REVIEW

# Effects of Music, Massage, Exercise, or Acupuncture in the Treatment of Depression Among College Students: A Network Meta-Analysis

Fang-bo Li[1],*, Ping Lu[2],*, Hai-tao Wu[1], Ming-han Wang[1], Jing-dong Wang[1]

[1]Graduate School, Guangzhou Sport University, Guangzhou, Guangdong, 510500, People's Republic of China; [2]School of PE and Health, Guangzhou University of Chinese Medicine, Guangzhou, Guangdong, 510006, People's Republic of China

*These authors contributed equally to this work

Correspondence: Fang-bo Li, Graduate School, Guangzhou Sport University, Linhe West Road, Tianhe District, Guangzhou, Guangdong, 510500, People's Republic of China, Tel +86 18860292906, Email 975394244@qq.com

**Objective:** To assess the therapeutic impacts of exercise, massage, and music interventions on college students experiencing depression by employing a mesh meta-analysis approach. This research intends to offer valuable insights to aid in the development of non-pharmaceutical treatment strategies for depression.

**Methods:** We conducted a thorough search across various databases including Cochrane, PubMed, Embase, Web of Science, CNKI, and Wanfang to explore the effects of music, massage, aerobic exercise, fitness Qigong, yoga, tai chi, ball games, strength training, dance, whole body vibration training, and high-intensity interval training on the treatment of depression in college students. The search period was from January 1, 2023, which marks the establishment of each database. Subsequently, a mesh meta-analysis was performed using the "Stata 15.1" software, incorporating outcome indicators from 24 included literature comprising a total of 1458 patients.

**Results:** Based on the ranking of the optimal intervention effects of various non-pharmaceutical methods, the order, from highest to lowest probability, was as follows: high-intensity interval training (96%), yoga (94.90%), dance (78.30%), music (73.30%), ball games (62.50%), strength training (51.70%), aerobic training (45.30%), tai chi (35.40%), vibration training (27.30%), massage (20.10%), qigong (14.30%), and no intervention (1.00%). This ranking aligns closely with the findings obtained from pairwise comparisons between different interventions.

**Conclusion:** High-intensity interval training is likely to yield the most effective therapeutic results for college students with depression. In the pairwise comparison of different interventions, High-intensity interval training is also better than most interventions. However, to establish its intervention effect more conclusively, further validation through additional high-quality randomized controlled trials is necessary.

**Keywords:** depression, music, exercise, college student, network meta-analysis

## Introduction

Depression is a common and serious mental health concern among college and university students.[1] The 2019 Global Burden of Illness, Injury, and Risk Factors study showed that depression is one of the most disabling mental disorders, and among adolescents, depression ranked fourth on the list of the world's leading causes of burden in 2019.[2] Studies have shown that depression has become a major emotional problem among college students. College students in their early adulthood are prone to emotional dysregulation and despair.[3] In 2021, China's Ministry of Education requested for the first time that depression screening be included among students' physical examinations, demonstrating that the harm of depression in college students has piqued the state and society's attention.[4] In this context, how to provide effective non-drug treatment to improve depressive symptoms for patients with depression has attracted the attention and research of many researchers. Non-drug treatment methods for depression are currently exercise intervention, music intervention,

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meditation, acupuncture, massage, and so on. Studies have found that aerobic exercise, traditional Chinese sports (fitness qigong, tai chi, etc.), and meditation can effectively improve the depressive symptoms of college students.[1] Music, massage, and acupuncture have also been proven to be effective in the treatment of depression.[5–9] Several interventions have been evaluated individually or in comparison using randomized controlled trials.[5,10–13] However, there are only a few studies comparing the efficacy of multiple non-pharmacological interventions in network meta-analysis. Therefore, four interventions (exercise, music, massage, and acupuncture) that are regularly utilized in the treatment of depression among college students were selected as research objects. The network meta-analysis method was used to integrate the relevant clinical evidence of direct and indirect comparison. The different interventions of the same evidence were summarized, quantitatively synthesized, and analyzed, the probability was ranked according to the efficacy of the index, and the best therapy was screened.

## Materials and Methods

### Literature Searching and Selection of Articles

Two investigators independently conducted a literature search. The databases were searched until 1 January 2023. The keywords utilized for the searches were "college student depression", "exercise", "dance", "yoga", "tai chi", "qi gong", "music", "massage" and "acupuncture". Studies in the Cochrane, PubMed, Embase, Web of Science, CNKI, and Wanfang databases that were written in Chinese or English and were related to the study were retrieved. The terms were grouped into three categories (intervention, outcome measure, and intervention), connected by Boolean logical operators (OR or AND), and applied to three search levels. The retrieved papers were initially screened using the bibliographic management software Endnote, such as deduplication, reading titles, and abstracts and the remaining studies were examined in detail, according to the PICOS set appropriate inclusion criteria.

The following were the research inclusion criteria: (1) The participants of the study were specifically college students who were experiencing depression. It is important to note that the study focused on undergraduate students, excluding high school students; (2) experimental interventions related to exercise, music, massage, and acupuncture; (3) the outcome indicators were the depression scores assessed by the scale, and the before and after indicators were reported in detail, such as mean, standard deviation, sample size, etc. to generate effect sizes; (4) the research type is two-arm experimental research; (5) the baseline data are comparable.

The following were the research exclusion criteria: (1) The literature is in the form of reviews, conference abstracts, case reports, etc.; (2) the data reported in the literature were incomplete, the contact authors were unsuccessful, and the original data could not be obtained; (3) the baseline data is incomplete; and (4) the intervention target receives drug intervention at the same time in addition to several interventions prescribed.

After determining the criteria for inclusion and exclusion, two investigators began screening the literature at the same time, compared the findings of the inclusion of their selected literature, and the third investigator moderated the disagreeable material.

### Assessment of Methodological Quality

The PEDro scale developed by the Center for Evidence-Based Medicine in Physical Therapy was used to assess the quality of the literature.[14] The scale comprises 11 items, including subjects, allocation concealment, blinding, and other main content, and the score ≤3 is poor quality; the score in 4–5 is medium quality; the score in 6–8 is good quality; and the score of 9 points is high quality. At the same time, the Cochrane risk bias assessment tool was employed to assess the quality of the included studies. The evaluation primarily focused on seven aspects, which included random sequence generation, allocation concealment, blinding of participants, blinding of outcome variable evaluation, loss of outcome data, selective reporting, and other potential biases.

