



Original article

Interventions for psychiatric disorders among university students: An umbrella review of systematic reviews and meta-analyses



Huan Huang^{a,†}, Shaofen Huang^{b,†}, Shiyun Chen^c, Xuping Gao^{c,d}, Jun Cai^c, Yonghui Feng^c, Jiazi Liu^c, Xin Su^c, Jiamin Qiu^c, Shiwen Zhang^c, Ying Xu^e, Zheng Liu^{e,*}, Ting Wang^{f,*}, Fangfang Zeng^{c,*}

^a Political Security Department of the Party Committee/People's Armed Forces Department, Jinan University, No.601 Huangpu Road West, Guangzhou 510632, Guangdong, PR China

^b Shenzhen Qianhai Shekou Free Zone Hospital, 36 Gongye 7th Road, Shekou, Shenzhen 518067, Guangdong, PR China

^c Department of Public Health and Preventive Medicine, School of Medicine, Jinan University, No.601 Huangpu Road West, Guangzhou 510632, Guangdong, PR China

^d Peking University Sixth Hospital (Institute of Mental Health), National Clinical Research Center for Mental Disorders & Key Laboratory of Mental Health, Ministry of Health (Peking University), 51 Huayuan Bei Road, Beijing 100191, PR China

^e Baoan Center for Chronic Diseases Control, 332 Yu'an 2nd Road, Bao'an District, Shenzhen 518101, Guangdong, PR China

^f School of Management, Jinan University, No.601 Huangpu Road West, Guangzhou 510632, Guangdong, PR China

ARTICLE INFO

Keywords:

Mental disorders
Exercise interventions
Cognitive behavioural interventions
Umbrella review
Meta-analysis

ABSTRACT

Background: Mental disorders are considered to be the main reason for the increase of the disease burden. College students seem to be more vulnerable to the adverse effects of stress, which makes them more at risk of suffering from mental disorders. This umbrella review aimed to evaluate the credibility of published evidence regarding the effects of interventions on mental disorders among university students.

Methods: To identify systematic reviews and meta-analyses investigating the effects of interventions on mental disorders in the university student population, extensive searches were carried out in databases including PubMed, Embase, and the Cochrane Database, spanning from inception to July 21, 2023. Subsequently, a thorough reanalysis of crucial parameters such as summary effect estimates, 95 % confidence intervals, heterogeneity I^2 statistic, 95 % prediction intervals, small-study effects, and excess significance bias was performed for each meta-analysis found.

Results: Nineteen articles involving 74 meta-analyses were included. Our grading of the current evidence showed that interventions based on exercise, Cognitive-behavioural Intervention (CBI), mindfulness-based interventions (MBI), and other interventions like mood and anxiety interventions (MAI) were effective whereas exercise intervention had the highest effect size for both depression and anxiety among university students. However, the credibility of the evidence was weak for most studies. Besides, suggestive evidence was observed for the positive effects of CBI on sleep disturbance (SMD: -0.603, 95 % CI: -0.916, -0.290; P-random effects < 0.01) and MAI on anxiety (Hedges' g = -0.198, 95 % CI: -0.302, -0.094; P-random effects < 0.01).

Conclusion: Based on our findings, it appears that exercise interventions, CBI, and MAI have the potential to alleviate symptoms related to mental disorders. Despite the overall weak credibility of the evidence and the strength of the associations, these interventions offer a promising avenue for further exploration and research in the future. More high-quality randomized controlled trials should be taken into account to verify the effects of these interventions on various mental disorders.

Introduction

Mental disorders are increasingly considered the major driver of the

growth of disease burden and a worldwide public health concern ("Global, regional & national burden of 12 mental disorders in 204 countries & territories, 1990–2019: a systematic analysis for the Global

* Corresponding authors.

E-mail addresses: liuzheng8411@126.com (Z. Liu), wangtingjinu@126.com (T. Wang), zengffjnu@126.com (F. Zeng).

† These authors have contributed equally to this work and share first authorship.

Burden of Disease Study 2019", 2022). The global burden of diseases study (GBD) 2019 finds that depression and anxiety are rated as the 13th and 24th leading causes of DALYs, respectively, with prevalence estimates and disability significantly higher than other diseases ("Global, regional & national burden of 12 mental disorders in 204 countries & territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019", 2022).

Mental illness can negatively affect many people throughout their entire lives in different forms and degrees (Vigo, Thornicroft & Atun, 2016). It is suggested that students are vulnerable populations because they are often susceptible to the impacts of stress (Auerbach et al., 2016). To be specific, post-secondary students are at a high risk of developing mental health problems and university students may suffer from mental diseases in any given year (Auerbach et al., 2018; Ibrahim, Kelly, Adams & Glazebrook, 2013). Mental disorders can lead to various longstanding negative impacts, including poor academic performance, increased dropout rates, lowered life satisfaction, and even increased suicide risk (Gong et al., 2023; Sheldon et al., 2021).

Despite the Lancet Commission on global mental health and sustainable development advocating for paying more attention to mental health and emphasizing more investment in mental health services, global decision-makers and funders fail to realize the importance of treatment and support of people with mental diseases to some extent (Saxena, Thornicroft, Knapp & Whiteford, 2007; Sheldon et al., 2021). Given the imbalance between the increasing global burden of mental disorders and insufficient attention to mental health, evaluating and determining an effective intervention for people with mental illness is necessary.

To date, a great variety of mental health promotion interventions have been developed for people with common mental illnesses. Although methodological approaches differed between existing studies, the main promising ways include physical exercise, cognitive behavioural therapy, mindfulness-based intervention, art intervention, educational intervention, support groups, etc. totally (Sun et al., 2022). Such interventions might exert a positive effect in alleviating mental disorders. However, limited reviews systematically evaluate the effectiveness of various interventions for mental disorders, in which many of them are focused on a single topic. As such, the existing evidence is prone to occur bias like publication bias and excess significance bias, leading to an overestimated result (Jüni, Altman & Egger, 2001).

Umbrella reviews are increasingly taken into account as a methodological way to consolidate the highest quality level of evidence by merging and assessing the systematic reviews and meta-analyses (Kim et al., 2021; Papatheodorou, 2019). Compared with conventional meta-analyses examining the same treatment comparison, umbrella reviews give a more comprehensive overview of different treatments on the given question. It enables researchers to re-assess the risk of bias and hierarchies of evidence of published studies, allowing decision-makers to develop an objective guideline (Ioannidis, 2009).

Therefore, we aimed to perform an umbrella review of systematic reviews with meta-analyses to assess the effects of interventions for mental disorders in university students and evaluate the certainty of the evidence.

Method

This umbrella review was conducted by Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines (Page et al., 2021). The study was registered on the International Prospective Register of Systematic Reviews (PROSPERO) under the registration number CRD42023450905.

Search strategy and study selection

We systematically searched the electronic databases PubMed, Embase, and Cochrane from inception to 21 July 2023. The full search

strategy is available in the **Supplemental Methods**. There were no language restrictions. To identify potentially eligible studies, two reviewers (HH and HSF) independently screened titles and abstracts followed by full-text screening. We also hand-searched the references list of eligible studies to identify further relevant articles. All discrepancies were resolved by consensus through discussion with a third reviewer (ZFF). If 2 or more published meta-analyses examined an identical theme, we included the most recent meta-analysis with the largest number of individual studies and high-quality studies to avoid overlaps (Ioannidis, 2009).

