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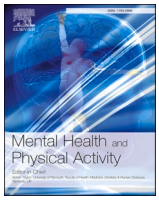

Integrating mental health interventions in higher education: An evidence-based umbrella review

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ABSTRACT

University students face increasing mental health challenges, including anxiety, stress, and depression, affecting their well-being and academic performance. This review assessed the effectiveness of physical activity interventions (PAI) combined with mindfulness-based therapy (MBT), mindfulness-based interventions (MBI), and psychoeducational interventions (PPI) in improving mental health. A systematic search was conducted in Scopus, Web of Science, and PubMed, including recent meta-analyses. A total of 24 meta-analyses were included, encompassing a wide range of mental health outcomes in university students. Statistical analyses included the DerSimonian and Laird random-effects model, heterogeneity tests (I^2), and Egger's regression test for publication bias. Results showed that combined Findings indicate that had the strongest and most consistent effects, particularly for reducing stress (SMD = −1.37) and depression (SMD = −0.79). MBI produced moderate effects on anxiety (SMD = −0.45), while PPI and MBI + PPI yielded limited improvements. These findings support the prioritization of PAI + MBT programs in university mental health strategies. Future research should aim to standardize protocols and explore intervention effectiveness across diverse student subgroups.

1. Introduction

University education not only aims to develop students' intellectual capabilities and prepare them for professional success but also represents a period of significant challenges that can impact their well-being. Academic pressure, social integration, financial difficulties, family separation, and the transition to adulthood can contribute to high levels of stress, anxiety, and psychological distress, ultimately affecting students' academic performance and quality of life (Campbell et al., 2022; Ward et al., 2022). The increasing prevalence of mental health issues among university students, as reported in numerous global studies, highlights the urgent need for effective strategies that complement traditional interventions.

The mental health of university students has become a growing global concern, with high rates of anxiety, stress, and depression significantly affecting their well-being and academic success (Henriques et al., 2025). University students represent a distinct population undergoing a transitional life stage marked by instability, identity formation, and increased responsibility. This period often coincides with exposure to new academic, social, and emotional demands that are not present in other age groups. These unique characteristics require specific and contextualized mental health interventions adapted to the university environment.

In response, various interventions—such as physical activity (Huang et al., 2024a), cognitive-behavioral therapies (Dong et al., 2024), psychoeducational programs (Savell et al., 2024), and mindfulness-based approaches (González-Martín et al., 2023)—have been developed to address these challenges (Sun et al., 2023). However, despite increasing research efforts, evidence regarding their effectiveness remains fragmented and inconsistent due to methodological heterogeneity, biases, and variations in study designs.

Most reviews on mental health interventions for university students focus on a single type of intervention, limiting direct comparisons and potentially overestimating their effectiveness (Jüni et al., 2001). Furthermore, contextual factors—such as differences in student populations, implementation settings, and intervention adherence—are often overlooked, making it difficult to determine the most effective and scalable strategies. Given these limitations, a comprehensive synthesis of the available evidence is essential to guide future research and inform university-based mental health programs.

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Umbrella reviews have emerged as a powerful methodological tool to synthesize findings from systematic reviews and meta-analyses, providing a higher-level evaluation of intervention effectiveness, consistency, and evidence quality (Kim et al., 2021; Papatheodorou, 2019). Unlike traditional meta-analyses, umbrella reviews systematically reassess bias risk and the hierarchy of evidence, offering a more objective and robust framework for decision-making in mental health policy and practice (Ioannidis, 2009).

Although several systematic reviews and meta-analyses have explored the effects of individual interventions—such as physical activity or mindfulness—on student mental health, few have compared multiple types of interventions in a single synthesis. Furthermore, many reviews include mixed populations, do not apply structured methodological quality assessments (e.g., AMSTAR 2), or focus on a narrow range of outcomes. These limitations hinder the ability to develop comprehensive and reliable recommendations tailored to the university context. This umbrella review addresses these gaps by systematically comparing a range of interventions and incorporating a rigorous quality appraisal of the included meta-analyses.

Given the rising prevalence of mental health disorders among university students and the inconsistencies in existing research, this umbrella review aims to provide a comprehensive synthesis of evidence on the effectiveness of physical activity, mindfulness-based interventions, and psychological therapies in improving mental health outcomes. Specifically, it evaluates their impact on primary outcomes such as anxiety, depression, and stress, as well as secondary outcomes like mood and sleep disorders. By consolidating findings from multiple meta-analyses, this study seeks to identify methodological gaps, assess the certainty of the evidence, and provide actionable recommendations for developing scalable, evidence-based mental health programs tailored to university populations.

2. Method

2.1. Protocol and registration

This umbrella review was conducted in accordance with the PRISMA guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) outlined by Page et al. (2021), ensuring transparency and comprehensiveness in the reporting of systematic reviews and meta-analyses.

Additionally, the methodology was aligned with the framework proposed by Aromataris et al. (2015), which provides detailed guidance for conducting umbrella reviews. The review protocol has been registered in the International Prospective Register of Systematic Reviews (PROSPERO) under the code CRD42023477463.

2.2. Data sources and search strategy

Systematic searches were conducted in the Scopus, Web of Science, and PubMed databases. The detailed search strategy for each database is available in Supplementary Material. The searches were limited to studies published in Spanish and English. Two independent reviewers screened titles and abstracts to identify potentially eligible studies, with any discrepancies resolved by a third reviewer.

2.3. Inclusion and exclusion criteria

The identified studies were independently reviewed by two authors using criteria based on the PICOS framework. Included studies were meta-analyses evaluating students enrolled in higher education institutions and analyzing interventions such as physical activity, body/mind therapies, mindfulness-based interventions, and psychological and/or educational interventions designed to address mental health conditions. Only in-person interventions were considered, excluding internet-based interventions. Comparisons could include interventions versus no treatment (control) or interventions versus other interventions. Outcomes had to involve mental health conditions assessed using validated rating scales, with reported summary effect sizes and 95 % confidence intervals. Only studies explicitly identified as "meta-analyses," targeting university students, published in English or Spanish, and within the last five years were included. Studies that did not clearly describe the intervention or failed to meet the stated criteria were excluded. All discrepancies between reviewers were discussed and resolved by consensus. The five-year restriction was applied to ensure that the evidence analyzed reflects the most current and relevant findings, particularly in the context of post-pandemic shifts in mental health. Internet-based interventions were excluded to focus exclusively on face-to-face approaches, which offer greater ecological validity for on-campus mental health strategies.

Furthermore, only systematic reviews that conducted quantitative meta-analysis were considered eligible. These meta-analyses had to report pooled effect sizes and confidence intervals for at least one mental health outcome. Narrative reviews or systematic reviews without meta-analytic calculations were excluded. In addition, the included meta-analyses were required to synthesize data primarily from randomized controlled trials (RCTs) focused on university student populations.