### Data Extraction and Statistical Analysis

For the included indices, the mean, standard deviation, and sample size of the before-and-after test data were extracted from each experimental group and control group. The analytical data utilized the change from baseline as the basis for

comparison. The effect size of different types of intervention on depressive symptoms in college students was explored through a network meta-analysis.

The statistical analysis was performed using the Stata 15.1 software for network meta-analysis. The effect size of the measured data was expressed in weighted mean difference (WMD) or standardized mean difference (SMD) with its 95% confidence interval (CI). In cases where the units, measures, or rating scales of the extracted data were not consistent, SMD was utilized to represent the effect size. If the 95% CIs did not include zero, it indicated a statistically significant difference between the two treatments. Conversely, if the difference fell within the confidence interval, it was considered not statistically significant.[15] The surface under the cumulative ranking (SUCRA) was used to represent the preferred ranking of each treatment measure.[16] A larger area under curve indicates a greater probability that the psychotherapy will be the best treatment. Funnel plots were used to indicate publication bias, and the symmetry of the funnel plots was used to assess publication bias between included studies. The pooled effect size of each included study was a study in which the x-axis intersected on the funnel plot as a perpendicular line, and the points distributed to the left of the perpendicular line represented studies with fewer effect sizes than pooled effect sizes; the dots distributed to the right of the perpendicular line represent studies in which the effect size is greater than the combined effect size: the number of dots on both sides is essentially the same, indicating no publication bias, and conversely, there is publication bias.

# Results

## Literature Search results

We searched Cochrane, PubMed, Embase, Web of Science, CNKI, and Wanfang databases for references 102, 409, 544, 696, 211, and 907. The screening was carried out in accordance with the established inclusion and exclusion criteria. A total of 2845 irrelevant articles were removed, leaving only 24 for evaluation. The selection process is shown in Figure 1.

## Characteristics of the Studies

The 24 included papers came from 5 different countries and were divided into Randomized controlled trial and Controlled trial by experimental category, with 17 randomized controlled trials and 7 non-randomized controlled trials. The intervention targeted all college students with varying degrees of depression symptoms, with a total of 1458 people and about 63% of them being women. After data screening, the experimental group contained 117 cases of music intervention, 21 cases of massage, 98 cases of aerobic exercise, 15 cases of qigong, 61 cases of yoga, 97 cases of Tai Chi, 230 cases of ball games, 15 cases of strength training, 101 cases of dance, 15 cases of whole-body vibration training, and 14 cases of high-intensity interval training (The category "movement" is refined according to its type). Regarding the duration of interventions, one study lasted for two weeks, three studies for four weeks, one study for six weeks, seven studies for eight weeks, one study for ten weeks, seven studies for twelve weeks, and four studies for sixteen weeks. The outcome measures utilized scales to assess the levels of positive response and depression, including SDS, SCL-90, DERS, BDI, PHQ-9, CES-D, among others (refer to Table 1).

## Quality Assessment Results

Table 2 presents the details of the Quality assessment results, which included a total of 24 articles. These articles were rated on the PEDro scale, with one article scoring 9, fifteen articles scoring 7, and eight articles scoring 6. All the included studies satisfied the eligibility criteria, which encompassed factors such as source credibility, adequate follow-up (85% compliance), intention-to-treat analysis, intergroup statistical comparisons, reporting of point measurements, and variability measurements. Given that the studies employed various self-assessment scales to measure depression, the majority did not employ double-blind trials or blinded outcome evaluators. When considering the results of the Cochrane system evaluation tool, it can be observed that the included literature generally meets the quality requirements, although there is a scarcity of high-quality studies (see Figure 2).
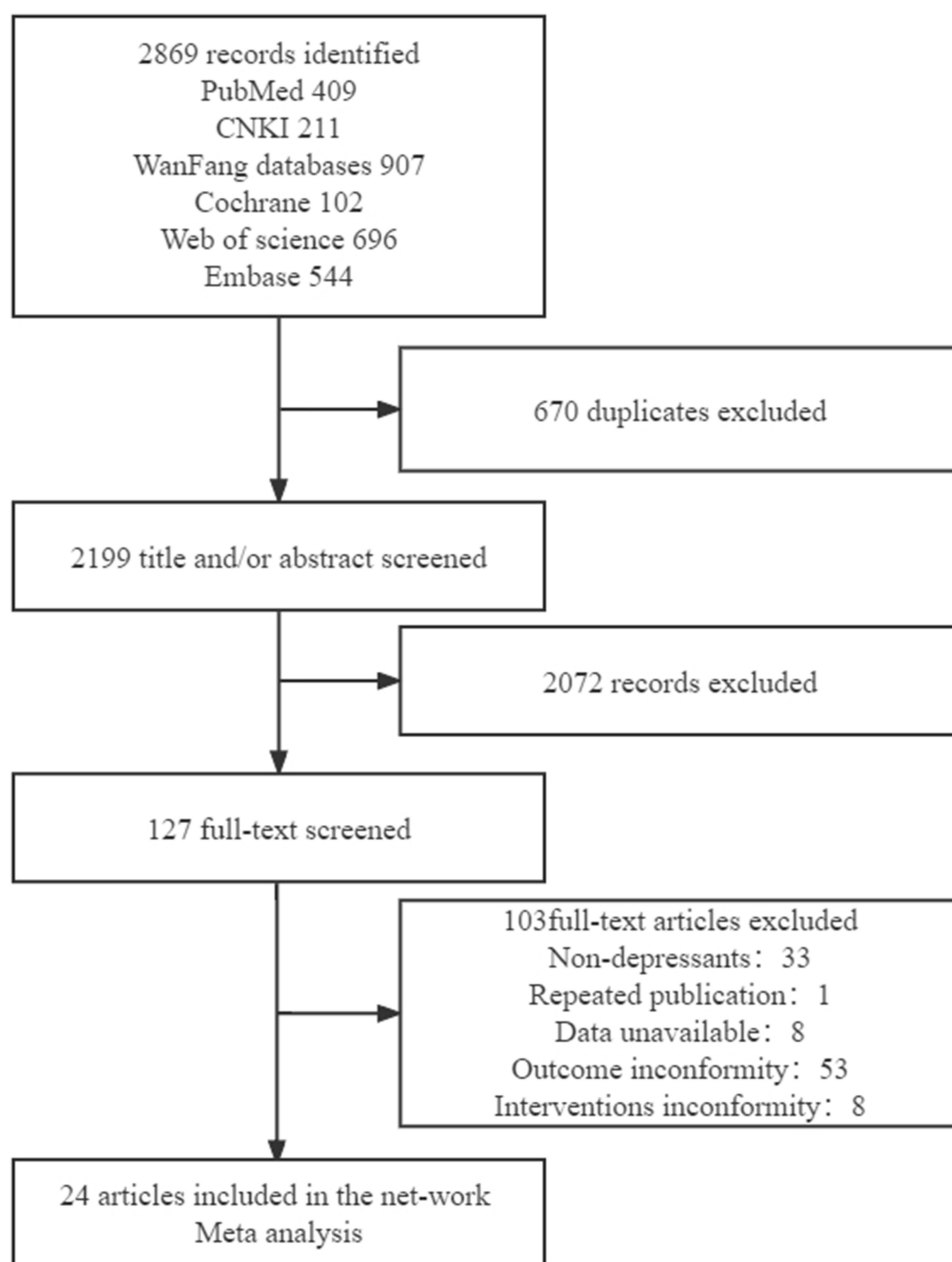
**Figure 1** Study selection process.

