review reported small to moderate effects. If different DMHIs are used in tandem, there is a possibility that their effects would compound, potentially leading to greater overall effectiveness and sustained benefits over time. Exploration of the possibility of such synergistic interaction between different DMHIs could contribute to the development of personalized and effective mental health care solutions.

In examining the distribution of DMHIs across Greater China, it became evident that most have been tested or conducted in provinces or regions characterized by higher income and greater development. This concentration in more affluent areas may skew the perceived effectiveness and accessibility of these interventions, as they are not being widely tested in lower-income, less developed regions where digital infrastructure and healthcare resources are more limited. The primary advantage of DMHIs, especially those that are mobile or web-based, lies in their potential to expand the reach and accessibility of traditional mental healthcare⁵⁰. This is especially important in the geographically, demographically, and culturally diverse Greater China regions, where regional disparities in healthcare provision are pronounced and national and regional strategies could benefit from digitally scalable solutions that can reach underserved areas, where traditional in-person mental health services are scarce or non-existent. However, the current focus on high-income regions raises concerns about the applicability and effectiveness of these interventions in diverse socioeconomic environments. Moreover, our review focused exclusively on self-guided interventions, which inherently possess a greater potential for scalability due to their lower reliance on continuous professional oversight. Self-guided DMHIs could be crucial in democratizing mental health support, making basic care accessible to a broader audience at a significantly reduced cost. Nevertheless, the challenge remains to be how these technologies are made adaptable and relevant to the cultural and social contexts of users across development contexts.

A trend identified in this review was the adaptation of internationally developed DMHIs for the Chinese context. Six of the included studies investigated interventions originating from countries including the United States, Switzerland, and Australia. While some research teams took a straightforward approach by translating these effective interventions into Chinese, three interventions incorporated some degree of cultural adaptation. Despite the differences in adaptation levels, these interventions generally demonstrated significant positive outcomes among the target populations.

Among the three interventions that included cultural modifications, only one described a rigorous adaptation process based on the Ecological Validity Model²⁰, while the others relied more on expert opinion for guidance^{23,29,31}. The lack of detailed descriptions of the adaptation process in the majority of the studies raises concerns about the adequacy and appropriateness of these adaptations for the Chinese population. This oversight highlights a critical gap in ensuring that these interventions are culturally relevant and effective in the adapted context. Additionally, this field faces an issue with transparency, as the full contents and methodologies of DMHIs often remain undisclosed and are frequently inaccessible to the broader community. Open source DMHIs can significantly improve transparency, which allows for a greater and more flexible iteration by the wider scientific and clinical communities, thus improving the quality, cultural relevance, and accessibility of such interventions⁵¹.

DMHIs have a well-established track record of development and validation in Western countries. However, their introduction to China has

been more recent, with a notable exponential increase over the past decade⁸. With aims towards the broader implementation of DMHIs in China, it is crucial that future research focuses on developing robust frameworks for comprehensive cultural adaptation. This will help ensure the interventions are not only relevant but also effective for the Chinese population, thereby maximizing their efficacy and impact. Moreover, enhancing cultural adaptation may not only boost the effectiveness of DMHIs within China but also increase their appeal and applicability to Chinese communities abroad.

Seven interventions used virtual reality as the medium and were all conducted in hospital settings. Among these, two studies incorporated mindfulness techniques, ranging from mindfulness training to stress reduction therapy. Feng et al.'s³⁹ reported that VR-based mindfulness intervention improved depression symptoms in Parkinson's patients, Mao et al.⁴² observed reductions in depressive and anxiety symptoms among ovarian cancer patients. These positive outcomes suggest that MBI delivered through virtual reality have the potential to be developed for broader public use, potentially offering significant benefits to individuals who can access these resources.