2.4. Data extraction

Two researchers (author 1 and author 2) independently extracted data from the selected studies, including the title, lead author, year of publication, number of studies and participants included, type of intervention, and specific statistical outcomes (standardized mean difference (SMD), such as Hedge's g and Cohen's d, with 95 % confidence intervals). The interventions were categorized into four main groups: physical activity and body-mind therapies (PAI + MBT), mindfulness-based interventions (MBI), psychological and/or psychoeducational interventions (PPI), and combined interventions (MBI + PPI).

2.5. Quality assessment

The methodological quality of the included meta-analyses was assessed using the AMSTAR 2 tool, a 16-item instrument designed to evaluate systematic reviews with or without meta-analyses (Shea et al., 2017). The application of AMSTAR 2 efficiently identified the methodological strengths and weaknesses of the studies, providing a reliable assessment of the quality and robustness of the synthesized evidence. Although none of the included meta-analyses were excluded based on AMSTAR 2 scores, those rated as "low" or "critically low" were interpreted with caution, and their influence was qualitatively considered during the synthesis of findings.

2.6. Data analysis

The average estimated effect, along with its 95 % confidence intervals (CI) and corresponding P-value, was recalculated using the DerSimonian and Laird random-effects model, as applied in previous umbrella reviews (Huang et al., 2024b; Kim et al., 2020). To assess heterogeneity among studies, Cochran's Q test was used for group analysis, while tau was applied for subgroup analysis, and the I^2 statistic was calculated. A P-value below 0.10 in Cochran's Q test was considered significant, while an I^2 value above 50 % was interpreted as indicative of high heterogeneity (Ioannidis et al., 2007). Egger's regression test was conducted to detect potential publication bias (Egger et al., 1997). A P-value below 0.10 in Egger's test indicated the presence of small-study effects, suggesting that smaller studies were more likely to produce high-risk estimates, whereas larger studies exhibited more moderate effects. All statistical analyses were conducted using the R statistical software (http://www.R-project.org, The R Foundation).

3. Results

3.1. Search and study selection process

The study selection process is illustrated in Fig. 1. A systematic search across Web of Science (n = 504), PubMed (n = 356), and Scopus (n = 403) identified a total of 1263 records. Before screening, 1033 records were excluded using built-in database filters and criteria-based automation. Specifically, we applied automatic filters for publication year (2019–2024), language (English and Spanish), and document type (meta-analyses). In addition, 82 duplicates were removed using EndNote's duplication tool. As a result, 951 records that clearly did not meet eligibility criteria were filtered out prior to manual screening. The remaining 230 records underwent title and abstract screening, leading to the exclusion of 193 studies for the following reasons: not being intervention studies (n = 103), not assessing mental health-related outcomes (n = 28), not being meta-analyses (n = 30), focusing exclusively on internet-based interventions (n = 20), or not targeting university students (n = 12). The 37 remaining full-text articles were assessed for eligibility, with 13 additional studies excluded due to being meta-analyses of digital interventions (n = 4), examining non-university populations (n = 3), having inadequate study designs such as protocols or reviews (n = 4), or lacking relevant mental health outcomes (n = 2). As a result, 24 studies met the inclusion criteria and were incorporated into this umbrella meta-analysis review.

3.2. Characteristics of included studies

Table 1 presents the details of the included meta-analyses. The review encompassed studies conducted between 2019 and 2024, analyzing a total of 53,679 university students. These studies examined a range of interventions aimed at improving mental health, with anxiety, stress, and depression being the primary outcomes assessed. The most frequently evaluated approaches included PAI, MBT often incorporating Traditional Chinese Exercises (TCE) and MBI typically compared against waitlist or usual care controls. To assess mental health outcomes, standardized instruments such as GAD-7, PHQ-9, PSS, and STAI were commonly employed, with effect sizes reported as SMD or Hedges' g. Notably, combined interventions integrating MBI with PPI tended to show greater effectiveness in reducing depression, stress, and anxiety, whereas psychological interventions alone yielded more variable results. The methodological quality of the studies ranged from high to low confidence, reflecting considerable variability in design rigor and implementation.

3.3. Synthesis of results

3.3.1. Interventions in physical activity and body-mind therapies

The meta-analysis assessed the impact of PAI and MBT interventions on key mental health outcomes, including anxiety, depression, mood changes, sleep disorders, and stress (Fig. 2). It is important to note that all interventions included in this category combined both physical activity and mind-body therapies. There were no interventions that used physical activity alone without a mind-body component.

For anxiety, based on eight studies, a moderate effect was observed, with a standardized mean difference (SMD) of −0.62 (95 % CI: −0.77 to −0.47), along with moderate but non-significant heterogeneity (I^2 = 49.6 %, p = 0.0533).

For depression, eleven studies reported a moderate-to-high effect (SMD = −0.79, 95 % CI: −1.12 to −0.47). However, the high level of heterogeneity (I^2 = 91.9 %) suggests caution in interpreting these results, as variability among studies may influence the overall effect size.

For mood changes, data were derived from a single study, which suggested a potentially strong effect (SMD = −4.15, 95 % CI: −8.30 to