## Results of the Network Meta-Analysis
### Network Evidence Map of the Impact of Different Interventions on Depression

In the network evidence map, dots indicate the sample size of the intervention, with larger dots indicating more sample size included in the intervention; lines represent direct comparisons of interventions, with thicker lines suggesting a higher number of inclusions for direct comparisons of the two interventions. The network evidence map of the efficacy of depression involved 11 treatment measures: music, massage, aerobic exercise, qigong, yoga, tai chi, ball games, strength exercise, dance, whole body vibration training, and high-intensity interval training. The network evidence plot for depression scores showed that direct or indirect comparisons between different psychological interventions were essential for network meta-analysis. A network plot of evidence for the efficacy of depression is shown in Figure 3.

**Table 1** Research Characteristics Table

| No | Author, Years | Country | Study Design | Population Characters | Number Analysed at End of Treatment (N) | Classification | Duration | Main Outcomes | Reference |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Zhang et al, 2014 | China | Controlled trial | College students with depression; Gender: 36m/56w | 82 (50/32) | Five Elements Music of Traditional Chinese Medicine | 6 weeks, 2 times a week | SDS; SCL-90 | [17] |
| 2 | Ming Zhang et al, 2022 | China | RCT | College students with DERS ≥ 101, BDI score ≥ 10, and depressive symptoms; Gender: 34m/37w | 71 (36/35) | Group improvisational music therapy (GIMT) | 4 weeks, 1 times a week | DERS;BDI | [3] |
| 3 | Hye-Kyung Lee et al, 2014 | Korean | Non equivalent control group design | College students with PHQ-9 score >5; Gender: 12m/29w | 41 (21/20) | Self-Aromatherapy Massage | 2 weeks, 3 times a week | PHQ-9; | [7] |
| 4 | Cheng Xiang et al, 2016 | China | RCT | Mildly depressed college students; Gender: 15m/15w | 30 (15/15) | Health Qigong Wuqinxi | 12 weeks, 3 times a week | BDI | [18] |
| 5 | Nasrin Falsafi et al, 2016 | USA | RCT | Students who had a diagnosis of depression or anxiety | 90 (30/30/30) | Yoga | 8 weeks, 75 minutes a week | BDI | [19] |
| 6 | Jiayuan Zhang et al, 2018 | China | RCT | Freshman and sophomore had subthreshold symptoms of depression; Gender: 21m/41w | 62 (32/30) | Mindfulness-based Tai Chi Chuan (MTCC) | 8 weeks, 2 times a week | PHQ-9; | [20] |
| 7 | Chen et al, 2019 | China | RCT | Moderate depression [CES-D score 24–29] female college students | 36 (18/18) | Taijiquan exercise | 16 weeks, 3 times a week | CES-D | [21] |
| 8 | Duan et al, 2014 | China | Controlled trial | College students with SDS score≥53; Gender: 61m/48w | 109 (30/41/38) | Basketball; sports dance; badminton | 12 weeks, 3 times a week | SDS | [22] |
| 9 | Ma et al, 2017 | China | RCT | College students with depression and anxiety scores exceeding the critical value; Gender: 59m/65w | 124 (31/31/31/31) | Basketball; dance; badminton (moderate-intensity) | 12 weeks, 3 times a week | SDS | [23] |

(*Continued*)

**Table I** (Continued).

| No | Author, Years | Country | Study Design | Population Characters | Number Analysed at End of Treatment (N) | Classification | Duration | Main Outcomes | Reference |
|---|---|---|---|---|---|---|---|---|---|
| 10 | Wang et al, 2016 | China | Controlled trial | College Students with positive anxiety and depression scores; Gender: 58m/40w | 98 (39/22/37) | Badminton (Singles; doubles); volleyball | 16 weeks, 3 times a week | SDS | [24] |
| 11 | Li et al, 2017 | China | RCT | College students with depression factor score>3; Gender: 33m/31w | 64 (32/32) | Volleyball and group psychological guidance | 8 weeks, 4 times a week | SDS | [25] |
| 12 | Mao et al, 2014 | China | RCT | Male college students with mild depression | 29 (15/14) | Tennis with different intensity | 12 weeks, 3 times a week | SDS | [26] |
| 13 | Zhang et al, 2012 | China | Controlled trial | College students with mild and moderate depression; Gender: 43m/77w | 120 (40/40/40) | Sports dance training group, basketball training group and table tennis training group | 16 weeks, 3 times a week | SDS | [27] |
| 14 | Guan et al, 2008 | China | RCT | Female students with low to moderate levels of depression (CES-D score is 16–29) | 30 (15/15) | Progressive Strength Training | 8 weeks, 3 times a week | CES-D | [28] |
| 15 | Li et al, 2014 | China | RCT | Female college students with depression symptoms | 45 (15/15/15) | Strength training; aerobic exercise | 8 weeks, 3 times a week | CES-D | [29] |
| 16 | Tang et al, 2009 | China | RCT | College students with moderate and mild depression | 104 (39/34/31) | Basketball, badminton, etc; Yoga, aerobics, etc | 12 weeks, 3 times a week | SDS | [30] |
| 17 | Jiao et al, 2010 | China | RCT | College students with depression; Gender: 18m/26w | 44 (21/23) | Aerobic Exercise | 8 weeks, 3 times a week | SDS | [31] |
| 18 | Duk, Oh Sang et al, 2012 | Korean | RCT | College students with depressive symptoms; Gender: 0m/16w | 16 (8/8) | Moderate aerobic exercise | 12 weeks, 3 times a week | BDI | [32] |