Inclusion and exclusion criteria

The identified studies were independently reviewed by two authors based on the following inclusion criteria: 1) published 'meta-analysis' or 'systematic review and meta-analysis' focused on randomized controlled trials (RCTs) or non-randomized intervention studies; 2) mental health conditions (i.e., mental disorders and related symptoms) should be assessed using structured psychiatric diagnostic interviews, as well as validated or commonly used rating scales; 3) the research targeted university students; and 5) reported the summary effect size with 95 % confidence intervals (CI). In addition, studies that did not clearly describe the intervention were excluded. All disagreements between the two authors were discussed and resolved consistently. In addition, if several articles used the same population (from the same original study), only the most recent, complete, or largest study would be included in the review. However, if different meta-analyses report different results for that population, all of those results will be included in the omnibus review (Ioannidis, 2009).

Data extraction and quality assessment

Two investigators (HH and HSF) independently extracted data from the studies, including the title, first author, publication year, number of included studies and participants, intervention, comparison, outcomes, and specific effect metrics (i.e., standardized mean difference (SMD; including Hedge's g and Cohen's d) with 95 % CIs. Interventions in this umbrella review were classified into 4 categories: 1) mindfulness-based interventions; 2) exercise interventions; 3) cognitive and behavioural-related interventions; 4) other interventions (e.g., educational interventions, aromatherapy, animal-assisted interventions, and internet-based interventions).

The methodological quality of each included meta-analysis was assessed by applying AMSTAR 2. This 16-item tool rated the overall confidence of systematic review into 4 categories (high, moderate, low, and critically low) rather than deriving an overall score (Shea et al., 2017).

Data analysis

The summary effect estimate, its corresponding 95 % CIs and P value were recalculated using the random effects model of DerSimonian and Laird, as in previous umbrella reviews (Barbui et al., 2020; Kim et al., 2020). We conducted Cochran's Q tests and calculated the I^2 statistic to detect heterogeneity between studies. P value < 0.10 was considered significant for Cochran's Q test and $I^2 > 50$ % indicated high heterogeneity (Ioannidis, Patsopoulos & Evangelou, 2007; WG, 1954). We also estimated the 95 % prediction interval, suggesting the range in which the effect estimate of a future study examining the same research question is expected to lie (Riley, Higgins & Deeks, 2011). Egger's regression asymmetry test was applied to assess publication bias (Egger, Davey Smith, Schneider & Minder, 1997). An Egger's P value < 0.10 indicated the presence of small-study effects, which meant the small studies were more likely to give high-risk estimates and the effects estimate of large studies tended to be more conservative (Papadimitriou et al., 2021). The potential excess significance bias was evaluated to

investigate whether the observed number of studies (O) with nominally statistically significant results ($P < 0.05$) of each meta-analysis was different from the expected (E) (Ioannidis & Trikalinos, 2007). The expected number of significant results was calculated based on the sum of the statistical power estimates, with an algorithm from a non-central t distribution and a plausible effect size for the tested association, which was defined as the estimate of the largest study in each meta-analysis (J, 2013). P value < 0.10 was considered as a statistical threshold of excess significance. All statistical analyses were performed using R Statistical Software (<http://www.R-project.org>, The R Foundation). The statistical tests were all two-tailed.

Certainty of evidence

We determined the strength of evidence for each outcome included in the umbrella review in line with previous umbrella reviews (Gao et al., 2022; Papatheodorou, 2019). The approach categorized evidence from systematic reviews and meta-analyses into 5 classes: convincing evidence (class I), highly suggestive evidence (class II), suggestive evidence (class III), weak evidence (class IV), and no significant evidence (class V). Criteria for each level of evidence were as follows (Hermelink et al., 2022): 1) P values $< 10^{-6}$ under a random effects model, > 1000 cases, $I^2 < 50\%$, 95% prediction interval excluding the null value, no small-study effect and no excess significance bias, 2) P values $< 10^{-6}$ under a random effects model, largest study with a statistically significant effect and criteria of class I not met, 3) > 1000 cases, P values $< 10^{-3}$

under a random effects model and criteria of class I-II not met, 4) P value < 0.05 under random-effects and criteria of class I-III not met, 5) P value ≥ 0.05 under random-effects.

Results

The flowchart of the study selection process was shown in Fig. 1. The systematic search resulted in a total of 776 records. After the removal of duplicates and scanning of the titles and abstracts, 525 articles were excluded: 387 inappropriate intervention, 51 traditional reviews, 87 others (editorial and non-human studies, etc.), and 37 full-text articles were assessed for potential eligibility. Finally, 19 articles involving 74 meta-analyses met the umbrella review inclusion criteria and were eventually included for reanalysis. Table 1 shows the details of the included systematic reviews. The included reviews analysed intervention effects on university students with anxiety, depression or stress, respectively. Among these systematic reviews, 15 meta-analyses examined the effect of exercise-based interventions, 15 meta-analyses examined the effect of cognitive and behavioural-related interventions, 20 meta-analyses assessed the effect of mindfulness-based interventions, and 24 meta-analyses assessed the effect of other interventions including educational-based interventions, Aromatherapy, animal-assisted interventions and international-based interventions.

Of the 19 included systematic reviews, 26% ($n = 5$) (Bolinski et al., 2020; Huber et al., 2022; Lin et al., 2022; Luo, Zhang, Liu, Ma & Jennings, 2022; Oliveira Silva et al., 2023) studies were rated as “high”, 26