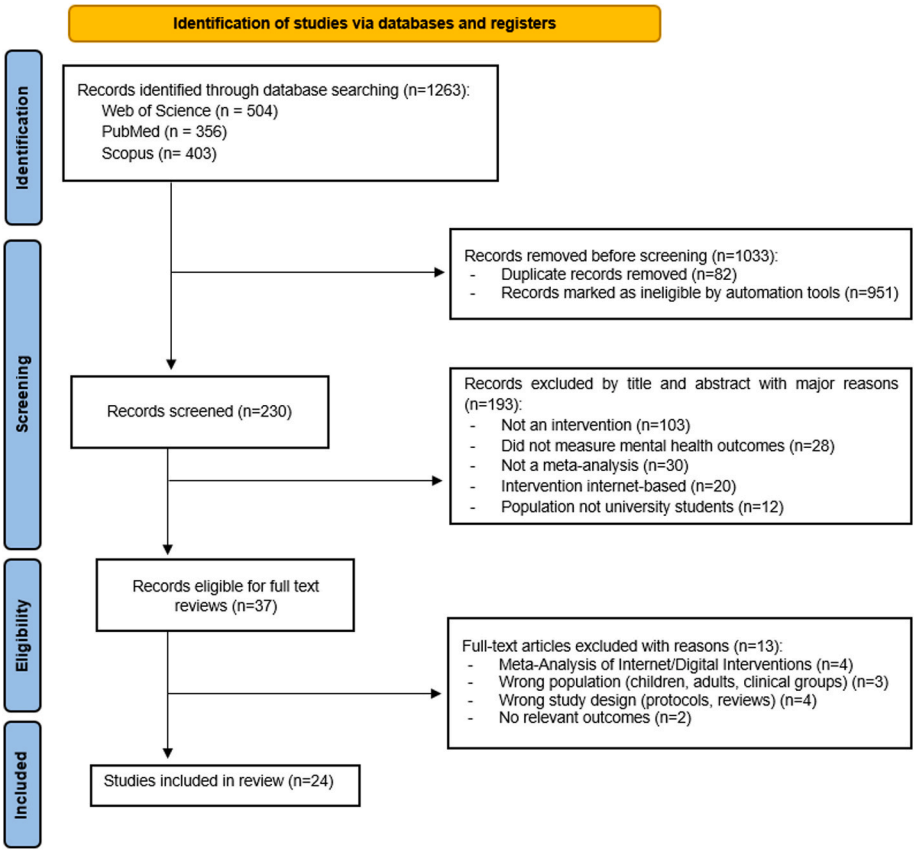

Fig. 1. Selection of studies.

Table 1
Characteristics and assessed quality of the meta-analyses included in the study.

Study	Participants IG/CG	Type of intervention	Comparison	Mental health disorders	Instruments	Effects metrics	Overall rating
Huang et al. (2024b)	2620/793	PAI (aerobic exercise, dance, sports, resistance training), MBT (yoga and TCE: Qiqong, Tai Chi Quan)	Waitlist	Anxiety, Depression, Stress	STAI, BDI, PSS, BAI, GAD-7, SAS, PHQ-9, DASS-21, HADS, CES-D	SMD	Low
Molinero et al. (2024)	1570	PPI (Forgiveness training program)	Control group/no intervention	Anxiety, Depression, hostility	TRIM, EFI, STAI, CES-D	SMD	Moderate
Zhang et al. (2024)	264/231	PAI (biodanza, HIIT, aerobic exercise, resistance training); MBT (pilates, yoga and TCE: Tai Chi Chuan, Baduanjin, Bafa Wufu of Tai Chi)	Waitlist, Usual Care	Depression	CES-D, HADS, DASS-21, PHQ-9, SDS	SMD	Moderate
da Silva et al. (2023)	2234/2157	MBI	Waitlist, Usual Care, Active Control	Anxiety, Stress, Depression	PSS, GAD-7, PHQ-9	SMD	Moderate
González-Martín et al. (2023)	1741/2722	MBI (MBSR, MBCT, ACT)	Waitlist, Usual Care, Active Control	Anxiety, Stress, Depression, Psychological Distress; Well-being	PSS, DASS-21, FFMQ, MAAS, SDS, BDI	Hedges'g	Moderate
Li et al., (2023a)	837/621	PAI (aerobic sports, ball games, HIIT, traditional), MBT (yoga and TCE: Taliquan, Tai Chi), Music and Massage,	Waitlist, usual care	Depression	SDS, CES-D, BDI, PHQ-9	SMD	Moderate
Li et al. (2023b)	801/801	MBI (MBSR, MBCT)	Control group/no intervention	Anxiety	SAS, HAMA, BAI, ACS, GAD-7	SMD	High
Lin and Gao (2023)	483	PAI (aerobic exercise, resistance training), MBT (yoga and TCE: Taichi)	Control group/no intervention	Anxiety	STAI, ASI-R score, PHQ-9, PSWQ, ASI, BAI, Heart rate	SMD	Moderate
Wang et al. (2023)	755/741	PPI (CBT, DBT); MBI (MBSR)	Blank control	Anxiety, Stress, Depression	GAD-7, PHQ-9, PSS	SMD	Moderate
Zuo et al. (2023)	846/849	MBI (MBSR, ACT, DBT, MBCT)	Waitlist; Usual care	Anxiety, Stress, Depression, Sleep Quality	GAD-7, PHQ-9, PSS, DASS, PSQI, BDI	SMD	High
Du et al. (2022)	439/351	MBT (TCE:Taijiquan)	Control group/no intervention	Anxiety, Depression	SDS, SCL-90, CES-D	SMD	High
Lin et al. (2022)	809/819	MBT (TCE: Qiqong Baduanjin)	No intervention, active control groups	Depression, Anxiety	HAMD, POMS, SDS, CES-D, HAMA, SCL-90, SAS,	SMD	Moderate
Luo et al. (2022)	607/588	PAI, (physical training, running, aerobic exercises, HIIT) MBT (yoga, nadi shuddi and TCE: Tajiquan, Baduanjin)	No intervention, active control	Anxiety disorder, Depression	SCL-90, SAS, SDS, PSS-10 DASS, PHQ-4	SMD	High
Yang et al. (2022)	516/536	MBT (TCE: Tai Chi, Baduanjin, Yijinjing, Liuzjue, Qu Qin Xi, Quqinxi)	Waitlist, routine care	Depression, Anxiety, Sleep Disorders	SCL-90; SDS, PSQI	SMD	Moderate
Barnett et al. (2021)	7158	MBT (meditation); PPI (CBT)	Active controls, waitlist	Anxiety, Depression,	GAD-7, PHQ-9, PSS, STAI, BDI, HADS	SMD	Low
Chen et al. (2021)	725/732	MBI (MBSR, MBCT, meditation)	Waitlist	Anxiety, Depression, Stress	BDI, STAI, SAS, PSS-10	SMD	Low
Song et al. (2021)	308/337	PAI (aerobic exercise); MBT (TCE and meditation)	No intervention, active control	Depression, Anxiety, Stress	BDI, SDS, BSI, LAS, MOODS, SAS, STAI	SMD	Moderate
Amanvermez et al., 2023	4800	PPI (CBT, TWCCT, skills training), MBT (yoga), MBI	Active control groups	Anxiety, Stress, Depression	DASS-21; PSS; GHQ; Kessler-10	Hedges'g	High
Fu et al. (2020)	1462/1421	PPI (CBT)	Waitlist, usual care	Depression	BDI, SDS, CES-D	Hedges'd	Low
Guo et al. (2020)	703/501	PAI (dance, running, volleyball, bádminton, running); MBT (yoga and TCE: tai chi)	Usual care	Depression	SDS, HAMD, BDI-II	SMD	Low
Saruhanjan et al., 2021	1002/1406	PPI (CBT for Insomnia)	Waitlist, usual care	Sleep Disturbances, Insomnia	PSQI, ISI, Sleep Diaries	Hedges'd	Moderate
Strehli et al., 2021	842/783	MBT (yoga and TCE: Tai Chi, Qiqong)	Usual Care	Stress-Related Physiological Markers	Hear Rate, Cortisol, Blood Pressure	Hedges'd	Moderate
Ma et al., 2019	2472	MBI	Waitlist, Control group/no intervention	Depression	DASS, CES, BDI-II	SMD	Moderate
Gonzalez-Valero et al., 2019	3296	MBI (meditation); PPI (CBT)	Control group/no intervention	Stress, Anxiety, Depression	DASS-21; PSS	Hedges'd	Low

Note: PAI: Physical Activity Intervention; TCE: Traditional Chinese Exercises; MBT: Mind-Body Therapy; PPI: Psychological and/or psychoeducational interventions; MBI: Mindfulness-Based Interventions; MBSR: Mindfulness-Based Stress Reduction; MBCT: Mindfulness-Based Cognitive Therapy; ACT: Acceptance and Commitment Therapy; TWCCT: Third wave conductual-cognitive therapy.