| 19 | Geetanjli Chawla et al, 2022 | India | RCT | College students with Depression, Anxiety Stress Scale (DASS) (depression > 10); Gender: 9m/21w | 30 (15/15) | Whole-body vibration (WBV) training | 4 weeks, 2 times a week | DASS scores (Depression; Anxiety; Stress) | [33] |
|---|---|---|---|---|---|---|---|---|---|
| 20 | Zhao et al, 2017 | China | RCT | College students with SDS score≥53;Gender:0m/43w | 43 (14/14/15) | High intensity intermittent exercise group (HIT); Continuous exercise group | 4 weeks, 3 times a week | SDS | [34] |
| 21 | Li et al, 2017 | China | Controlled trial | College students with SDS score≥50;Gender:15m/23w | 38 (20/18) | Taijiquan exercise | 12 weeks, 3 times a week | SDS | [35] |
| 22 | Song et al, 2017 | China | Controlled trial | College students with depression; Gender: 0m/51w | 51 (27/24) | Taijiquan exercise, Aerobic Exercise | 16 weeks, 3 times a week | BDI | [36] |
| 23 | Khirollah Sadeghi et al, 2016 | Iran | RCT | Undergraduate students with BDI score>13; Gender: 24m/6w | 30 (16/14) | Aerobic Exercise | 8 weeks, 2 times a week | BDI | [37] |
| 24 | Chen-Jung Chen et al, 2014 | China Taiwan | RCT | Nursing students with DMSRIA scores of 8points or higher; Gender: 2m/69w | 71 (31/40) | Five Elements Music of Traditional Chinese Medicine | 10weeks, 2 times a week | Depression Mood Self Report Inventory for Adolescence (DMSRIA) | [38] |

**Notes**: The scores of several scales used in the included study are positively correlated with the degree of depression, that is, the higher the score, the more severe the degree of depression.

Neuropsychiatric Disease and Treatment 2023:19

https://doi.org/10.2147/NDT.S416643

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**Table 2** The Physiotherapy Evidence Database (PEDro) Scores for the Articles Included

| Publication | Item on the PEDro Scale | | | | | | | | | | | Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | i | j | k | |
| Zhang et al, 2014[17] | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 6 |
| Ming Zhang et al, 2022[3] | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 7 |
| Hye-Kyung Lee et al, 2014[7] | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 6 |
| CHENG Xiang et al, 2016[18] | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 6 |
| Nasrin Falsafi et al, 2016[19] | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 7 |
| Jiayuan Zhang et al, 2018[20] | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 9 |
| Chen et al, 2019[21] | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 7 |
| Duan et al, 2014[22] | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 6 |
| Ma et al, 2017[23] | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 7 |
| Wang et al, 2016[24] | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 6 |
| Li et al, 2017[25] | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 7 |
| Mao et al, 2014[26] | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 7 |
| Zhang et al, 2012[27] | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 6 |
| Guan et al, 2008[28] | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 7 |
| Li et al, 2014[29] | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 7 |
| Tang et al, 2009[30] | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 7 |
| Jiao et al, 2010[31] | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 7 |
| Duk, Oh Sang et al, 2012[32] | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 7 |
| Geetanjli Chawla et al, 2022[33] | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 7 |
| Zhao et al, 2017[34] | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 7 |
| Li et al, 2017[35] | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 6 |
| Song et al, 2017[36] | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 6 |
| Khirollah Sadeghi et al, 2016[37] | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 7 |
| Chen-Jung Chen et al, 2014[38] | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 7 |

**Notes**: Item on the PEDro scale (a: Eligibility criteria and source; b: Random allocation; c: Concealed allocation; d: Baseline comparability; e: Blinding of participants; f: Blinding of therapists; g: Blinding of assessors; h: Adequate follow-up (. 85%); i: Intention-to-treat analysis; j: Between-group statistical comparisons; k: Reporting of point measures and measures of variability).

## A Network Meta-Analysis of Efficacy in Depression

Twenty-four studies provided data on depression scores among college students following various treatments. However, the original studies used different depression rating scales, necessitating the use of SMD and its 95% CI to indicate the magnitude of the effect on depression scores. It is important to note that all depression scores on the scales reflected the level of depression positively, meaning that a lower effect size corresponds to a more favorable effect on depressive symptoms. Pairwise comparisons of depression scores by treatment revealed the following results: high-intensity interval training was superior to vibration training [SMD = −13.61, 95% CI (−20.61 to −6.62)]; high-intensity interval training was superior to dance [SMD = −8.13, 95% CI (−13.44 to −2.83)]; high-intensity interval training was superior to strength training [SMD = −10.81, 95% CI (−16.77 to −4.85)]; high-intensity interval training was better than ball games [SMD = −9.39, 95% CI (−14.65 to −4.13)]; high-intensity interval training was better than Tai Chi [SMD = −12.62, 95% CI (−17.81 to −7.43)]; high-intensity interval training was better than qigong [SMD = −14.81, 95% CI (−20.04 to −9.59)]; high-intensity interval training was better than aerobic training [SMD = −11.60, 95% CI (−16.72 to −6.49)]; high-intensity interval training was better than music [SMD = −8.52, 95% CI (−13.80 to −3.25)]; high-intensity interval training was superior to massage [SMD = −14.23, 95% CI (−19.61 to −8.86)]; high-intensity interval training was superior to no intervention [SMD = −16.61, 95% CI (−21.78 to −11.45)].