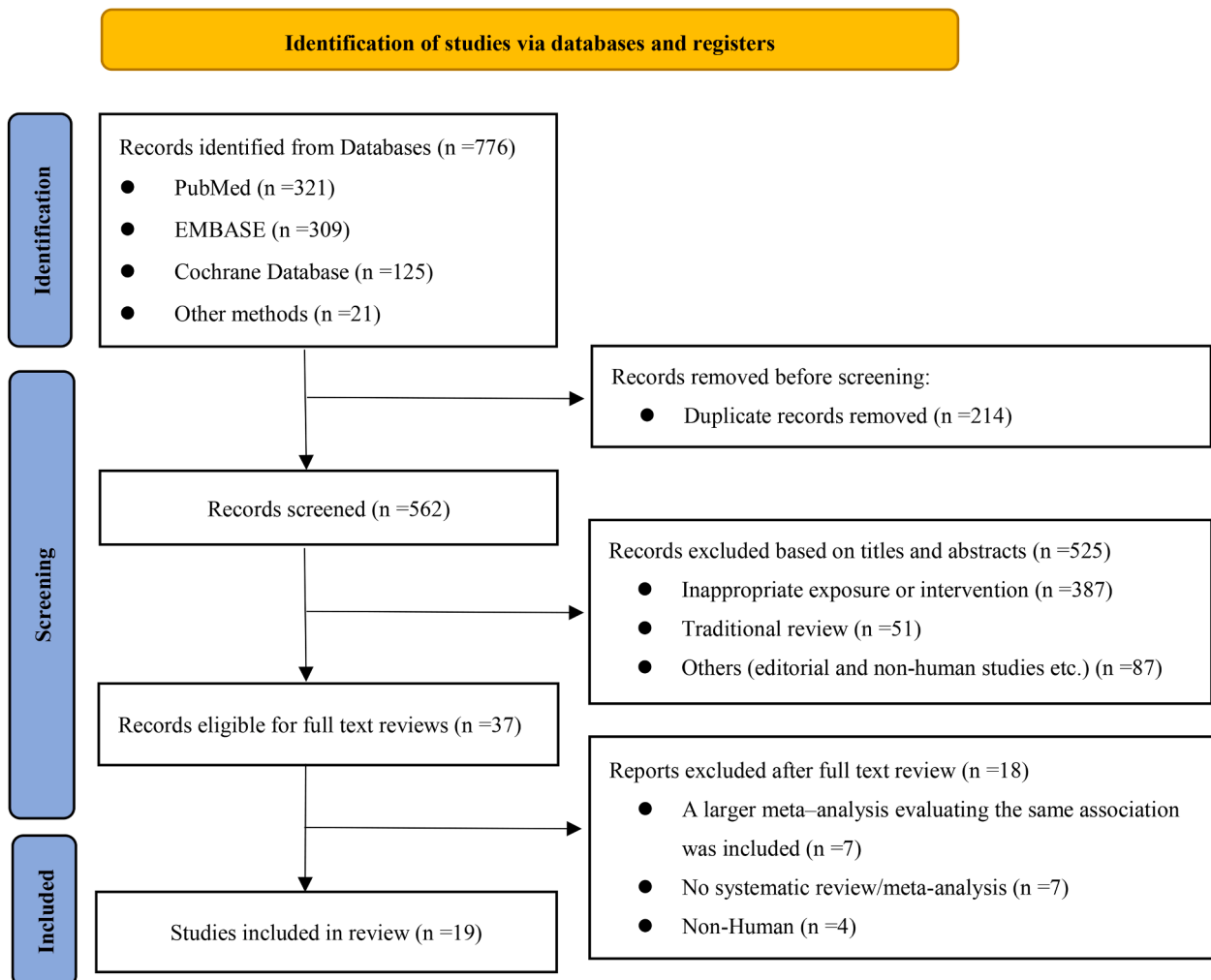


Fig. 1. Study selection profile.

Table 1

Characterization and quality assessment of a qualified meta-analysis assessing the relationship between mental disorders and interventions for college students.

First-author, year	No. of participants	Intervention	Comparison	Mental disorders	Outcomes	Effect metrics	Overall Rating
Gong et al., 2023 ^(Gong et al., 2023)	447/461	MBCT	Inactive (waitlist)	Depression, anxiety, stress	Depression, anxiety, stress	SMD	Moderate
Oliveira Silva et al., 2023 ^(Oliveira Silva et al., 2023)	609/574	Simulation; compared conventional educational strategies with simulation	Conventional educational interventions	Stress, anxiety	Stress, anxiety	SMD	High
Chandler et al., 2022 ^(Chandler et al., 2022)	6558/6356	CBT-I-based interventions	Waitlist or treatment as usual (passive) Alternative intervention (active)	Sleep disturbance, anxiety, depression	Sleep, anxiety, depression	SMD	Low
Du et al., 2022 ^(Du et al., 2022)	369/332	Taijiquan intervention	Regular physical activity group	Depression, anxiety	Depression, anxiety	SMD	Low
Huber et al., 2022 ^(Huber et al., 2022)	320/312	Active intervention	Active animal control Active other control No-treatment control	Acute anxiety, acute self-perceived stress, negative affect	Acute anxiety, acute self-perceived stress, negative affect	SMD	High
Lin et al., 2022 ^(Lin et al., 2022)	712/714	Qigong exercise	Original sports exercise practices, relaxation training or maintaining the original lifestyle without any intervention	Depression, anxiety, mood	Depression, anxiety, mood	SMD	High
Luan et al., 2022 ^(Luan et al., 2022)	151/139	Aromatherapy	No intervention or placebo intervention	Anxiety	Test anxiety	SMD	Low
Luo et al., 2022 ^(Luo et al., 2022)	295/292	Physical activity	Not doing regular exercise training Learning health knowledge and CBT intervention	Anxiety disorder, depression	Anxiety disorder, depression	SMD	High
Yang et al., 2022 ^(Yang et al., 2022)	45/45	Traditional Chinese fitness exercises	Routine lifestyle	Anxiety, depression, sleep disorder	Anxiety, depression, sleep disorder	SMD	Moderate
Zhang et al., 2022 ^(Zhang et al., 2022)	257/257	Exercise	Blank, non-exercise intervention group	Anxiety	Test anxiety	SMD	Critically low
Chen et al., 2021 ^(Chen et al., 2021)	481/460	Mindfulness meditation; acceptance and commitment training	Physical exercise, waitlist	Depression, anxiety, stress	Depression scores, anxiety scores, stress scores	SMD	Low
Song et al., 2021 ^(Song et al., 2021)	2910/2627	Aerobic exercise; traditional Chinese exercises; meditation	Nr	Depressive, anxiety	Depressive symptoms, anxiety	SMD	Low
Bolinski et al., 2020 ^(Bolinski et al., 2020)	1433/1346	Mood and anxiety intervention	Assessment only waitlist	Depression, anxiety	Depression, anxiety	Hedges' g	High
Harrer et al., 2019 ^(Harrer et al., 2019)	1039/891	Internet interventions	Wait list, Mental health education website, psychoeducation, Expressive writing, No treatment and Placebo	Depression, anxiety, stress	Depression, anxiety, stress	Hedges' g	Moderate
Huntley et al., 2019 ^(Huntley et al., 2019)	1362/847	BT; CBT; SST; combined	Attentional control, instructional control, no treatment control, self-help, supportive counselling, and waitlist control	Anxiety	Test anxiety	Hedges' g	Moderate
Ma et al., 2019 ^(Ma et al., 2019)	120/119	Mindfulness-based intervention	No intervention, waiting list	Depression	Depression	SMD	Moderate
Huang et al., 2018 ^(Huang et al., 2018)	2306/2356	Cognitive and behavioural related interventions; mindfulness-based interventions; attention/perception modifications; other interventions	No treatment, waitlist or placebo control	Depression, anxiety	Depression, anxiety	SMD	Low
Lo et al., 2018 ^(Lo et al., 2018)	1128/1198	Cognitive-behavioural; mindfulness; psychoeducational; relaxation	Waitlist, non-meditating activity, placebo, education control	Anxiety, depression, stress	Anxiety, depression, stress	SMD	Low
Regehr et al., 2013 ^(Regehr et al., 2013)	831/734	Cognitive behavioural, mindfulness-based interventions	NR	Depression, anxiety	Depression, anxiety	SMD	Critically low

Abbreviation. MBCT, Mindfulness-based cognitive therapy; CBT-I, cognitive behavioural therapy for insomnia; BT, behavior therapy; CBT, cognitive-behavioural therapy; SST, study skill training; NR, not reported; SMD, standardized mean difference.

% ($n = 5$) (Gong et al., 2023) (Yang, Guo, Cheng & Zhang, 2022) (Harrer et al., 2019; Huntley et al., 2019; Ma, Zhang & Cui, 2019) as “moderate”, 37 % ($n = 7$) (Chandler et al., 2022; Du et al., 2022) (Chen et al., 2021; Lo et al., 2018; Luan et al., 2022) (Huang, Nigatu, Smail-Crevier, Zhang & Wang, 2018; Song, Liu, Huang, Wu & Tao, 2021) as “low” and 11 % ($n = 2$) (Regehr, Glancy & Pitts, 2013; Zhang, Li & Wang, 2022) as “critically low” quality with the AMSTAR2 scoring system. Supplementary Table 1 presented the details of the quality of each included study evaluated using the AMSTAR2 tool. The most frequent flaws for the low methodological quality reviews were as follows: the protocol of the systematic overview was not mentioned, no description of the study selection process and the data extraction process, the potential impact of risk of bias (RoB) was not assessed and the literature was not accounted for the RoB in individual studies when interpreting the results of the review, and publication bias was not examined or discussed.