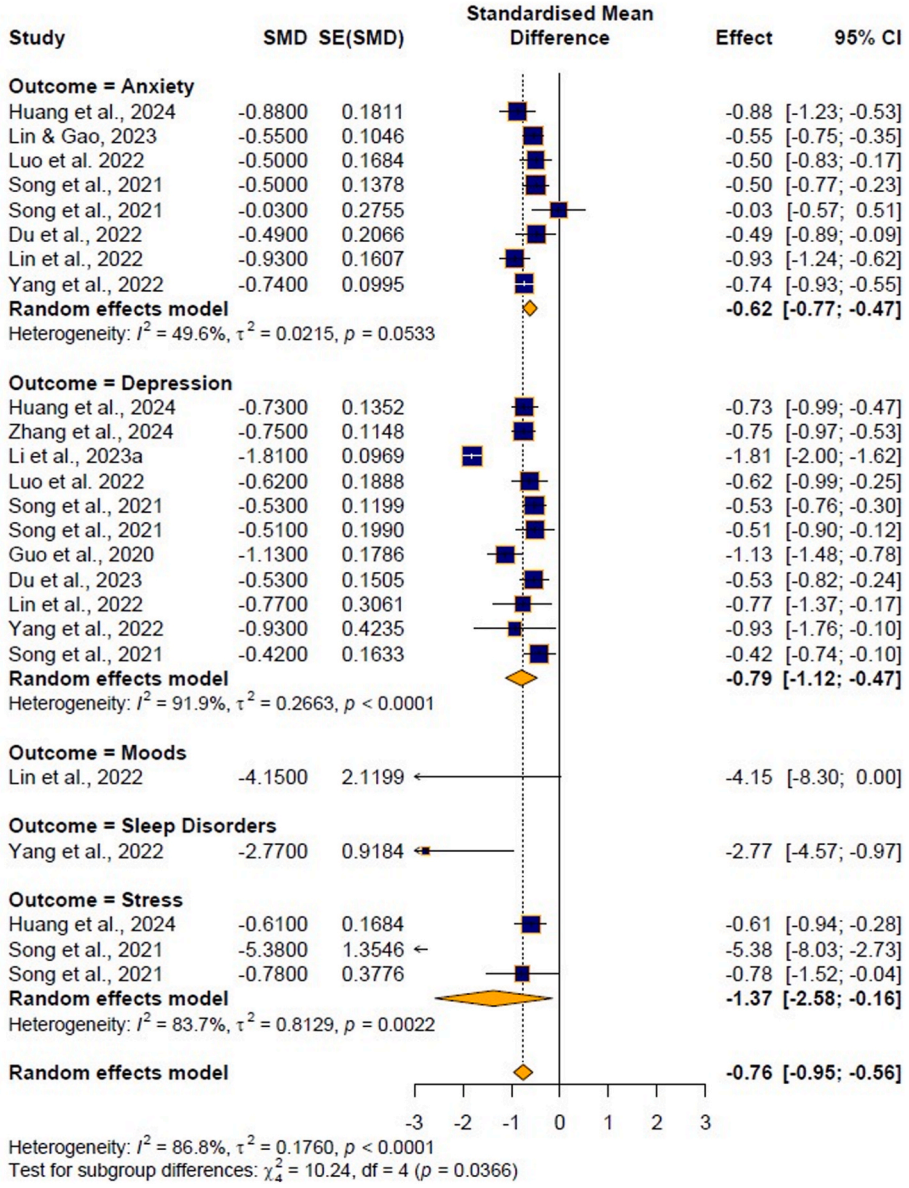

Fig. 2. Forest Plot on the efficacy of PAI and MBT to improve MH in university students.

0.00). However, the wide confidence interval indicates considerable uncertainty, limiting the robustness of this finding.

For sleep disorders, another single study reported a significant effect (SMD = −2.77, 95 % CI: −4.57 to −0.97). While this suggests potential benefits, the limited number of studies warrants further research to confirm the reliability of this result.

For stress, data from three studies showed a significant reduction (SMD = −1.37, 95 % CI: −2.58 to −0.16), although the presence of high heterogeneity (I^2 = 83.7 %) suggests variability in intervention effectiveness across different contexts.

Overall, the combined effect size for all outcomes was SMD = −0.76 (95 % CI: −0.95 to −0.56), indicating a moderately beneficial impact of PAI and MBT interventions on mental health. Despite this, considerable heterogeneity was observed (I^2 = 86.8 %, τ^2 = 0.1760, p < 0.0001), suggesting variability across studies in terms of intervention types, duration, and participant characteristics.

Additionally, the Egger's test for publication bias found no significant evidence of asymmetry (t = 0.7612, p = 0.4601). The regression coefficient (b = −0.5729, 95 % CI: −1.2415 to 0.095) further supports the absence of significant publication bias, reinforcing the reliability of the findings.

3.3.2. *Mindfulness-based intervention*

As shown in Fig. 3, the analysis of MBI interventions examined their effects on psychological outcomes, including anxiety, depression, stress, and sleep quality.

For anxiety, based on five studies, a small but statistically significant effect was observed (SMD = −0.45, 95 % CI: −0.88 to −0.03). However, high heterogeneity (I^2 = 97.6 %, τ^2 = 0.2275, p < 0.0001) suggests substantial variability among studies, indicating that the effectiveness of interventions may depend on specific implementation factors.

For depression, four studies reported a small and non-significant effect (SMD = −0.15, 95 % CI: −0.55 to 0.24), with substantial heterogeneity (I^2 = 97 %, τ^2 = 0.1925, p < 0.0001), suggesting a limited overall impact.

For stress, findings from four studies yielded an SMD of −0.19 (95 % CI: −0.56 to 0.19), indicating a small and non-significant effect, with high heterogeneity (I^2 = 95.3 %, τ^2 = 0.1372, p < 0.0001).