In the comparison of vibration training intervention with other treatments: vibration training intervention was inferior to dance [SMD = 5.48, 95% CI (0.60 to 10.37)]; vibration training intervention was inferior to yoga [SMD = 13.10, 95% CI (7.68 to 18.51)]; vibration training intervention was inferior to music [SMD = 5.09, 95% CI (0.24 to 9.94)]. For dance compared to other treatments: dance was superior to ball games [SMD = −1.26, 95% CI (−2.13 to −0.38)]; dance was
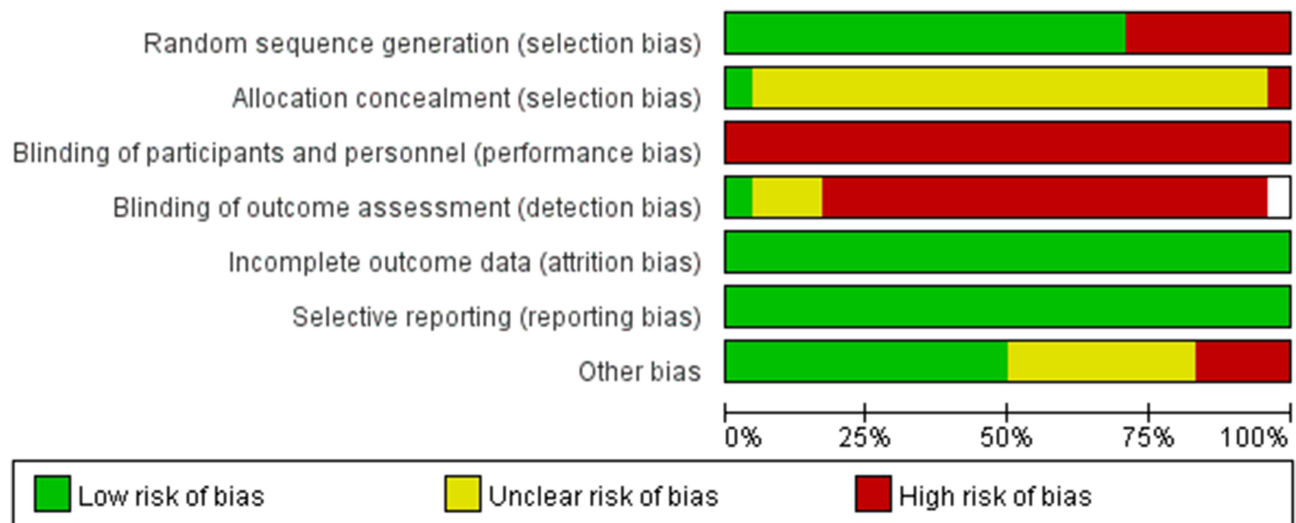
**Figure 2** Results of Cochrane system evaluation.
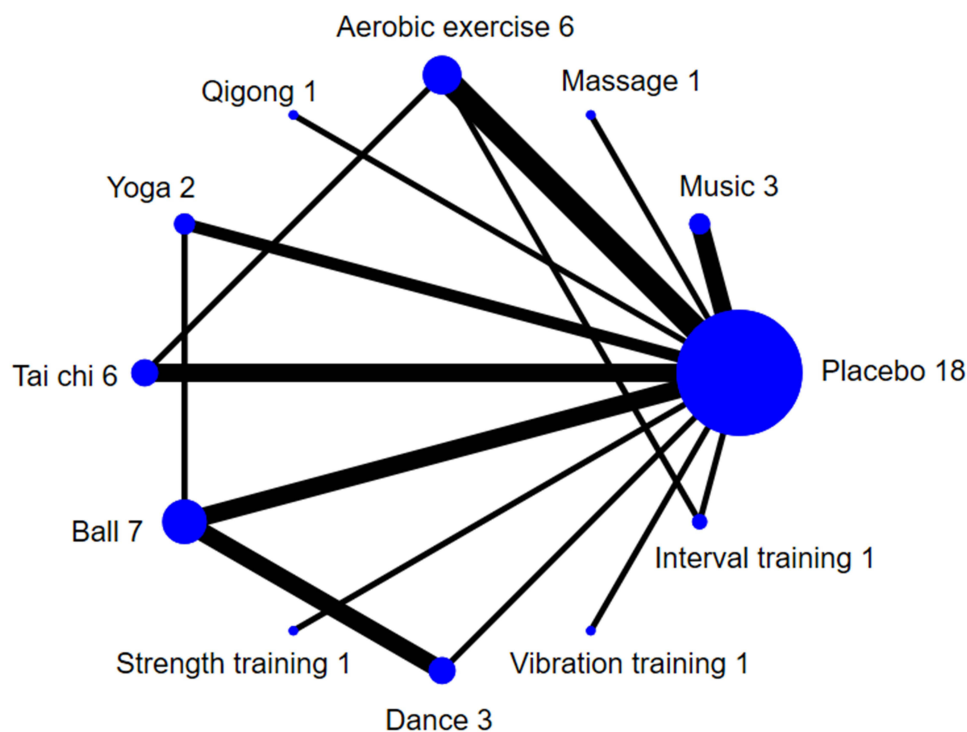


**Figure 3** Network analysis of depression efficacy. The numbers represent the quantity after intervention measures.

superior to Tai Chi [SMD = −4.49, 95% CI (−5.93 to −3.05)]; dance was superior to yoga [SMD = 7.61, 95% CI (4.77 to 10.46)]; dance was superior to qigong [SMD = −6.68, 95% CI (−8.16 to −5.20)]; dance was superior to aerobic training [SMD = −3.47, 95% CI (−5.64 to −1.30)]; dance was superior to massage [SMD = −6.10, 95% CI (−8.04 to −4.16)]; dance was superior to no intervention [SMD = −8.48, 95% CI (−9.72 to −7.25)].

In the comparison of strength training with other treatments: strength training was superior to yoga [SMD = 10.30, 95% CI (6.31 to 14.28)]; strength training was superior to qigong [SMD = −4.00, 95% CI (−7.09 to −0.91)]; strength training was superior to massage [SMD = −3.42, 95% CI (−6.75 to −0.09)]; strength training was superior to no intervention [SMD = −5.80, 95% CI (−8.78 to −2.82)]. For ball games compared to other treatments: ball games were better than Tai Chi [SMD = −3.23, 95% CI (−4.48 to −1.98)]; ball games were inferior to yoga [SMD = 8.87, 95% CI

(6.13 to 11.61)]; ball games were better than qigong [SMD = −5.42, 95% CI (−6.72 to −4.13)]; ball games were better than aerobic training [SMD = −2.21, 95% CI (−4.27 to −0.16)]; ball games were better than massage [SMD = −4.84, 95% CI (−6.64 to −3.05)]; ball games were better than no intervention [SMD = −7.22, 95% CI (−8.23 to −6.22)].

