Systematic Review and Meta-Analysis

Medicine®

OPEN

Comparative efficacy of seven exercise interventions for symptoms of depression in college students

A network of meta-analysis

Shengyu Guo, MD[a,c], Feiyue Liu, MD[a], Jing Shen, MD[a], Min Wei, MD[a], Yan Yang, MD[b,*]

Abstract

Background: Depression among college students is common, exercise interventions are valued as one of the most widely prescribed interventions for depressed college students, however, it is especially difficult for university administrators to determine which exercise intervention is most effective, and efficacy of exercise interventions among depressed college students have not been evaluated.

Objectives: To systematically review and compare the efficacy of 7 exercise interventions for decrease symptoms of depression in college students.

Method: A network of meta-analysis (NMA) was conducted to fill the objectives. Five relatived electronic databases were searched for the related articles.

Eligibility criteria: Randomized controlled trials comparing the efficacy of 7 Exercise interventions with usual care of college students with depression were included in the review.

Main outcomes: The primary outcome of the present study was standardized mean difference (SMD) and the mean change of depressive symptoms.

Results: Fourteentrials were identified, including 2010 depressed college students. The result of direct meta-analysis of this review indicated exercise interventions overall had a significantly lower mean depression scores (SMD = −1.13) when compared with usual care. The result of NMA indicated when comparing with badminton intervention, yoga (SMD = −7.7, 95%CI: −14 to −0.93) and Tai chi (SMD = −9.4, 95%CI: −16 to −2.7) can significantly decrease depression scores of the depressed college students. The rank of 7 exercise interventions with respect to efficiently decrease symptom of depressed undergraduates was Tai chi > Yoga > Volleyball > Dance > Run > Basketball > Badminton, respectively.

Conclusions: Tai chi exhibited the highest probability that became the most efficacy intervention among the comparions, and Yoga showed the second most effectiveness to alleviate depressive symptoms of depressed college students, and dance ranks the third, followed by run, volleyball, basketball, and badminton respectively.

Abbreviations: NMA = network of meta-analysis, SMD = standardized mean difference.

Keywords: college students, depression, efficacy, exercise interventions, network of meta-analysis

Editor: Andrea Giuseppe Maugeri.

This work was supported by Education fund of Hunan province (Number: 18B409, http://jyt.hunan.gov.cn/sjyt/xxgk/tzgg/201903/t20190318_5297301.html).

The data analysised in this study came from publicly accessible papers, thus it was not applicable or necessary to institutional review board approval.

All authors agree with publish the work in this journal.

All data generated or analyzed during this study are included in this published article

The authors have declared that no competing interests exist.

The datasets generated during and/or analyzed during the current study are publicly available.

[a] Department of economics and management, ChangSha University, [b] Institute of natural resources and conservation lands, Hunan Academy of Forestry, [c] Department of Social Medicine and health management, Xiangya School of Public Health, Central South University, Changsha, Hunan, China.

[*] Correspondence: Yan Yang, Institute of natural resources and conservation lands, Hunan Academy of Forestry, Changsha, Hunan, China (e-mail: zndxxhl@126.com).

How to cite this article: Guo S, Liu F, Shen J, Wei M, Yang Y. Comparative efficacy of seven exercise interventions for symptoms of depression in college students: a network of meta-analysis. Medicine 2020;99:47(e23058).

Received: 21 July 2020 / Received in final form: 26 September 2020 / Accepted: 5 October 2020

http://dx.doi.org/10.1097/MD.0000000000023058

1. Introduction

Depression is common in some age groups, which cause the global disease burden increased greatly.[1] Studies indicated that depression can seriously affect the physical and mental health of patients, and was associated their poor life quality.[2] Mountaining studies have revealed that the prevalence of depression among college students was much higher compared the same age group[3] and the adult group.[4] It is estimated that the prevalence of depression in university students is about 40% or more,[5] which influence their mental health greatly, and study also shows that the students who have symptoms of depression were significantly related to their poor academic performance.[6] According to the Diagnostic and Statistical Manual of Mental Disorders, fourth edition (DSM-IV), depression can be classified as mild, moderate and severe with respect to the severity.[7] For most reported depression college students, their symptoms of depression belong to mild to moderate, which can effectively be relieved with appropriate interventions.[8,9] Although there are different interventions to provide for depressed college students, however, some interventions have limited effect for their depressive symptoms. For example, antidepressants are the first recommended intervention by many psychiatrists, however, duo to the side effects and resistance of this medicines, the intervention of antidepressants has very limited effect for most depressed college students.[10] Some studies have proved the effectiveness of alternative interventions for depression of college students, such as psychological treatments,[11] exercise therapy.[12] Most of psychological interventions are generally free from side effects and are recommended by many college psychological counselors, however, studies indicated that many students refused to receive this kind of intervention duo to its low expectations of positive outcome, which also deepen the perceived stigma of depressed students .[13]