Regarding sleep quality, a single study reported a moderate and statistically significant effect (SMD = −0.81, 95 % CI: −1.53 to −0.09),

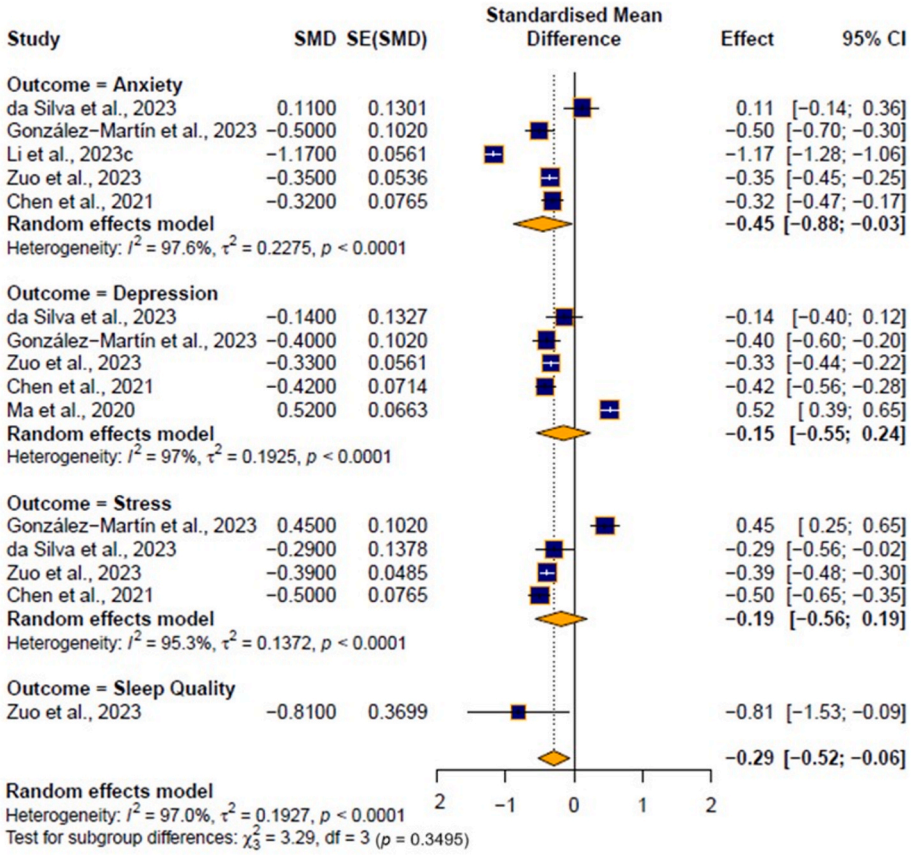

Fig. 3. Forest Plot of efficacy of MBI on mental health in university students.

suggesting potential benefits. However, given that this finding is based on only one study, further research is needed to confirm its reliability.

Overall, the combined effect size across all outcomes was SMD = −0.29 (95 % CI: −0.52 to −0.06), indicating a small but significant improvement in mental health outcomes. Despite this, the high heterogeneity ($I^2 = 97.0$ %, $\tau^2 = 0.1927$, $p < 0.0001$) highlights substantial variability in intervention effectiveness.

The subgroup difference test revealed no significant variation among

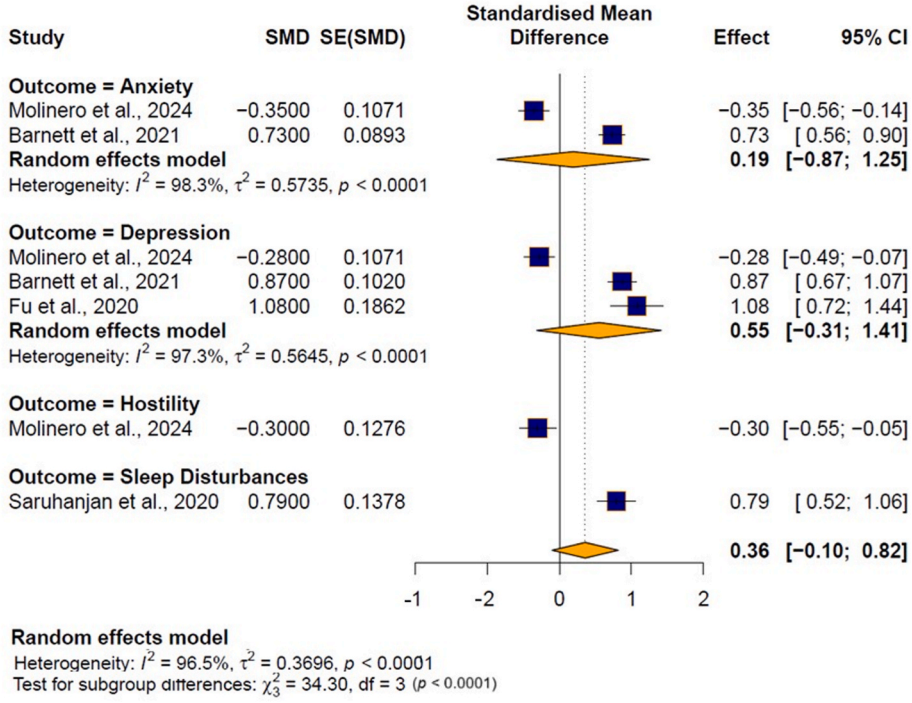

Fig. 4. Forest Plot on PPI for MH in university students.

outcomes (χ^2 = 3.29, p = 0.3495). Meanwhile, funnel plot analysis indicated no publication bias (t = 0.7612, df = 13, p = 0.4601), and the regression estimate (b = −0.5729, 95 % CI: −1.2415 to 0.0957) confirmed no significant relationship between effect size and study precision.

3.3.3. Psychological and psychoeducational intervention

As illustrated in Fig. 4, this meta-analysis examined the effects of PPI interventions on anxiety, depression, hostility, and sleep disorders.

For anxiety, findings from two studies indicated a small, non-significant effect (SMD = 0.19, 95 % CI: −0.87 to 1.25), with extremely high heterogeneity (I^2 = 98.3 %, τ^2 = 0.5735, p < 0.0001), suggesting substantial variability across studies.

Regarding depression, results from three studies showed a potentially positive but statistically non-significant effect (SMD = 0.55, 95 % CI: −0.31 to 1.41), accompanied by high heterogeneity (I^2 = 97.3 %). This indicates that while some benefit may exist, the inconsistency across studies prevents firm conclusions.

For hostility, a single study reported a small but statistically significant reduction (SMD = −0.30, 95 % CI: −0.55 to −0.05), implying some effectiveness in reducing hostile behavior.