Wong et al.⁴⁰ and Ran et al.'s⁴³ VR interventions were both distraction interventions where VR was used on pediatric patients to ease their anxiety symptoms with positive outcomes. The interventions provided real-time distraction and emotional support for pediatric patients undergoing chemotherapy or dental treatments, complementing traditional medical treatments, and improving patient well-being and compliance^{40,43}. This innovative use of VR-based DMHIs extends their application beyond traditional mental health settings into multidisciplinary healthcare environments. Integrating VR-based DMHIs into such diverse settings demonstrates their versatility and their potential to bridge gaps between mental health and general healthcare. The positive outcomes observed suggest that integrating VR-based DMHIs into routine clinical practice could potentially improve patient care in medical disciplines, leading to more holistic and patient-centered approaches to health.

VR interventions can also deliver another means of exposure therapy, as evidenced by studies such as Zhu et al.'s study⁴⁵ on female OCD patients and Zhang et al.'s study⁴⁴ on anxiety patients with COVID-19-specific symptoms. Unlike traditional imaginal exposure methods, VR can simulate environments that trigger symptoms, providing patients with a fully immersive experience. Both studies observed positive results, including significant symptom reduction. This indicates that VR exposure therapy holds considerable potential for enhancing treatment outcomes by creating more engaging and realistic therapeutic experiences. The ability to replicate and control symptom-inducing scenarios in a virtual setting could also lead to more effective and personalized treatment options.

None of the virtual reality interventions reviewed are publicly available, as they were specifically developed for use in the intervention and have not been commercialized. Accessibility of VR interventions is also limited due to the requirement for VR equipment or headsets. Despite the growth of the VR industry, headsets remain relatively costly and are not easily accessible to most households. Furthermore, most VR interventions were examined in hospital settings with the necessary resources, and it was not specified whether the VR interventions were compatible with specific headset models.

The evolving landscape of DMHIs in Greater China calls for continued research to explore digital innovations such as poly-digital interventions that integrate multiple tools to create personalized care pathways. Future studies are recommended to focus on developing scalable and adaptable solutions that address the needs of diverse populations, particularly those in low-resource or rural areas, ensuring these interventions are both accessible and cost-effective. As DMHIs continue to evolve, their successful integration into existing health systems, particularly in primary care settings, is likely to be crucial for sustainability and bridging gaps in mental health service delivery. Furthermore, research should prioritize evaluating the long-term effectiveness of DMHIs, assessing not only their immediate impact but also their ability to sustain improvements over time. Rigorous cultural adaptation of successful international DMHIs can be a promising approach to ensure these tools are relevant and effective within the Chinese

context. Ultimately, with further research in these key areas, DMHIs have the potential to transform the mental health care in Greater China, providing scalable, accessible solutions to meet the diverse mental health needs of local populations.

Methods

Search strategy and selection criteria

Zhang et al.⁸ reviewed the digital mental health landscape in China up to June 2021. This review builds on their work by incorporating the latest progresses in the field. To do this, four English-language databases (MEDLINE, PsycINFO, EMBASE, Cochrane Central Register of Controlled Trials via Ovid) and four Chinese-language databases (CNKI, Weipu, Wanfang, and Sinomed) were searched for peer-reviewed articles reporting DMHIs interventions available in the Chinese language published between January 1, 2021, and February 24, 2024. Search terms including “mental health”, “telehealth”, and “Chinese” or “China” were used to search the databases. The search strategy (Supplementary Table 1) focused on mental health disorders to prioritize interventions targeting diagnosable outcomes that are commonly reported in clinical trials. Additionally, the Cochrane Central Register of Controlled Trials database was further examined for the publication of complete trials, and only the published articles of the complete trials were included. During manuscript revision, we identified one additional publication evaluating the same intervention as an included pilot via a targeted supplementary check; this study was added for completeness and is reported in the PRISMA diagram under “Others.”