Exercise intervention can alleviate symptoms of depression and improve overall emotional well-being, which is important to relief from depressive symptoms.[14] A large number of studies have indicated that exercise can be viewed as an effective treatment for depressed patients.[15,16] For college psychological counselor, exercise therapy is ideal intervention for depressed students because there are various sports grounds and facilities on university campuses.

Moreover, depressed students can effectively reduce their stigma by taking part in sports, increasing the opportunities to communicate with others, which is vital to matain their mental health.[17]

Several meta-analysis have been conducted to analysis the effectiveness of exercise intervention on depression of different patients, all conclusions are consistent to proved the effectiveness of such interventions.[18,19] However, we have not found any network of meta analysis to compare the efficacy of different exercises on depression of college students. Because previous study have indicated that different kind of sports may have variety effectiveness when they were used as an alternative treatment for depression.[20] Thus, some exercise interventions may be an very effective treatment for mild to moderate depressive college students, while others may have not the same effectiveness. So, it is important to assess which kind of exercises is the most effective for depressed college students. Meta-analyses were limited by few trials with direct comparisons between 2 treatments, instead, a network meta-analysis (NMA) can combine both direct and indirect evidences into 1 single comparison,[21] and can provide ranking of the efficacy of subject exercise interventions.

In this study, we conducted a NMA to assess the efficacy of 7 exercise interventions for symptoms of depression in college students, so we can provide valuable information for college psychological counselors to relieve the symptom of depressed college students.

2. Method

2.1. Search strategy

We searched Embase, Web of science, PubMed and 2 Chinese language electronic databases WANFANG and CNKI for relative studies. Studies from onset up to May to 2019 were identified to evaluate the efficacy of 7 exercise (Badminton, Basketball, Dance, Volleyball, Run, Tai chi, and Yoga) interventions on the symptom of depressed college students. Only English and Chinese language was searched. "Exercise(s)" or "Sport(s)" or Badminton, Basketball, Dance, Volleyball, Run, Tai chi, Yoga were combined with "depressed college students (undergraduates)", "depression of college students (undergraduates)" were used as Medical Subject

Heading (MeSH) terms for relative studies.

2.2. Risk of bias assessment

We assessed the risk of bias according to the guidelines of the Cochrane reviews.[22] Two of our authors conducted the evaluation independently on such information: representativeness of sample (whether it satisfies the principle of random and blind method) and information integrity. Included studies were classfied as "low risk of bias", "unclear risk of bias", or "high risk of bias", with respect to the above information.

2.3. Interventions of interest

In this study, exercise interventions were defined as in order to get the objective of improving or maintaining health of physical and mental fitness, a planned, structured, repetitive, and purposive physical activity was conducted.[23] Usual care was defined as only the school administration paid attention to their mental health, without any special intervention to ensure consistency with the intervention group in other aspects.[24] Exercise intensity is determined by heart rate and oxygen intake, for moderate intensity, the range of heart rate was 100 to 150 per minute, Oxygen intake is 50% to 60% of the maximum oxygen intake.[25]

2.4. Study selection

We included such studies that meet all the follow criteria:

1. comparison amongBadminton, Basketball, Dance, Volleyball, Run, Tai chi, Yoga, and usual care;
2. the subject samples were college students with depressive symptoms, in this study, students with depressive symptoms were defined as after screening with the depression scales, students with scores above the critical threshold, for Beck Depression Inventory-II, scores greater than 13 indicate depressive symptoms; for Self-rating depression scale (SDS), scores greater than 50 indicate depressive symptoms; or have been diagnosed with depression according to clear diagnostic criteria such as DSM-IV or ICD-10 or CCMD-3;

3. language was English or Chinese;
4. included studies should provide such informations: depression scores of depressed students before and after intervention, sample size, specific depression assessment scales and criteria;
5. included studies should be randomized controlled trials, which the allocation of participants to treatment and comparison groups was described as randomized.

We excluded such studies: sample size was less than 20; the trial time was less than 4 weeks; not comparison between the above items; without needed information.

2.5. Primary outcome

The mean change of depressive symptoms was the primary outcome of interest, which was assessed by by different validated scales, from baseline to post-intervention. Standardized mean difference (SMD, 95% confidence interval; CI) was calculated to compare the difference of depressive scores between intervention and control groups.