For sleep disorders, another single study found a moderate improvement (SMD = 0.79, 95 % CI: −0.52 to 1.06). Although this suggests a beneficial effect, further research is necessary to validate these findings due to the limited number of studies available.

The overall combined effect size across all outcomes was SMD = 0.36 (95 % CI: −0.10 to 0.82), but heterogeneity remained extremely high (I^2 = 96.5 %, τ^2 = 0.3696, p < 0.0001), reflecting the substantial variation in intervention effects.

Egger's regression analysis found no significant evidence of publication bias (t = 0.1644, df = 5, p = 0.8759). Additionally, the limit estimate (b = 0.1234, 95 % CI: −3.0810 to 3.3279) confirmed no meaningful relationship between effect size and study precision.

3.3.4. Combined mindfulness interventions and psychological/psychoeducational interventions

As depicted in Fig. 5, this meta-analysis assessed the impact of combined MBI and PPI interventions on anxiety, depression, and stress.

For anxiety, findings from three studies indicated a small, non-significant effect (SMD = −0.10, 95 % CI: −0.76 to 0.55), with extremely high heterogeneity (I^2 = 97.6 %), suggesting substantial variation across studies.

Similarly, for depression, the analysis revealed a small and non-significant effect (SMD = −0.23, 95 % CI: −0.88 to 0.43), indicating minimal improvements in depressive symptoms.

The overall combined effect size across all outcomes was SMD = −0.21 (95 % CI: −0.54 to 0.13), reflecting an overall non-significant effect with substantial heterogeneity (I^2 = 97.1 %, τ^2 = 0.2371, p < 0.0001), further emphasizing the high variability among studies.

To evaluate the potential for publication bias, Egger's regression test was conducted, showing no evidence of small-study effects (t = −0.3938, df = 7, p = 0.7054). Additionally, the limit estimate (b = 0.0932, 95 % CI: −0.8598 to 1.0462) confirmed no significant relationship between effect size and study precision, reinforcing the reliability of the findings.

3.3.5. General comparison between the studies

As depicted in Fig. 6, the heatmap provides a visual representation of the differential effectiveness of various interventions on key mental health outcomes: anxiety, depression, and stress.

The findings indicate that the combination of PAI and MBT is the most effective intervention for improving mental health, particularly in reducing stress (SMD = −1.37), depression (SMD = −0.79), and anxiety (SMD = −0.62). This suggests that integrating physical activity with body-mind approaches could be a highly beneficial strategy for addressing mental health concerns.

In contrast, PPI show a moderate positive effect on depression (SMD = 0.55) but only minimal effects on anxiety (SMD = 0.19) and stress (SMD = −0.30), indicating that while these interventions may support depressive symptom improvement, they might be less effective for stress and anxiety management.

The combination of MBI and PPI demonstrates near-null effects across all three outcomes (anxiety: SMD = −0.10, depression: SMD = −0.23, stress: SMD = −0.38), suggesting that these strategies may not be

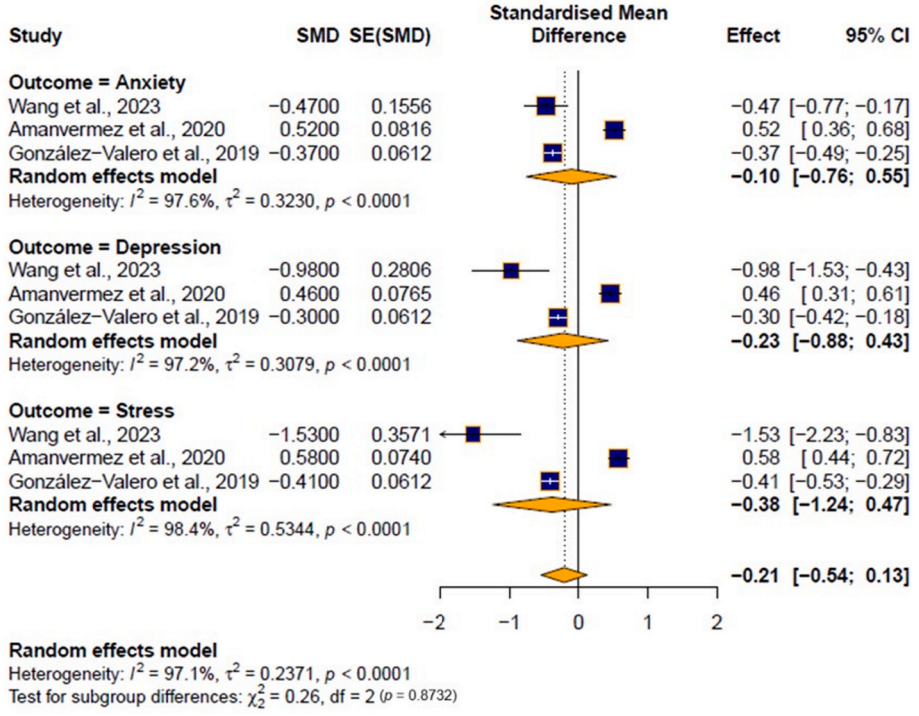

Fig. 5. Forest Plot of combined PPI with MBI interventions on MH in university students.