Exercise intervention

A total of 15 meta-analyses assessed the effects of exercise interventions including Baduanjin, Taichi, Wuqinxi, traditional Chinese exercises, and aerobic exercise on mental illness, of which 7 (Du et al., 2022; Lin et al., 2022; Song et al., 2021; Yang et al., 2022) meta-analyses related to depression, 7 (Du et al., 2022; Lin et al., 2022; Luo et al., 2022; Song et al., 2021; Zhang et al., 2022) related to anxiety and 1 (Lin et al., 2022) related to mood changes. 10 re-analyses were nominally statistically significant under random effects models ($P < 0.05$), however, only one 95 % prediction interval excluded the null value. 73 % ($n = 11$) of the included meta-analyses had high heterogeneity ($I^2 > 50$ %). Evidence of small-study effects bias was observed in 3 meta-analyses, and excess significance bias was detected in 10 meta-analyses. However, 8 meta-analyses consisted of less than 5 studies, in which case the power of the test would be reduced (Fig. 2 and Supplemental Table 2).

As for the strength of evidence, there is no meta-analysis presented convincing, highly suggestive, or suggestive evidence. 10 meta-analyses had weak evidence, indicating that exercise intervention could alleviate depression, including one meta-analyses item about Baduanjin (SMD: -0.718 , P-random effects: < 0.01) (Lin et al., 2022), one about Wuqinxi (SMD: -1.455 , P-random effects: 0.02) (Lin et al., 2022) one about Tai Chi (SMD: -0.555 , P-random effects: 0.01) (Du et al., 2022), one about traditional Chinese exercises and (SMD: -0.418 , P-random effects: 0.01) (Song et al., 2021), and one about Aerobic Exercise (SMD: -0.533 , P-random effects: < 0.01) (Song et al., 2021). Weak evidence also indicated that exercise intervention could alleviate anxiety symptoms, including two meta-analyses items about Baduanjin (SMD: -0.453 , P-random effects: < 0.01) (Lin et al., 2022); and SMD: -0.220 , P-random effects: < 0.01) (Luo et al., 2022)), two about Tai Chi (SMD: -1.346 , P-random effects: < 0.01) (Zhang et al., 2022); and SMD: -0.255 , P-random effects: 0.03) (Du et al., 2022)), and one about Aerobic Exercise (SMD: -0.499 , P-random effects: < 0.01) (Song et al., 2021)).

Cognitive behavioural intervention (CBI)

A total of 15 meta-analyses assessed the effects of cognitive behavioural intervention on mental health problems including depression, anxiety, sleep disturbance, and stress. Overall 12 re-analyses reported a nominally statistically significant summary result using random effects models ($P < 0.05$). The 95 % prediction interval excluded the null value in only two meta-analyses. There was significant heterogeneity ($I^2 > 50$ %) in 33 % ($n = 5$) of the included meta-analyses. Evidence of small-study effects bias was noticed in two meta-analyses whereas excess of significance bias was observed in six meta-analyses. 7 meta-analyses consisted of less than 5 studies, suggesting the power of the test would be reduced (Fig. 2 and Supplemental Table 2).

Only one meta-analysis (Chandler et al., 2022) was supported by suggestive strength of the evidence that CBI has positive effects on sleep disturbance, with the SMD of -0.603 (95 % CI: -0.916 , -0.290) and

P-random effects < 0.01 . Strength of association was weak for nine meta-analyses, suggesting that CBI could reduce the risk of depression (SMD: -0.588 to -0.295 , all P-random effects < 0.01), anxiety (SMD: -0.768 to -0.234 , P-random effects: $< 0.01-0.04$; Hedges' g : -0.579 to -0.830 , all P-random effects < 0.01) and stress (SMD: -0.544 to -0.603 , all P-random effects < 0.01). In addition, 2 meta-analyses supported by weak evidence also indicated that there were CBI effects on depression and anxiety. The Hedges' g was 0.456 (95 % CI: 0.082 , 0.831) for depression and 0.553 (95 % CI: 0.283 , 0.823) for anxiety, separately.

Mindfulness-based intervention (MBI)

A total of 20 meta-analyses assessed the effect of a mindfulness-based intervention on mental health problems including depression, anxiety, and stress. Among these comparisons, 14 re-analyses were nominally statistically significant at $P < 0.05$ under random effects models, and only two 95 % prediction intervals excluded the null value. About 25 % ($n = 5$) of the included meta-analyses that we re-analysed had high heterogeneity ($I^2 > 50$ %). The risk of small-study effects bias was noticed in 1 comparison, and excess significance bias was verified for 6 comparisons. However, most comparisons (15/20) consisted of less than 5 studies, in which case the power of the test was reduced (Fig. 2 and Supplemental Table 2).

None of the 20 meta-analyses achieved convincing, highly suggestive, or suggestive strength of the evidence. In addition, the strength of the evidence was weak for meta-analyses, which showed that MBI could reduce the risk of anxiety (SMD: -0.803 to -0.483 , P-random effects: $< 0.01-0.04$), depression (SMD: -0.728 to -0.287 , P-random effects: $< 0.01-0.03$) and stress (SMD: -0.624 to -0.343 , P-random effects: $< 0.01-0.04$). Weak evidence also showed that MBI was effective for the prevention of depressive symptoms, with SMD (95 % CI) of 0.836 (0.371 , 1.301).

Other interventions

A total of 24 meta-analyses assessed the effect of other interventions (i.e., educational interventions, simulation, aromatherapy, study skill training, acceptance, and commitment therapy, etc.) on mental health problems including depression, anxiety, and stress. 11 re-analyses reported a nominal statistically significant summary effect under random effects models ($P < 0.05$), however, only two 95 % prediction interval excluded the null value. 46 % ($n = 11$) of the included meta-analyses had high heterogeneity ($I^2 > 50$ %). The risk of small-study effects bias was noticed in three meta-analyses whereas the excess of significance bias was observed in eight meta-analyses. However, most meta-analyses (17/24) consisted of less than 5 studies, indicating the power of the test would be reduced (Fig. 2 and Supplemental Table 2).

A meta-analysis achieved suggestive strength of evidence suggesting that mood and anxiety intervention (MAI) had positive effects on anxiety (Hedges' $g = -0.198$, 95 % CI: -0.302 , -0.094 , P-random effects < 0.01). Furthermore, 11 meta-analyses were supported by weak evidence, which suggested other interventions like simulation (SMD: -0.415 , P-random effects: 0.86) (Oliveira Silva et al., 2023), present control intervention (Hedges' g : 0.417 , P-random effects: < 0.01) (Harrer et al., 2019), acceptance, commitment training (SMD: -0.552 , P-random effects: < 0.01) (Chen et al., 2021) and attention/perception modification (SMD: -0.530 to -0.494 , P-random effects: 0.01) (Huang et al., 2018) could have effects on university students with mental health problems including depression, anxiety and stress.