2.6. Data extraction

Relevant datas were independently extracted from the included articles by our 2 authors, including name of first author, year of publication, study design, duration of treatment, number of samples. For intervention and control groups, the depressive symptom scores of any validated scale, along with their standard deviation (SD) from baseline to post-intervention were extracted. In some studies, the above information were not provided, the mean change and SD from pre- and post-test was used.

2.7. Statistical analysis

Network of meta-analysis was used to compare the mean change of depressive symptoms of 7 exercise interventions. A Bayesian model network meta-analysis was conducted to combine both direct and indirect evidences into 1 single comparison. Standardized mean difference (SMD) and corresponding 95% confidence intervals (CIs) were calculated. I^2 test was used to assess the heterogeneity, if $I^2 > 50\%$, indicating the existence of heterogeneity.[26] P values were calculated to identify the difference between direct and indirect evidences. And the node-splitting plot was applied to check the consistency. Publication bias of this study was checked by Eggers test and the result was showen in funnel plot. R version 3.4.4 (R Project for Statistical Computing, Vienna, Austria) was used to conduct the above statistical analysis. $P < .05$ was considered to be significant.

3. Result

3.1. Study selection

Relative database were searched according to the search strategy, and found 2751 potentially eligible trials, after removing 439 duplicates, there were still 2041 studies left, after screening titles and abstracts, we screened the rest 271 full text studies, among of them, 257 studies were ruled out duo to without valuable outcome which we wanted to research. So a total of 14[27–40] articles with 2010 depressed undergraduates were included in the present study to evaluate the efficacy of 7 exercise interventions on their depressive symptoms, the flow chart was schematically shown in Figure 1.

3.2. Study characters

Among the identified articles, there were 25 comparions which contain ten two-arm studies, 3 three-arm studies and 1 four-arm study. Four trials compared the efficacy of Basketball and Dance, which contain 459 depressed undergraduates. Four studies were aimed to compare the effectiveness of Badminton and Basketball, containg 423 depressed college students, other comparison also include 3 trials of Badminton and Dance, which contain 268 depressed undergraduates, 2 trials of Badminton and Volleyball, 1 trial of comparison between Tai chi and Yoga, 1 trial of Run and Yoga, and comparison between above mentioned 7 exercise interventions and usual care respectively. The general characters

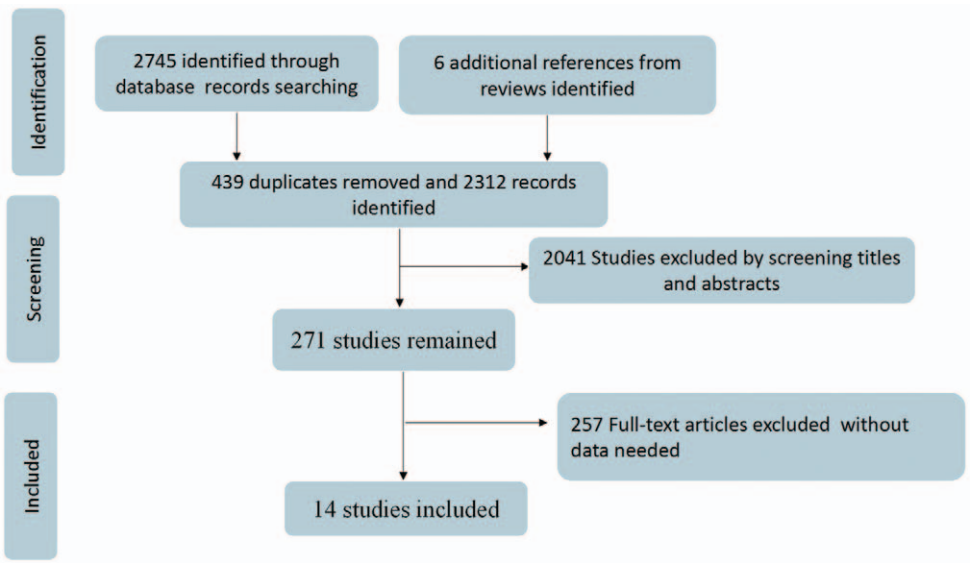

Figure 1. Flowchart presenting the steps of the literature search and selection.

Table 1

The basic information and data of all included studies in the meta-analysis.