In the comparison of Tai Chi with other treatments: Tai Chi was inferior to yoga [SMD = 12.10, 95% CI (9.36 to 14.84)]; Tai Chi was better than qigong [SMD = −2.19, 95% CI (−3.29 to −1.09)]; Tai Chi was inferior to music [SMD = 4.10, 95% CI (2.79 to 5.40)]; Tai Chi was superior to no intervention [SMD = −3.99, 95% CI (−4.73 to −3.25)]. For yoga compared to other treatments: yoga was superior to qigong [SMD = −14.30, 95% CI (−17.06 to −11.54)]; yoga was superior to aerobic training [SMD = −11.08, 95% CI (−14.27 to −7.90)]; yoga was better than music [SMD = −8.00, 95% CI (−10.85 to −5.16)]; yoga was superior to massage [SMD = −13.72, 95% CI (−16.75 to −10.68)]; yoga was superior to no intervention [SMD = −16.10, 95% CI (−18.73 to −13.46)].

In the comparison of qigong with other treatments: qigong was inferior to aerobic training [SMD = 3.21, 95% CI (1.25 to 5.18)]; qigong was inferior to music [SMD = 6.29, 95% CI (4.94 to 7.64)]; qigong was superior to no intervention [SMD = −1.80, 95% CI (−2.61 to −0.99)]. For aerobic training compared to other treatments: aerobic training was inferior to music [SMD = 3.08, 95% CI (0.99 to 5.17)]; aerobic training was superior to massage [SMD = −2.63, 95% CI (−4.96 to −0.30)]; aerobic training was superior to no intervention [SMD = −5.01, 95% CI (−6.80 to −3.22)].

In the comparison of music with other treatments: music was superior to massage [SMD = −5.71, 95% CI (−7.55 to −3.87)]; music was superior to no intervention [SMD = −8.09, 95% CI (−9.17 to −7.01)]. For massage compared to no intervention: massage was better than no intervention [SMD = −2.38, 95% CI (−3.87 to −0.89)]. In all the comparisons mentioned above, none of the 95% confidence intervals included 0, indicating that the differences were statistically significant. The results of the network meta-analysis of depression scores are shown in Figure 4.

## Ranking of Efficacy

Efficacy ranking: The probability that an intervention will be the best measure is assessed using the area under the cumulative ranking probability plot (SUCRA), with larger areas under the curve indicating a greater likelihood that the intervention will be the best measure. SUCRA results showed that the interventions were ranked in order of efficacy: interval training (96%) > yoga (94.90%) > dance (78.30%) > Music (73.30%) > ball games (62.50%) > strength training (51.70%) > aerobic training (45 30%) > Tai Chi (35.40%)> vibration training (27.30%) > massage (20.10%) > Qigong (14.30%) > no intervention (1.00%), indicating that the probability of interval training is the best treatment for depression in college students. The results of the preferred ranking of various treatment measures for depression are shown in Table 3.
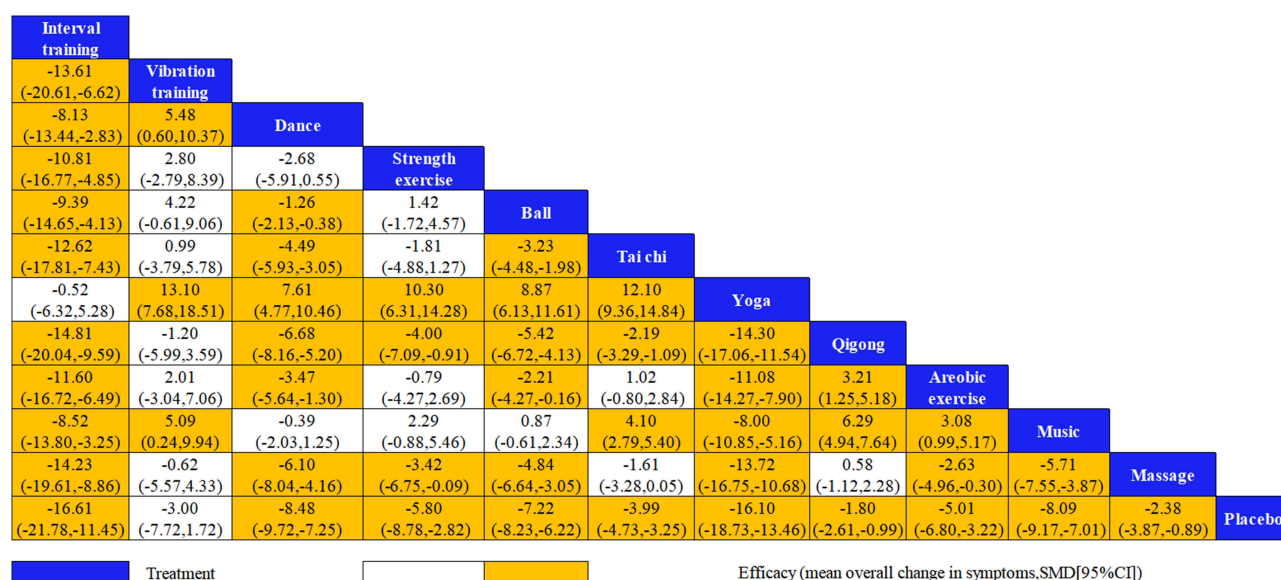


**Figure 4** Meta-analysis results of depression score rates.

**Table 3** Probability: Ranking of Different Mind-Body Exercise Therapies to Improve Depression Grade in College Students

| Treatment | SUCRA | MeanRank | No |
|---|---|---|---|
| Interval training | 96% | 1.4 | 1 |
| Yoga | 94.90% | 1.6 | 2 |
| Dance | 78.30% | 3.4 | 3 |
| Music | 73.30% | 3.9 | 4 |
| Ball | 62.50% | 5.1 | 5 |
| Strength exercise | 51.70% | 6.3 | 6 |
| Aerobic exercise | 45.30% | 7 | 7 |
| Taichi | 35.40% | 8.1 | 8 |
| Vibration training | 27.30% | 9 | 9 |
| Massage | 20.10% | 9.8 | 10 |
| Qigong | 14.30% | 10.4 | 11 |
| Placebo | 1.00% | 11.9 | 12 |