Discussion

To our knowledge, this study is the first umbrella review to comprehensively and quantitatively identify and evaluate the hierarchy of evidence for various types of interventions for university students with mental disorders. We included 19 published systematic reviews,

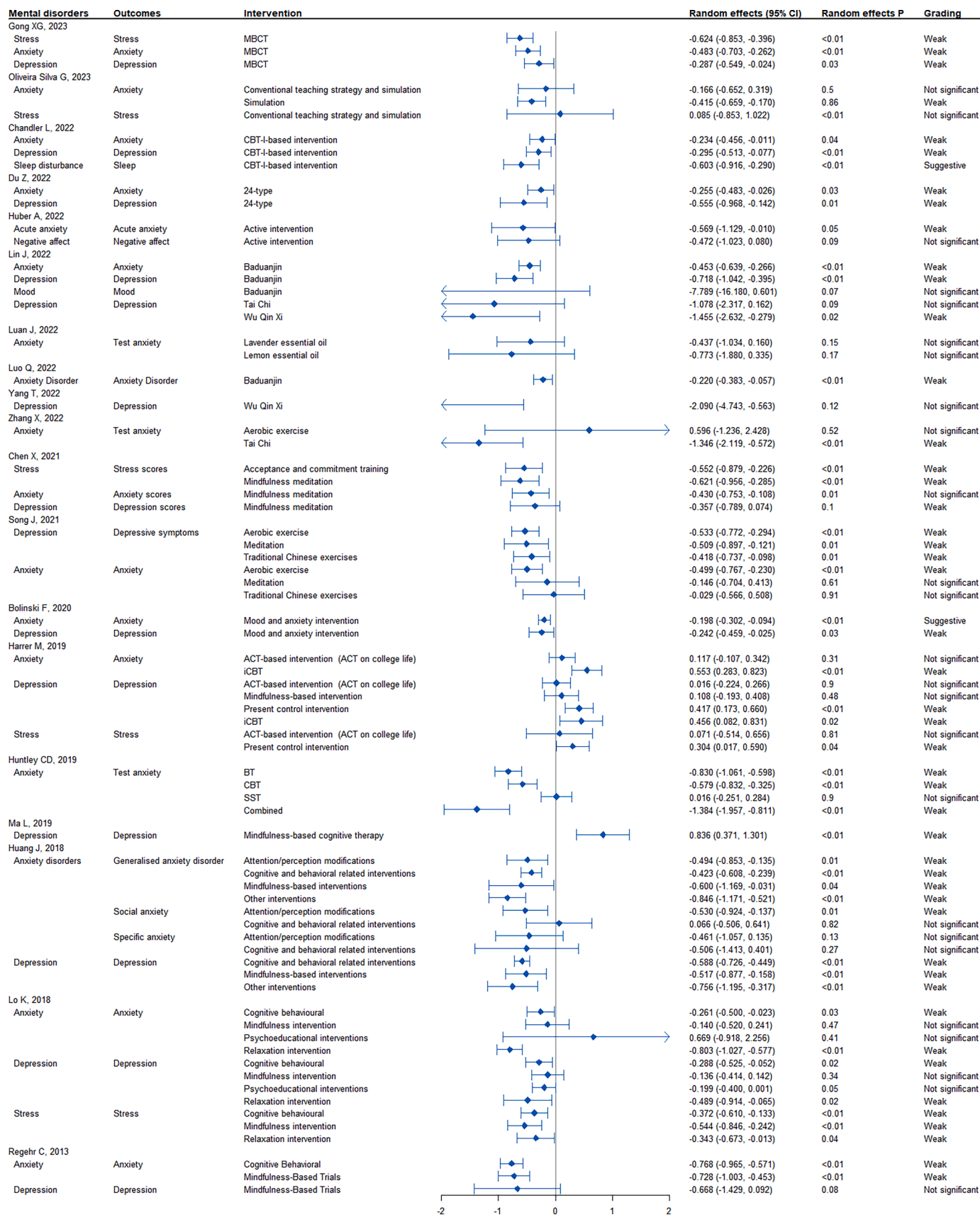


Fig. 2. Efficacy of interventions for psychiatric disorders among university students with evidence grading. Note: Small study bias is considered positive if the p-value in Egger's test is less than 0.10. Excess significance bias is considered positive if the number of significant studies is greater than the expected number of significant studies ($O > E$) (based on the largest study with the smallest SE) and the p-value is less than 0.10. Abbreviations: MBCT mindfulness-based cognitive therapy, CBT-I cognitive behavioural therapy for insomnia.

which comprised 74 meta-analyses for the efficacy of different interventions for mental health outcomes including depression, anxiety, stress, and sleep disturbance. Overall, approximately 64 % ($n = 47$) of the included associations between interventions and mental disorders reported a nominally statistically significant summary random-effects estimate. 43 % ($n = 32$) associations represented large heterogeneity ($I^2 > 50$ %). When the 95 % prediction intervals were calculated, which further indicated between-study heterogeneity, we found that the null value was excluded in only 9 % of the associations, this estimate could be explained by the low percentage of nominally significant meta-analyses. Furthermore, in about 12 % ($n = 9$) of the associations, the summary estimates were overestimated because of small study effects and in 41 % ($n = 30$) the observed number of studies with nominally statistically significant results in each meta-analysis was larger than expected, which implied that the results might have low power of test due to many meta-analyses with a small number of individual studies.

Our grading of the current evidence suggested that interventions based on exercise, CBI, MBI, and other interventions like MAI were effective while exercise intervention had the highest effect size for both depression and anxiety among university students. However, the strength of the efficacy and credibility of evidence was weak for most studies according to the umbrella review criteria. We found that the reduced confidence in the evidence could be attributed to the between-study heterogeneity, risk of excess significance bias, and prediction intervals including the null value, thus the reported associations need to be interpreted with caution.

It was suggested that contemporary university students are under pressure from study, life, job and family stressors, which were increasingly becoming the source of their psychological distress (Yang et al., 2022). Continuous stress and mental tension could trigger a range of unfavorable feelings and increase the risk of mental disorders such as anxiety and depression (Bonnet & Arand, 2000). The use of psychiatric medication was common among people with mental disorders. However, a significant number of side effects were frequently associated with medical treatment, which reduced treatment compliance and therefore negatively impacted the efficacy of the psychiatric medication (Carrascal-Laso et al., 2021; Lally & MacCabe, 2015). The findings of this umbrella review might provide an alternative or adjunctive treatment for disorders of this type. In this study, the efficacy of exercise intervention for depression and anxiety was supported by the strength of weak evidence. Despite the credibility of the estimate for this efficacy was not being optimal, it was worth conducting more high-quality randomized controlled trials to verify the effects of exercise interventions on various mental disorders. Previous studies examining the relationship between exercise and mental health have been widely conducted (Huang et al., 2021). The results of this review were in agreement with the previously published review suggesting that physical activity is one of the mainstay effective approaches in the management of depression, anxiety, and other mental health problems (Gao, 2022; Liu et al., 2021; Singh et al., 2023). Routine traditional fitness practice could alleviate fatigue and tension in the brain through the reduction of negative mood (Yang et al., 2022). The potential mechanism of exercise intervention contributing to alleviating severe anxiety and depression symptoms could be explained by the increased training of the middle cerebral cortex from exercises such as Qigong and Taichi, which has been shown to regulate the hypothalamic-pituitary-adrenal axis, brain-derived neurotrophic factor, monoamine neurotransmitter, and adiponectin. Developing the habits of routine exercise would be beneficial for the promotion of physical and psychological health (Yeung, Chan, Cheung & Zou, 2018).

Moreover, the current umbrella review found suggestive evidence to support a moderate positive effect of cognitive behavioural therapy for insomnia (CBT-I) intervention on sleep disturbance among university students, which was in concert with previous studies looking at the effects of CBT for insomnia on sleep and even extend to mental health (Cheung, Jarrin, Ballot, Bharwani & Morin, 2019; Murawski, Wade,

Plotnikoff, Lubans & Duncan, 2018). The development of insomnia is typically accompanied by depression, and often continuous following depression alleviated (Henry et al., 2021). Improvements in sleep quality could contribute to moderate improvements in mental health and improvements in insomnia have been observed to mediate the effects of depression using a CBT-I intervention (Henry et al., 2021; Scott, Webb, Martyn-St James, Rowse & Weich, 2021). It is hypothesized that CBI including sleep restriction therapy and stimulus management could boost slow-wave sleep, which was recognized as a disruption in both insomnia and depression, leading to increased homeostatic sleep drive (Krystal & Edinger, 2010; Staner, 2010). University students have the unique advantage of resources to utilize free services offered by university settings for counselling and intervention treatment of mental disorders, however, mental health problems are still high in this population. Sleep is rarely stigmatized way, thus universities can improve the condition by offering services through campus accommodation and/or university apps (Chandler et al., 2022). Additionally, we also found suggestive evidence that mood and anxiety intervention (MAI) has a small effect on anxiety. Notably, the evidence from a meta-analysis included only 4 individual studies. Therefore, the summary estimates might be inflated due to small study effects bias.