Study/ author	year	Interventions	Sample size	Baseline depression sore	Sd (Baseline)	post-intervention scor	Sd (post)	Scale	N of treat (per week)	Durations (weeks)
Duan YM[27]	2014	Dan/Bas/Bad	30/41/38	58.74/58.67/58.71	4.18/4.1/4.12	53.07/54.18/56.44	2.63/2.18/2.45	SDS	3 (90min) M	12
Yang PP[28]	2018	Dan/Bas/Bad	103/103/103	58.75/58.68/58.72	4.23/4.33/4.24	52.71/53.86/57.79	2.55/2.11/2.47	SDS	3 (90min) M	12
Wang B[29]	2016	Dan/Bas	60/60	65.84/63.56	3.56/2.69	27.41/26.59	2.66/3.78	SDS	3 (90min) M	12
Ma MK[30]	2017	Dan/Bas/ Bad/usual	31/31/ 31/31	58.74/58.69/ 58.74/58.76	4.19/4.12/ 4.14/4.21	53.08/53.48/ 57.16/58.74	2.64/2.17/ 2.44/4.19	SDS	3 (90min) M	12
Wang J[31]	2016	Bad/Vol	39/37	58.64/58.59	4.23/4.37	56.75/51.12	3.74/3.59	SDS	3 (80min) M	16
Zhao YF[32]	2016	Run/Bas	20/20	25.23/25.02	2.65/3.89	9.23/12.53	2.65/4.81	HAMD	3 (N),M	24
Zhao HQ[33]	2017	Run/usual	14/14	63.92/63.44	6.87/7.27	54.22/64.06	5.12/6.97	SDS	3 (N),H	4
Yan J[34]	2016	Tai/Yoga	22/22	27.09/27.68	6.2/5.67	10/19.5	2.94/4.48	BDI-II	3 (90min),M	12
Song XY[35]	2017	Yoga/Run	28/27	27/27.8	6.2/4.99	11/18.2	4.87/3.27	BDI-II	3 (60min),M	16
Su Y[36]	2010	Tai/usual	15/15	27.13/28.13	6.94/6.52	17.27/29.27	5.69/6.98	BDI-II	5 (70min),N	12
Huang B[37]	2008	Tai/usual	32/32	14.95//14.11	4.42/4.67	7.12/10.55	5.58/5.28	BDI-II	7 (25min), N	14
Zhu L[38]	2011	Run/usual	24/24	46.43/46.53	5.33/4.88	41.01/45.21	4.96/5.26	SDS	3 (40min),M	8
Xiong M[39]	2014	Yoga/usual	30/27	22.3/21.1	5.9/5.8	6.5/18.1	4.2/6.7	BDI-II	3 (70min),N	8
Mohammadi M[40]	2011	Vol/Bad/usual	40/40/20	20.65/20.6/20.2	5.74/6.87/5.75	12.7/15.2/18.9	4.54/4.82/5.87	BDI-II	3 (75min), N	8

of included studies were shown in Table 1. Overall, the included studies had low assessment scores, 6 literatures cannot meet the principle of randomization and blind method when grouping, only 6 papers scored above 5 points, 6 papers scored only 3 points, which suggests that the quality of the included studies is not very high. The risk of bias assessment was shown in Table 2. A total of 2010 depressed college students were involved in this study, among of them, 251 (12.48%) depressed undergraduates received Badminton intervention, 255 (12.69%) students received Basketball intervention, 224 (11.14%) students received Dance intervention, 85 (4.23%) students received Run intervention, the number of receiving Tai chi, Yoga, volleyball, usual care was 69 (3.43%), 80 (3.98%), 77 (3.83%), 163 (8.1%) respectively. Network plots of SSRIs were shown in Figure 2.

3.3. Exercise interventions vs usual care

Among the included studies, 11 comparisons of 7 studies which contains 573 depressed college students, were analyzed to compare the effect of exercise interventions vs usual care. Depression scores were assessed at the end of treatment, which ranged from 6 to 24 weeks. The random effects model was selected duo to $I^2 = 73\%$ (Heterogeneity test), the SMD was -1.13 (95%CI: -1.48 to -0.78), and $P < .01$, which indicates that depressed students receiving exercise interventions had significantly lower mean depression scores (by 1.13 units) than students receiving usual care. The detail result was showen in Figure 3.

3.4. Analysis of NMA

As showen in Figure 4, the forest plot of network results indicated that when comparing the effectiveness of Badminton intervention, Yoga intervention can significantly decrease depression scores of the depressed college students (SMD = −7.7, 95%CI: −14 to −0.93, Fig. 4B), while comparing with badminton intervention, Tai chi intervention also showed significant effect in reducing depressive symptoms (SMD = −9.4, 95%CI: −16 to

Table 2

Risk of Bias Assessment .L indicated low risk, H: high risk, U: unclear risk.