## Subgroup Analysis of Different Types of Exercise Interventions

We further categorized and grouped different sports interventions and conducted a conventional meta-analysis based on four subgroups: aerobic exercise, traditional Chinese sports, ball games, and high-intensity interval sports. The results are depicted in Figure 5, where 1, 2, 3, and 4 represent aerobic sports, traditional Chinese sports, ball games, and High-intensity interval training, respectively. In terms of effectiveness, High-intensity interval training (SMD=−2.90, [95% CI: −3.96, −1.84]) exhibited the highest effect, followed by ball games (SMD=−2.05, [95% CI: −2.40, −1.70]), Chinese traditional sports (SMD=−1.80, [95% CI:
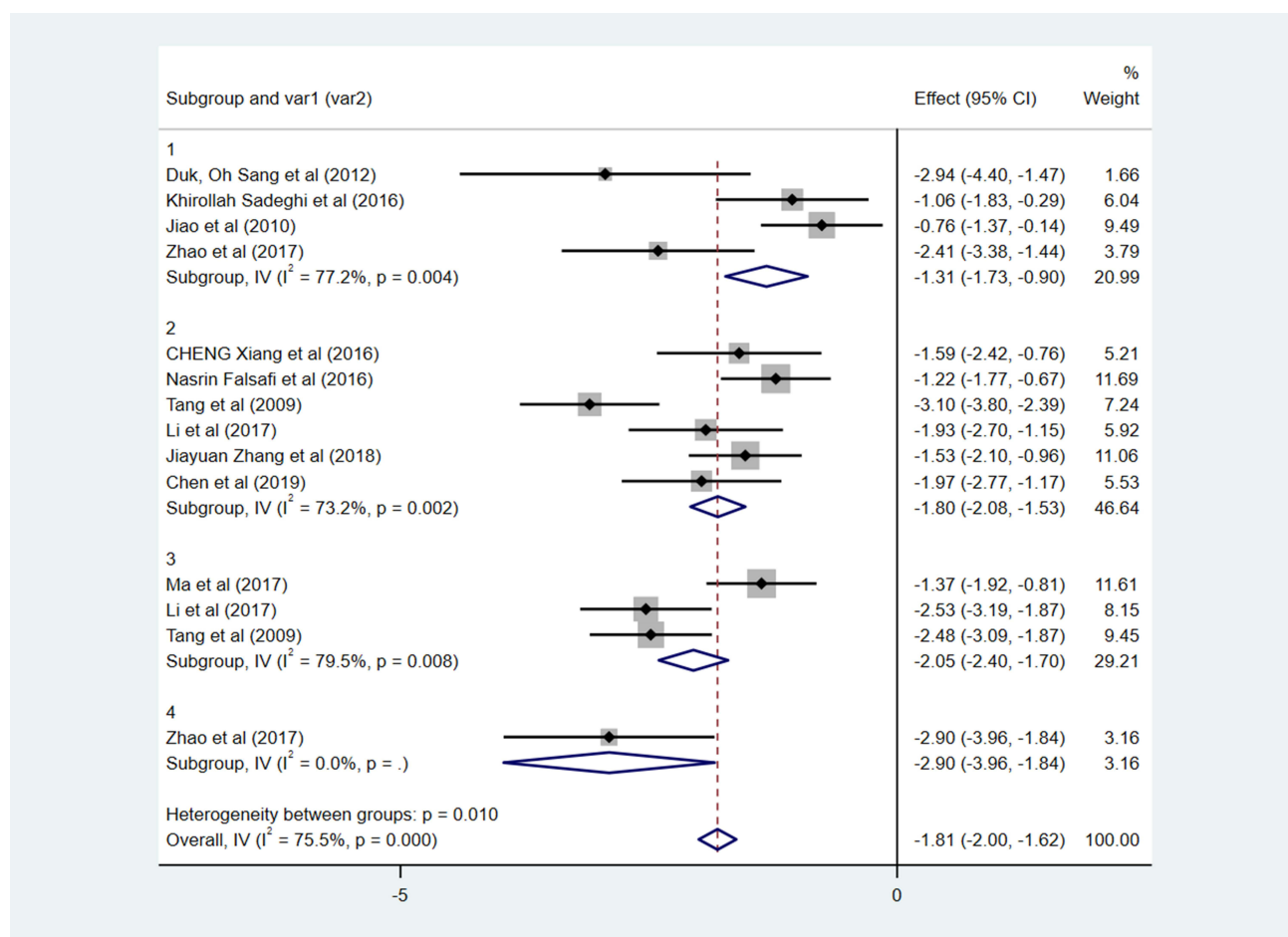


**Figure 5** Subgroup analysis. Number: 1, aerobic sports;[31,32,34,37] 2, traditional Chinese sports;[18–21,30,35] 3, ball games;[23,25,30] 4, high-intensity interval sports.[34]
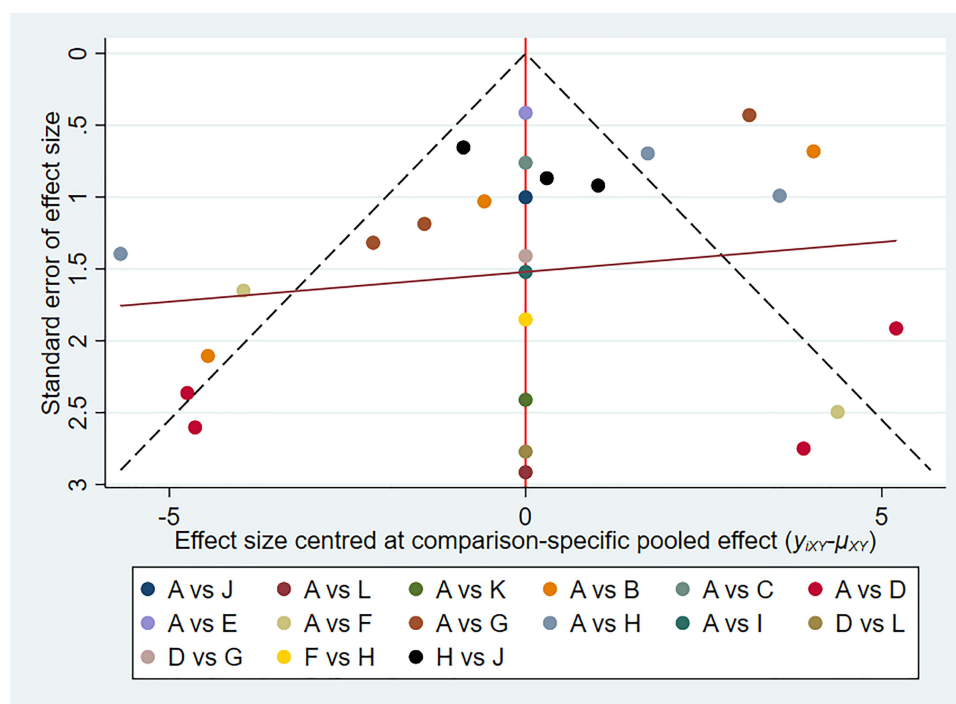
**Figure 6** Calibration comparison funnel diagram. Capital: A, Placebo; B, Music; C, Massage; D, aerobic sports; E, Qigong; F, Yoga; G, Tai chi; H, Ball games; I, strength exercise; J, Dance; K, whole body vibration training; L, high-intensity interval sports.