Mindfulness meditation is increasingly being included in mental health interventions, and our research shows weak evidence that mindfulness meditation can reduce the risk of anxiety and depression and prevent depressive symptoms. Mindfulness meditation training aims to help practitioners overcome depressive rumination by returning their attention to the present moment while eliminating rumination also reduces the emotional significance of the rumination thinking process, thereby reducing the risk of depression recurrence (Alsubaie et al., 2017). The effect of mindfulness meditation on anxiety is also to reduce repetitive negative thinking, similar to depression (Gu, Strauss, Bond & Cavanagh, 2015). After mindfulness meditation exercise, promotes top-down regulation of responsiveness to vague stimuli, leading to increased activation of brain regions important for emotional assessment and response (ventromedial PFC, ACC, and insula)(Goldin, Ziv, Jazaieri & Gross, 2012).

Limitation

The main limitations of this umbrella review are those of the included study, that is the limitations of the original meta-analyses. The most frequent flaws for the low methodological quality reviews, detected by AMSTAR2, were the absence of a protocol of the systematic overview, no description of the study selection process and the data extraction process, the potential impact of risk of bias (RoB) not assessed and absence of a thorough discussion of the RoB in individual studies when interpreting the results of the review, and publication bias were not examined or discussed.

Furthermore, we were not able to quantify the degree of mental disorders at a patient level, which could have minimized the between-study variability of the synthesized findings. We also did not analyze whether the efficacy of interventions is influenced by the type of inactive control, length of follow-up, type of provider, or other clinical or social-related variables. However, we have minimized potential bias using methodological approaches recommended by the available guidelines for evidence-based reviews.

Despite we searched major databases and additional sources to retrieve relevant literature, we could not include unpublished articles and those not published in the major databases. This potential exclusion of studies that could meet our criteria may inevitably result in publication bias. Finally, this umbrella study encompassed the meta-analyses conducted on university students, they are not representative of all sections of the overall population with mental disorders.

Conclusions

In conclusion, this umbrella review provides preliminary evidence of the effectiveness of different non-pharmacological interventions on university students with mental disorders. However, these results should be interpreted carefully since heterogeneity was high. Future high-quality studies are necessary to confirm more convincing evidence of the potential effects of non-pharmacological interventions in the prevention and control of mental disorders.

Funding

The 2022 Guangdong Provincial National Defense Education Project "Research on the National Defense Education System for Hong Kong, Macao, and Taiwan Overseas Chinese Students in Mainland Universities from the Perspective of the Overall National Security Perspective" by the Guangdong Federation of Social Sciences and the Guangdong Provincial Association of National Defense Education (SL22ZD01); Fundamental Research Funds for Central Universities in 2022 "Research on the influencing factors of scientific and technological security of Jinan University" (21622801); School level Teaching Quality and Teaching Reform Project of Jinan University "Reform and Practice of Teaching Military Theory Courses in Colleges and Universities Characterized by overseas Chinese in the New Era." (JG2022122).

Data availability

All data included in this study were extracted from publicly available systematic reviews.

CRedit authorship contribution statement

WT and XY designed the study. HH and HSF performed the searches and data extraction. CSY analyzed the data. HH and HSF drafted the manuscript. All authors contributed and approved the manuscript.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.ijchp.2023.100431](https://doi.org/10.1016/j.ijchp.2023.100431).

References

- Alsbaie, M., Abbott, R., Dunn, B., Dickens, C., Keil, T. F., Henley, W., et al. (2017). Mechanisms of action in mindfulness-based cognitive therapy (MBCT) and mindfulness-based stress reduction (MBSR) in people with physical and/or psychological conditions: A systematic review. *Clinical psychology review*, 55, 74–91. <https://doi.org/10.1016/j.cpr.2017.04.008>
- Auerbach, R. P., Alonso, J., Axinn, W. G., Cuijpers, P., Ebert, D. D., & Green, J. G. (2016). Mental disorders among college students in the world health organization world mental health surveys. *Psychological medicine*, 46(14), 2955–2970. <https://doi.org/10.1017/S0033291716001665>
- Auerbach, R. P., Mortier, P., Bruffaerts, R., Alonso, J., Benjet, C., & Cuijpers, P. (2018). WHO world mental health surveys international college student project: prevalence and distribution of mental disorders. *Journal of abnormal psychology*, 127(7), 623–638. <https://doi.org/10.1037/abn0000362>
- Barbui, C., Purgato, M., Abdulmalik, J., Acarturk, C., Eaton, J., & Gastaldon, C. (2020). Efficacy of psychosocial interventions for mental health outcomes in low-income and middle-income countries: An umbrella review. *The lancet. Psychiatry*, 7(2), 162–172. [https://doi.org/10.1016/S2215-0366\(19\)30511-5](https://doi.org/10.1016/S2215-0366(19)30511-5)
- Bolinski, F., Boumparis, N., Kleiboer, A., Cuijpers, P., Ebert, D. D., & Riper, H. (2020). The effect of e-mental health interventions on academic performance in university and college students: A meta-analysis of randomized controlled trials. *Internet interventions*, 20, Article 100321. <https://doi.org/10.1016/j.invent.2020.100321>