To be included in the current review, the mental health interventions should (i) enroll Chinese-speaking participants residing in Greater China (mainland China, Hong Kong, Macao, Taiwan); (ii) have at least one peer-reviewed publication reporting quantitative efficacy or effectiveness data in human participants (i.e., evidence-based); (iii) be enabled by digital technology; (iv) be fully automated and self-paced—meaning that all therapeutic content could be delivered without real-time, individualized clinician or coach contact, although one-off orientation or automated reminders were acceptable; (v) be available in either simplified or traditional Chinese; and (vi) include at least one of the mental health problems as the outcome. Any comparator or none was accepted. Interventions that are designed for severe mental conditions, including schizophrenia, psychosis, Alzheimer’s disease, and autism are not included in the current review. No additional exclusion criteria, such as age restrictions, were applied to capture a broad scope of the digital mental health literature for this scoping review. When multiple studies report on different clinical trials of the same mental health intervention, we included all papers that met our inclusion criteria. This approach allows us to assess how intervention has been applied across various settings and populations, enhancing our understanding of its generalizability and effectiveness. However, in cases where several publications report on the same trial, only those studies that contribute unique insights relevant to our primary interest in mental health outcomes associated with the intervention were included. Additionally, we prioritized studies that analyzed large original samples to ensure a comprehensive understanding of the intervention. This scoping review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) guideline (see the Supplementary Table 2), and the protocol has been registered with the Research Registry (#reviewregistry1861).

Data extraction and analysis

Studies were screened firstly based on titles and abstracts, with this initial screening conducted independently by three researchers (J.H., Y.L., V.S.), each reviewing a subset of the studies. Title and abstract screening was conducted as single screening. Following this, full-text reviews of 141 papers was conducted, with each paper independently double screened by Y.L. and V.S. Any disagreements in the full-text screening process were resolved through discussions facilitated by a senior reviewer (J.H.). Data of the eligible papers were then extracted using a custom spreadsheet to record the study population, trial design, the intervention name, online intervention modalities and therapeutic model, region of development, content of

intervention, study outcomes, and public availability (see Supplementary Table 3 for the final data collection form).

Each peer-reviewed study included in this review underwent quality assessment using the Joanna Briggs Institute (JBI) critical appraisal tools conducted by E.J. and Y.L. This approach involved examining items including study design, participant selection criteria, methods of intervention allocation, blinding procedures, and outcome measurement techniques. Each item was coded as “Yes” (“Y”, meeting the criterion), “No” (“N”, not meeting the criterion), and “Unclear” (“U”, not reported). If an item was not applicable to the study, its coding was left blank. The overall risk of bias for each study was determined by items on internal validity, excluding those on statistical validity. Thus, items 11–13 from the RCT appraisal tool and item 9 from the quasi-experimental appraisal tool were omitted from consideration. The risk of bias percentage was calculated from the number of “Yes” responses out of all applicable items—excluding any that were left blank. Based on this percentage, studies were categorized as high risk if fewer than 50% of the items are scored as “Y”, moderate risk if between 50% and 79% were scored as “Y”, and low risk if between 80% and 100% were scored as “Y”. The review’s compliance against the PRISMA-ScR guideline was assessed by J.H. and W.Y.Z. All the authors critically reviewed and approved the manuscript. Due to the heterogeneity among the studies, we organized the descriptive statistics based on interventions, creating separate entries for each eligible intervention within publications and combining studies that employed the same intervention or reported on the same trial into one entry.

Data availability

All data generated or analyzed in this study are provided in the published article and its supplementary information files.

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Author contributions

J.H., B.J.H., and Y.L. conceived the study. JH developed search strategies with assistance from Y.L., V.S., B.J.H., and E.J. Y.L., V.S., and J.H. conducted data analysis and created charts. Y.L. and E.J. performed quality assessments. J.H. and W.Y.Z. reviewed the manuscript to ensure compliance with the PRISMA-ScR guidelines. Y.L. and V.S. wrote the initial draft of the manuscript under J.H.'s supervision. All authors contributed to the manuscript revision and approved the final version submitted.

Competing interests

The authors declare no competing interests.

Additional information

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