−2.08, −1.53]), and aerobic sports (SMD=−1.31, [95% CI: −1.73, −0.90]). Heterogeneity testing revealed an I2 value of 75.5%, possibly attributed to factors such as intervention duration and sample size.

### Small Sample Effects or Publication Bias Tests

For the studies included in the network META, small sample effect estimation and publication bias test were performed by correcting the comparison funnel map. The included papers were basically symmetrical, indicating that the possibility of a small sample effect in this analysis was small, and no obvious publication bias was found. (Figure 6) Additionally, an Egger's test was performed on the included studies, yielding a P-value of 0.10, which is greater than 0.05. This suggests a low likelihood of significant publication bias.

## Discussion

Depression in young people is a serious mental health issue all over the world. In the treatment of depression, non-pharmacological interventions do not have problems such as drug resistance and side effects compared to pharmacological interventions.[39] A study found that after 4 months of experimentation, the exercise therapy group could achieve the same antidepressant effect as drug therapy (sertraline).[40] Meanwhile, physical and mental interventions, particularly exercise interventions, are rarely associated with mental illness stigma.[41] Therefore, this review conducted a network meta-analysis of experimental studies of commonly used non-pharmacological interventions for depression in college students, including music interventions, massage, aerobic exercise, qigong, yoga, Tai Chi, ball games, strength training, dance, whole-body vibration training, and high-intensity interval training, The study synthesized information from direct and indirect comparisons of various interventions, compared several interventions, and ranked the effectiveness of various non-pharmacological therapies based on the analysis results. The possibility of becoming the best treatment was explored.

The findings revealed that the 11 non-pharmacological interventions included were beneficial in reducing depression in college students, with high-intensity interval training having the highest probability of having the best effect. The effect of the intervention was statistically significant. According to scholar Zhao Hong-qin, while both gradual high-intensity interval exercise and continuous exercise can reduce depression in college girls, gradual high-intensity interval

exercise has a better positive impact. High-intensity interval exercise, as compared to continuous aerobic exercise, can significantly increase the pleasure of exercise, thereby more effectively stimulating the pituitary-adrenal axis and improving depressive conditions.[34] From the perspective of the mechanism of action, exercise can increase the content of relevant neurotransmitters in the blood of depressed patients and increase the efficiency of transmitters in the synaptic space of the central nervous system. The efficacy of most antidepressants in treatment is also to enhance the level of amine metabolism in the brain, indicating that the mechanisms of action of exercise and antidepressants are similar.[31] Antidepressants are currently widely used, but their clinical efficacy may be affected by poor adherence to medication regimens, which often have some side effects, or it takes up to 6 weeks after initiation to begin to have measurable effects on depressive symptoms; thereby, non-pharmacological treatments such as high-intensity interval training and yoga can be used as primary interventions. The results of SUCRA showed that in addition to the included exercise-based interventions, music interventions also rated highest. Michalak et al concluded that listening to appropriate and favorite music reduced participants' sympathetic nervous system activity while increasing parasympathetic nerve activity, resulting in peaceful breathing, stable blood pressure and heart rate, and the effect of sedation and hypnosis in the release of endorphin substances in the body, thereby significantly reducing anxiety and depression.[42] In addition, massage and Qigong are given low priority, with massage being regarded by researchers to be a synergistic measure to complement aromatic environmental therapy, and the results need to be validated by further studies due to the limited number of participants.[7] Furthermore, qigong and Tai Chi are often classified as traditional Chinese fitness exercises in research.[43,44] In terms of exercise characteristics, it falls within the category of moderate and low-intensity aerobic exercise.[1] According to the findings of this study, the low priority of traditional fitness exercises in China may be due to the relatively low intensity of exercise and the inability to provide suitable stimulation for young people to enhance their psychological condition.

There are still several limitations to this study: (1) From the perspective of study characteristics, the degree of depression of the subjects included in this study was different, and there were certain regional environments and genders Discrepancies may lead to inconsistency between studies. (2) From the perspective of study design, the intervention period, intensity, frequency, and time of different study designs were also slightly different. (3) From the perspective of literature screening, although this study conducted a comprehensive search of two major domestic databases and four major foreign databases, there was still the possibility of missing detection. At the same time, the number of articles on different interventions varied relatively significantly in the included literature. For example, there is only one paper on massage, which makes objectively explaining its intervention impact on college students with depression difficult, and the acupuncture therapy included in the pre-search was rejected during literature screening, which is regrettable. Additionally, a comparison of the measures is missing from the final result.

(4) There is a potential for "reporting bias" since a research protocol was not registered for this study. (5) Other possible biases should also be considered. Given the aforementioned limitations, it is suggested that future RCT studies: (1) RCT design and reporting should follow international standards in order to increase the quality of research and reporting; (2) RCTs directly compared the efficacy of different interventions on depression to compensate for the shortcomings of indirect comparisons.

## Conclusion

The network meta-analysis revealed that various non-pharmaceutical interventions, including music intervention, massage, aerobic exercise, Qigong, yoga, Tai Chi, ball games, strength training, dance, whole-body vibration training, and high-intensity interval training, had a discernible impact on regulating depression in college students. Among these interventions, high-intensity interval training showed a higher probability of yielding the most favorable effect on depression scores compared to others. However, further high-quality research is necessary to establish its specific effects more conclusively. Considering the limitations of this study, future studies should categorize and evaluate the basic situation of participants (such as depression level), as well as the impact of intervention time and frequency on depression. More high-quality clinical trials are needed to prove this in the future.

# Data Sharing Statement

Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

# Acknowledgments

We recognize effort and great work from all team members and appreciate project coordinators, investigators, and data operators.

# Disclosure

The authors report no conflicts of interest in this work.

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