- Bonnet, M. H., & Arand, D. L. (2000). Activity, arousal, and the MSLT in patients with insomnia. *Sleep*, 23(2), 205–212.
- Carrascal-Laso, L., Franco-Martín, M., Marcos-Vadillo, E., Ramos-Gallego, I., García-Berrocal, B., Mayor-Toranzo, E., et al. (2021). Economic impact of the application of a precision medicine model (5SPM) on psychotic patients. *Pharmacogenomics and personalized medicine*, 14, 1015–1025. <https://doi.org/10.2147/pgpm.S320816>
- Chandler, L., Patel, C., Lovecka, L., Gardani, M., Walasek, L., & Ellis, J. (2022). Improving university students' mental health using multi-component and single-component sleep interventions: A systematic review and meta-analysis. *Sleep Med*, 100, 354–363. <https://doi.org/10.1016/j.sleep.2022.09.003>
- Chen, X., Zhang, B., Jin, S. X., Quan, Y. X., Zhang, X. W., & Cui, X. S. (2021). The effects of mindfulness-based interventions on nursing students: A meta-analysis. *Nurse education today*, 98, Article 104718. <https://doi.org/10.1016/j.nedt.2020.104718>
- Cheung, J. M. Y., Jarrin, D. C., Ballot, O., Bharwani, A. A., & Morin, C. M. (2019). A systematic review of cognitive behavioral therapy for insomnia implemented in primary care and community settings. *Sleep medicine reviews*, 44, 23–36. <https://doi.org/10.1016/j.smrv.2018.11.001>
- Du, Z., Zhang, X., Qin, H., Wang, R., Bai, Y., & Yao, X. (2022). META analysis on the effect of taijiquan on improving negative psychological symptoms of college students and the optimal dose. *Frontiers in public health*, 10, Article 1032266. <https://doi.org/10.3389/fpubh.2022.1032266>
- Egger, M., Davey Smith, G., Schneider, M., & Minder, C. (1997). Bias in meta-analysis detected by a simple, graphical test. *BMJ (Clinical research ed.)*, 315(7109), 629–634. <https://doi.org/10.1136/bmj.315.7109.629>
- Gao, M. (2022). Experimental study on the effect of taijiquan on the physical function and mental health of college students. *Applied bionics and biomechanics*, 2022, Article 7346946. <https://doi.org/10.1155/2022/7346946>
- Gao, X., Su, X., Han, X., Wen, H., Cheng, C., & Zhang, S. (2022). Unsaturated fatty acids in mental disorders: an umbrella review of meta-analyses. *Advances in nutrition (Bethesda, Md.)*, 13(6), 2217–2236. <https://doi.org/10.1093/advances/nmac084>
- Global, regional, and national burden of 12 mental disorders in 204 countries and territories, 1990–2019: A systematic analysis for the Global Burden of Disease Study 2019. (2022). Feb *The lancet. Psychiatry*, 9(2), 137–150. [https://doi.org/10.1016/S2215-0366\(21\)00395-3](https://doi.org/10.1016/S2215-0366(21)00395-3).
- Goldin, P., Ziv, M., Jazaieri, H., & Gross, J. J. (2012). Randomized controlled trial of mindfulness-based stress reduction versus aerobic exercise: Effects on the self-referential brain network in social anxiety disorder. *Frontiers in human neuroscience*, 6, 295. <https://doi.org/10.3389/fnhum.2012.0029>
- Gong, X. G., Wang, L. P., Rong, G., Zhang, D. N., Zhang, A. Y., & Liu, C. (2023). Effects of online mindfulness-based interventions on the mental health of university students: A systematic review and meta-analysis. *Frontiers in psychology*, 14, Article 1073647. <https://doi.org/10.3389/fpsyg.2023.1073647>
- Gu, J., Strauss, C., Bond, R., & Cavanagh, K. (2015). How do mindfulness-based cognitive therapy and mindfulness-based stress reduction improve mental health and wellbeing? A systematic review and meta-analysis of mediation studies. *Clinical psychology review*, 37, 1–12. <https://doi.org/10.1016/j.cpr.2015.01.006>
- Harrer, M., Adam, S. H., Baumeister, H., Cuijpers, P., Karyotaki, E., & Auerbach, R. P. (2019). Internet interventions for mental health in university students: A systematic review and meta-analysis. *International journal of methods in psychiatric research*, 28(2), e1759. <https://doi.org/10.1002/mpr.1759>
- Henry, A. L., Miller, C. B., Emsley, R., Sheaves, B., Freeman, D., & Luik, A. I. (2021). Insomnia as a mediating therapeutic target for depressive symptoms: A sub-analysis of participant data from two large randomized controlled trials of a digital sleep intervention. *Journal of sleep research*, 30(1), e13140. <https://doi.org/10.1111/jsr.13140>
- Hermelink, R., Leitzmann, M. F., Markozannes, G., Tsilidis, K., Pukrop, T., Berger, F., et al. (2022). Sedentary behavior and cancer—an umbrella review and meta-analysis. *Eur J Epidemiol*, 37(5), 447–460. <https://doi.org/10.1007/s10654-022-00873-6>
- Huang, J., Nigatu, Y. T., Smail-Crevier, R., Zhang, X., & Wang, J. (2018). Interventions for common mental health problems among university and college students: A systematic review and meta-analysis of randomized controlled trials. *Journal of psychiatric research*, 107, 1–10. <https://doi.org/10.1016/j.jpsychires.2018.09.018>
- Huang, X., Wang, X., Hu, J., Xue, Y., Wei, Y., & Wan, Y. (2021). Inadequate mental health literacy and insufficient physical activity potentially increase the risks of anxiety and depressive symptoms in chinese college students. *Frontiers in psychiatry*, 12, Article 753695. <https://doi.org/10.3389/fpsyg.2021.753695>
- Huber, A., Klug, S. J., Abraham, A., Westenberg, E., Schmidt, V., & Winkler, A. S. (2022). Animal-assisted interventions improve mental, but not cognitive or physiological health outcomes of higher education students: a systematic review and meta-analysis. *International journal of mental health and addiction*, 1–32. <https://doi.org/10.1007/s11469-022-00945-4>
- Huntley, C. D., Young, B., Temple, J., Longworth, M., Smith, C. T., Jha, V., et al. (2019). The efficacy of interventions for test-anxious university students: A meta-analysis of randomized controlled trials. *Journal of anxiety disorders*, 63, 36–50. <https://doi.org/10.1016/j.janxdis.2019.01.007>
- Ibrahim, A. K., Kelly, S. J., Adams, C. E., & Glazebrook, C. (2013). A systematic review of studies of depression prevalence in university students. *Journal of psychiatric research*, 47(3), 391–400. <https://doi.org/10.1016/j.jpsychires.2012.11.015>
- Ioannidis, J. P. (2009). Integration of evidence from multiple meta-analyses: A primer on umbrella reviews, treatment networks and multiple treatments meta-analyses. *CMAJ : Canadian Medical Association journal = journal de l'Association medicale canadienne*, 181(8), 488–493. <https://doi.org/10.1503/cmaj.081086>
- Ioannidis, J. P., Patsopoulos, N. A., & Evangelou, E. (2007). Uncertainty in heterogeneity estimates in meta-analyses. *BMJ (Clinical research ed.)*, 335(7626), 914–916. <https://doi.org/10.1136/bmj.39343.408449.80>