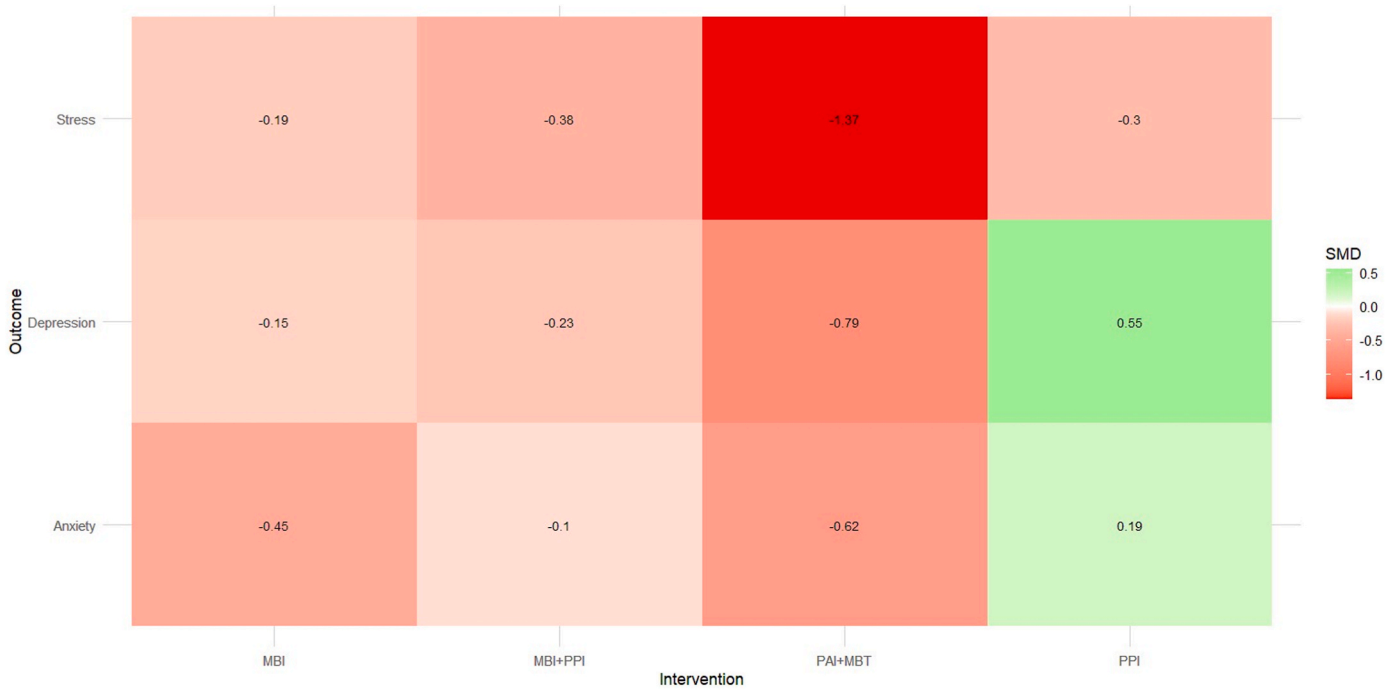

Fig. 6. Heatmap of effects by type of intervention and main outcome (anxiety, stress and depression).

particularly effective when combined.

Meanwhile, MBI alone exhibit a moderate impact on anxiety (SMD = −0.45) but only small effects on depression (SMD = −0.15) and stress (SMD = −0.19), implying that mindfulness alone may offer some anxiety relief but might not be as impactful for other mental health outcomes.

These results emphasize the strong effectiveness of PAI + MBT, particularly for stress reduction, and suggest that incorporating physical activity and body-mind therapies into mental health programs could provide the most significant benefits for university students. Additionally, the limited efficacy of MBI + PPI highlights the need for further research to explore potential synergies between mindfulness and psychoeducational strategies and to determine whether modifications in intervention structure, intensity, or duration could enhance their effectiveness.

3.4. Risk of bias assessment

Of the 24 studies evaluated using the AMSTAR 2 tool, they were categorized into three levels of methodological confidence. A total of 21 % (n = 5) were classified as high confidence, fully adhering to key methodological criteria, including protocol registration and comprehensive bias analyses. Meanwhile, 54 % (n = 13) were rated as moderate confidence, demonstrating partial adherence to critical domains, such as the consideration of bias in result interpretation and the assessment of publication bias.

Conversely, 25 % (n = 6) were categorized as low confidence, primarily due to significant limitations in essential aspects, including protocol registration and risk of bias evaluation (Supplementary Material). Notably, no studies were classified as critically low confidence, indicating that all studies met at least the fundamental methodological requirements, ensuring a baseline level of reliability in the findings.

4. Discussion

This study represents the first umbrella review to provide a comprehensive and hierarchical synthesis of the available evidence on interventions aimed at reducing psychological distress in university students. Through the analysis of 24 meta-analyses, encompassing a total of 504 RCTs, the effectiveness of multiple approaches to promoting mental health in this population was evaluated. The findings highlight that the combination of adapted PAI and MBT is the most effective strategy for reducing stress (SMD = −1.37) and depression (SMD = −0.79) in university students. These results align with previous studies supporting the positive effects of physical activity on mental health (Huang et al., 2024a). Importantly, these findings emerged primarily from meta-analyses rated as moderate or high quality according to the AMSTAR 2 criteria, which reinforces their methodological robustness and practical relevance. The efficacy of the PAI + MBT combination can be explained from a multifactorial perspective, as it integrates physiological, psychological, and behavioral components, maximizing its impact compared to isolated interventions.

From a physiological perspective, physical activity regulates cortisol levels, a key hormone in the stress response, and stimulates the release of neurotransmitters such as serotonin, dopamine, and endorphins, which are essential for mood regulation (Barahona-Fuentes et al., 2021). Various types of physical activity have demonstrated benefits for psychological well-being (Gordon et al., 2021; Song et al., 2021), reinforcing its importance as an effective non-pharmacological strategy to enhance student well-being. In this review, psychological well-being refers to the presence of positive affect, life satisfaction, and effective psychological functioning. This was assessed in the included studies through standardized instruments such as the WHO-5 and the WEMWBS. At a psychological level, these interventions have been shown to promote emotional regulation and strengthen resilience to stressful situations. Physical exercise not only helps channel tension but also improves self-esteem and self-efficacy, facilitating better management of negative emotions. Furthermore, integrating mindfulness and meditation techniques into MBT enhances students' ability to reduce cognitive rumination and improve attentional focus. The practice of these therapies also activates the parasympathetic nervous system (Khajuria et al., 2023), promoting relaxation and reducing the hyperactivation associated with anxiety and stress. These techniques strengthen the connection between the body, mind, behavior, and brain, contributing to overall well-being. In particular, approaches based on

Traditional Chinese Medicine, such as Tai Chi, Yoga, and Meditation, have shown benefits in managing chronic diseases and improving general well-being (Morone & Greco, 2007; Ramirez-García et al., 2019; Fogaça et al., 2021).

From a behavioral perspective, the social component present in many forms of physical activity and mind-body therapies fosters a sense of community and mutual support, strengthening students' emotional well-being. These effects can also be interpreted through established psychological frameworks. For instance, the self-determination theory (SDT) posits that interventions promoting autonomy, competence, and relatedness enhance intrinsic motivation and psychological well-being. Likewise, the stress-buffering hypothesis suggests that supportive behaviors and physical activity may mitigate the harmful effects of stress by strengthening coping resources, which may help explain the reductions in anxiety and depressive symptoms observed in this review. Participation in group activities promotes social interaction and reduces isolation, two key factors in preventing psychological distress in university settings (Aslamina et al., 2024). However, MBI showed a moderate reduction in anxiety (SMD = −0.45), although their impact on depression and stress was less significant. These results suggest that while mindfulness improves emotional regulation and reduces reactivity to stressful situations, its effectiveness could be enhanced when combined with more active strategies such as physical activity. In fact, the combination of PA and MBI offers a complementary approach, where meditation facilitates adherence to physical exercise by fostering an open and non-judgmental attitude toward bodily sensations, while physical activity enhances motivation and a sense of achievement —key elements for maintaining both practices over time (Remskar et al., 2024).

In contrast, PPI and the combination of MBI with PPI showed limited efficacy in reducing psychological distress. This low effectiveness could be attributed to the absence of an active behavioral component that reinforces adherence and facilitates sustained change over time. Previous studies have indicated that traditional psychoeducational approaches may be insufficient on their own and that their impact could be maximized by integrating experiential and interactive strategies (Sun et al., 2023). Despite the observed effectiveness of some interventions, considerable heterogeneity in effects was identified, particularly in PAI + MBT (I^2 = 91.9 % in depression) and MBI (I^2 = 97.6 %). This variability suggests that the efficacy of interventions depends on multiple factors, including differences in study design, intervention duration, intensity of implemented practices, and participant adherence levels. Additionally, characteristics of the studied populations influence the results, as some studies included students with high levels of pre-existing anxiety or depression, while others focused on general university populations with less severe symptoms.

Another key factor complicating comparisons across studies is the diversity of assessment tools used. Scales such as PHQ-9, GAD-7, PSS, and STAI were employed, each with varying sensitivity and specificity in measuring symptoms of anxiety, depression, and stress. The lack of uniformity in measurement highlights the need to establish standardized criteria in future research to improve the comparability of results and optimize the implementation of evidence-based strategies in university settings.

4.1. Practical implications for MH programs in university students

The findings of this review provide key insights for the planning and implementation of mental health programs in university settings. Given that the combination of PAI and MBT has demonstrated the most significant and clinically relevant effects, it should be considered a priority strategy for promoting student well-being.

MBI can be effective tools for reducing anxiety; however, their efficacy as a stand-alone treatment for depression and stress is limited. Nevertheless, their low cost and accessibility make them a viable complement to PAI + MBT, maximizing the overall impact of mental health programs in universities.

On the other hand, the low effectiveness observed in PPI and the combination of MBI + PPI suggests that traditional psychoeducational approaches require redesigns to incorporate more participatory elements, such as practical exercises, group dynamics, and real-life scenario simulations, in order to enhance their impact.

Moreover, the considerable heterogeneity found in the reviewed studies highlights the need to personalize interventions according to individual student characteristics, considering factors such as gender, socioeconomic level, and academic workload. Tailoring programs to these variables could optimize their effectiveness and foster greater long-term adherence.

In this regard, universities are uniquely positioned to develop and implement comprehensive, interdisciplinary mental health strategies that integrate physical activity and mindfulness components. Collaborations between psychology services, sports and physical education departments, and student affairs offices can facilitate the design of scalable programs embedded in academic schedules or extracurricular offerings. Providing accessible, inclusive, and evidence-based options on campus can strengthen students' emotional resilience and contribute to sustainable mental health support within higher education institutions.

4.2. Limitations and future directions

Although this umbrella review provides a rigorous and evidence-based synthesis of the effectiveness of mental health interventions for university students, it has certain limitations. Among the methodological weaknesses identified through AMSTAR 2 are the lack of pre-registered protocols, limited transparency in study selection, and inconsistent risk of bias assessments.

Additionally, the review focused exclusively on in-person interventions, excluding those based on digital technology, which have gained increasing relevance in university settings. Furthermore, the diversity of assessment tools used complicates direct comparisons of results, limiting the ability to draw homogeneous conclusions regarding the effectiveness of each intervention.

A further limitation is the absence of individual participant data, which prevented subgroup analyses by age, sex, or baseline mental health status. These variables may influence the outcomes and contribute to the observed heterogeneity. Future umbrella reviews should explore these factors using stratified or multilevel approaches to better identify which populations benefit most from each type of intervention.

Finally, the lack of long-term follow-up data in many of the included studies limits the ability to determine the sustainability of the effects observed beyond the intervention period.

4.3. Strengths of the study

Despite these limitations, this review presents several key strengths that reinforce its scientific rigor and practical relevance. By exclusively including meta-analyses, this umbrella review synthesizes the highest level of available evidence, integrating findings from multiple RCTs to provide a comprehensive evaluation of the effectiveness of various interventions.

The use of AMSTAR 2 to assess the methodological quality of the included studies ensures a robust approach, minimizing the risk of bias in result interpretation. One of the main advantages of this review is its comparative framework, which sets it apart from meta-analyses focusing on single interventions. By analyzing the effectiveness of PAI + MBT, MBI, PPI, and MBI + PPI, this study provides a clear understanding of their relative impact, allowing for well-founded recommendations for policymakers, educators, and mental health professionals in university settings.

Additionally, statistical rigor was maintained through the use of Egger's regression test and publication bias analysis, ensuring the

reliability of findings despite the observed heterogeneity.

Finally, by focusing on university students, a population particularly vulnerable to mental health challenges, this review fills a critical gap in the literature and provides valuable guidance for the design and implementation of evidence-based mental health programs in academic environments.

5. Conclusion

This umbrella review provides strong evidence on the effectiveness of various intervention strategies for improving university students' mental health. The combination of PAI and MBT emerges as the most effective approach, significantly reducing psychological symptoms. Meanwhile, MBI can serve as a valuable complement, whereas traditional psychoeducational and positive psychology approaches require adjustments or integration with more dynamic strategies to maximize their impact. Future research should focus on standardizing protocols, conducting subgroup analyses, and evaluating the long-term sustainability of these interventions.

A critical gap in the literature is the lack of research on healthy university populations, where interventions could play a preventive role rather than being solely directed at clinical cases. Additionally, the high heterogeneity among studies—stemming from differences in research designs, intervention protocols, and follow-up durations—highlights the urgent need for greater methodological standardization to enhance comparability and reliability in future findings.

Given the growing mental health crisis in higher education, universities must prioritize evidence-based, scalable, and sustainable intervention models. Future research should emphasize protocol standardization, strengthening long-term follow-up assessments, and conducting subgroup analyses to explore how factors such as sociodemographic variables and baseline mental health status influence intervention effectiveness. Moreover, the integration of digital and hybrid models, which were not included in this review, could provide more accessible and adaptable solutions for university-based mental health programs.

While this review lays a solid foundation for mental health intervention strategies, it also underscores the need for continued research to optimize and expand current approaches. Addressing these gaps will require multidisciplinary collaboration among researchers, educators, and policymakers to design effective and sustainable initiatives that ensure the long-term well-being of university students.

CRediT authorship contribution statement

García-Pérez Laura: Writing – review & editing, Writing – original draft, Visualization, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Ubago-Jiménez José Luis:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Formal analysis. **Cepero-González Mar:** Writing – review & editing, Validation, Supervision, Methodology, Investigation, Data curation. **Padial-Ruz Rosario:** Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Investigation, Formal analysis, Conceptualization.

Disclosure statement

The authors report there are no competing interests to declare.

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Declaration of competing interest

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.mhpa.2025.100708.

Data availability

No data was used for the research described in the article.

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