- Ioannidis, J. P., & Trikalinos, T. A. (2007). An exploratory test for an excess of significant findings. *Clinical trials (London, England)*, 4(3), 245–253. <https://doi.org/10.1177/1740774507079441>
- J, I. (2013). Clarifications on the application and interpretation of the test for excess significance and its extensions. *Journal of mathematical psychology*, 57, 184–187.
- Jüni, P., Altman, D. G., & Egger, M. (2001). Systematic reviews in health care: Assessing the quality of controlled clinical trials. *BMJ (Clinical research ed.)*, 323(7303), 42–46. <https://doi.org/10.1136/bmj.323.7303.42>
- Kim, J. H., Kim, J. Y., Lee, J., Jeong, G. H., Lee, E., & Lee, S. (2020). Environmental risk factors, protective factors, and peripheral biomarkers for ADHD: An umbrella review. *The lancet. Psychiatry*, 7(11), 955–970. [https://doi.org/10.1016/s2215-0366\(20\)30312-6](https://doi.org/10.1016/s2215-0366(20)30312-6)
- Kim, M. S., Kim, W. J., Khera, A. V., Kim, J. Y., Yon, D. K., & Lee, S. W. (2021). Association between adiposity and cardiovascular outcomes: An umbrella review and meta-analysis of observational and mendelian randomization studies. *Eur Heart J*, 42(34), 3388–3403. <https://doi.org/10.1093/eurheartj/ehab454>
- Krystal, A. D., & Edinger, J. D. (2010). Sleep EEG predictors and correlates of the response to cognitive behavioral therapy for insomnia. *Sleep*, 33(5), 669–677. <https://doi.org/10.1093/sleep/33.5.669>
- Lally, J., & MacCabe, J. H. (2015). Antipsychotic medication in schizophrenia: A review. *Br Med Bull*, 114(1), 169–179. <https://doi.org/10.1093/bmb/ldv017>
- Lin, J., Gao, Y. F., Guo, Y., Li, M., Zhu, Y., & You, R. (2022). Effects of qigong exercise on the physical and mental health of college students: A systematic review and Meta-analysis. *BMC Complement Med Ther*, 22(1), 287. <https://doi.org/10.1186/s12906-022-03760-5>
- Liu, X., Li, R., Cui, J., Liu, F., Smith, L., & Chen, X. (2021). The effects of Tai Chi and Qigong exercise on psychological status in adolescents: A systematic review and meta-analysis. *Frontiers in psychology*, 12, Article 746975. <https://doi.org/10.3389/fpsyg.2021.746975>
- Lo, K., Waterland, J., Todd, P., Gupta, T., Bearman, M., & Hassed, C. (2018). Group interventions to promote mental health in health professional education: A systematic review and meta-analysis of randomised controlled trials. *Advances in health sciences education : theory and practice*, 23(2), 413–447. <https://doi.org/10.1007/s10459-017-9770-5>
- Luan, J., Yang, M., Zhao, Y., Zang, Y., Zhang, Z., & Chen, H. (2022). Aromatherapy with inhalation effectively alleviates the test anxiety of college students: A meta-analysis. *Frontiers in psychology*, 13, Article 1042553. <https://doi.org/10.3389/fpsyg.2022.1042553>
- Luo, Q., Zhang, P., Liu, Y., Ma, X., & Jennings, G. (2022). Intervention of physical activity for university students with anxiety and depression during the COVID-19 pandemic prevention and control period: A systematic review and meta-analysis. *International journal of environmental research and public health*, 19(22), 19. <https://doi.org/10.3390/ijerph192215338>
- Ma, L., Zhang, Y. N., & Cui, Z. S. (2019). Mindfulness-based interventions for prevention of depressive symptoms in university students: A meta-analytic review. *Mindfulness (N Y)*, 10(11), 2209–2224. <https://doi.org/10.1007/s12671-019-01192-w>
- Murawski, B., Wade, L., Plotnikoff, R. C., Lubans, D. R., & Duncan, M. J. (2018). A systematic review and meta-analysis of cognitive and behavioral interventions to improve sleep health in adults without sleep disorders. *Sleep medicine reviews*, 40, 160–169. <https://doi.org/10.1016/j.smrv.2017.12.003>
- Oliveira Silva, G., Oliveira, F. S. E., Coelho, A. S. G., Fonseca, L. M. M., Vieira, F. V. M., & Campbell, S. H. (2023). Influence of simulation design on stress, anxiety and self-confidence of nursing students: Systematic review with meta-analysis. *Journal of clinical nursing*. <https://doi.org/10.1111/jocn.16681>
- Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., & Mulrow, C. D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ (Clinical research ed.)*, 372, n71. <https://doi.org/10.1136/bmj.n71>
- Papadimitriou, N., Markozannes, G., Kanellopoulou, A., Critselis, E., Alhardan, S., & Karafousia, V. (2021). An umbrella review of the evidence associating diet and cancer risk at 11 anatomical sites. *Nature communications*, 12(1), 4579. <https://doi.org/10.1038/s41467-021-24861-8>
- Papathodorou, S. (2019). Umbrella reviews: What they are and why we need them. *Eur J Epidemiol*, 34(6), 543–546. <https://doi.org/10.1007/s10654-019-00505-6>
- Regehr, C., Glancy, D., & Pitts, A. (2013). Interventions to reduce stress in university students: A review and meta-analysis. *Journal of affective disorders*, 148(1), 1–11. <https://doi.org/10.1016/j.jad.2012.11.026>
- Riley, R. D., Higgins, J. P., & Deeks, J. J. (2011). Interpretation of random effects meta-analyses. *BMJ (Clinical research ed.)*, 342, d549. <https://doi.org/10.1136/bmj.d549>
- Saxena, S., Thornicroft, G., Knapp, M., & Whiteford, H. (2007). Resources for mental health: Scarcity, inequity, and inefficiency. *Lancet (London, England)*, 370(9590), 878–889. [https://doi.org/10.1016/s0140-6736\(07\)61239-2](https://doi.org/10.1016/s0140-6736(07)61239-2)
- Scott, A. J., Webb, T. L., Martyn-St James, M., Rowse, G., & Weich, S. (2021). Improving sleep quality leads to better mental health: A meta-analysis of randomised controlled trials. *Sleep medicine reviews*, 60, Article 101556. <https://doi.org/10.1016/j.smrv.2021.101556>
- Shea, B. J., Reeves, B. C., Wells, G., Thuku, M., Hamel, C., & Moran, J. (2017). AMSTAR 2: A critical appraisal tool for systematic reviews that include randomised or non-randomised studies of healthcare interventions, or both. *BMJ (Clinical research ed.)*, 358, j4008. <https://doi.org/10.1136/bmj.j4008>
- Sheldon, E., Simmonds-Buckley, M., Bone, C., Mascarenhas, T., Chan, N., & Wincott, M. (2021). Prevalence and risk factors for mental health problems in university undergraduate students: A systematic review with meta-analysis. *Journal of affective disorders*, 287, 282–292. <https://doi.org/10.1016/j.jad.2021.03.054>
- Singh, B., Olds, T., Curtis, R., Dumuid, D., Virgara, R., & Watson, A. (2023). Effectiveness of physical activity interventions for improving depression, anxiety and distress: An overview of systematic reviews. *British journal of sports medicine*. <https://doi.org/10.1136/bjsports-2022-106195>
- Song, J., Liu, Z. Z., Huang, J., Wu, J. S., & Tao, J. (2021). Effects of aerobic exercise, traditional Chinese exercises, and meditation on depressive symptoms of college student: A meta-analysis of randomized controlled trials. *Medicine*, 100(1), e23819. <https://doi.org/10.1097/md.00000000000023819>
- Staner, L. (2010). Comorbidity of insomnia and depression. *Sleep medicine reviews*, 14(1), 35–46. <https://doi.org/10.1016/j.smrv.2009.09.003>
- Sun, Y., Ji, M., Leng, M., Li, X., Zhang, X., & Wang, Z. (2022). Comparative efficacy of 11 non-pharmacological interventions on depression, anxiety, quality of life, and caregiver burden for informal caregivers of people with dementia: A systematic review and network meta-analysis. *International journal of nursing studies*, 129, Article 104204. <https://doi.org/10.1016/j.ijnurstu.2022.104204>
- Vigo, D., Thornicroft, G., & Atun, R. (2016). Estimating the true global burden of mental illness. *The lancet. Psychiatry*, 3(2), 171–178. [https://doi.org/10.1016/s2215-0366\(15\)00505-2](https://doi.org/10.1016/s2215-0366(15)00505-2)
- WG, C. (1954). The combination of estimates from different experiments. *Biometrics*, 10(1), 101–129.
- Yang, T., Guo, Y., Cheng, Y., & Zhang, Y. (2022). Effects of traditional chinese fitness exercises on negative emotions and sleep disorders in college students: A systematic review and meta-analysis. *Frontiers in psychology*, 13, Article 908041. <https://doi.org/10.3389/fpsyg.2022.908041>
- Yeung, A., Chan, J. S. M., Cheung, J. C., & Zou, L. (2018). Qigong and Tai-Chi for mood regulation. *Focus (American Psychiatric Publishing)*, 16(1), 40–47. <https://doi.org/10.1176/appi.focus.20170042>
- Zhang, X., Li, W., & Wang, J. (2022). Effects of exercise intervention on students' test anxiety: A systematic review with a meta-analysis. *International journal of environmental research and public health*, 19(11), 19. <https://doi.org/10.3390/ijerph19116709>