Study	Random sequence generation	Allocation concealmentod	Blinding	Incomplete outcome data	Selective reporting	Other bias	Total score
Duan YM[27]	U	U	U	L	L	L	3
Yang PP[28]	L	U	U	L	L	L	4
Wang B[29]	L	U	U	L	L	L	4
Ma MK[30]	L	L	U	L	L	L	5
Wang J[31]	U	U	U	L	L	L	3
Zhao YF[32]	L	L	U	L	L	L	5
Zhao HQ[33]	U	U	U	L	L	L	3
Yan J[34]	L	L	U	L	L	L	5
Song XY[35]	U	U	U	L	L	L	3
Su Y[36]	L	L	U	L	L	L	5
Huang B[37]	L	L	U	L	L	L	5
Zhu L[38]	U	U	U	L	L	L	3
Xiong M[39]	U	U	U	L	L	L	3
Mohammadi M[40]	L	L	L	L	L	L	6

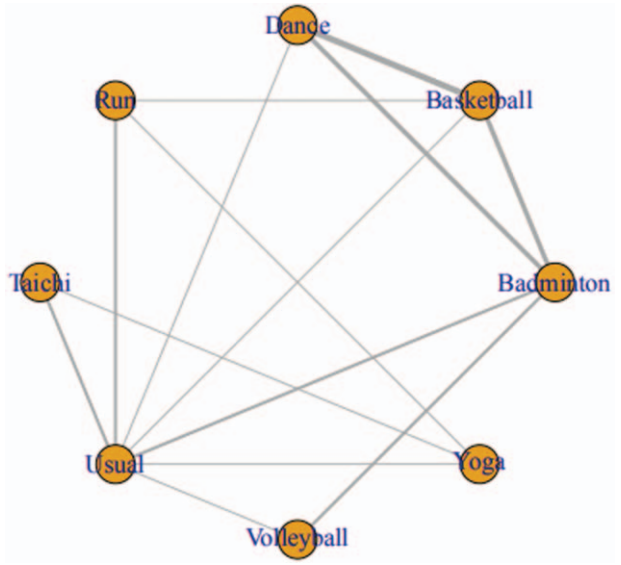

Figure 2. Network plots of exercises. The width of the lines represents the total number of trials for each comparison.

−2.7, Fig. 4B). Compared with usual care, Dance, Run, Tai chi, and Yoga showed their significant effect in reducing depressive symptoms, the SMD and their 95% CI were −5.5 (−11, −0.39) for Dance, −6 (−10, −1.6) for Run, −11 (−16, −6) for Tai chi, −9.1 (−14, −4) for Yoga, respectively (Fig. 4H). Among other comparions, the effect did not reach statistical significance, which can be seen in Figure 4 A, C, D, E, F, G.

3.5. The efficacy ranks of 7 exercise interventions

The ranking diagram and rank probability were showen in Table 3 and Figure 5. The exercise interventions were ranked according to the efficacy of 7 exercise interventions on depressive symptom of college students. The ranking is from high to low, and the larger the number was, the efficacy of the intervention was indicated better. The result showed that Tai chi intervention had the highest probability that became the most efficacy interventions with respect to reducing depressive symptom of college students (probability = 0.6733). The seconde was Yoga (probability = 0.2182), and then was Volleyball (probability = 0.0635), Dance (probability = 0.0232), Run (probability = 0.0182), Basketball (probability = 0.0035), Badminton (probability = 0.0001), and usual care (probability = 0.0000) exhibited the worst reliable performance in comparison with other interventions with respect to reducing depressive symptom of college students. So, the efficacy rank of 7 exercise interventions with respect to efficiently decrease symptom of depressed college students was Tai chi > Yoga > Volleyball > Dance > Run >Basketball >Badminton, respectively.

3.6. Heterogeneity, consistency and publication bias

The result of heterogeneity test indicated that there were significant heterogeneity among the included studies ($I^2 >$ 50%), so the node-splitting plot was used to check the consistency of related studies. The detail result could be seen in Table 4 and Figure 6. Some significant differences were observed in the present study, 2 comparions of related studies exsit significant inconsistency, which may be the source of heterogeneity. Eggers' test was used to identify whether exsit publication bias in the study, and there was not any significant publication bias was identifiedned, the result of publication bias analysis is presented in Figure 7.

4. Discussion

A large number of studies have confirmed that a variety of molecules or intracellular signal transduction factors involved in immune and inflammatory processes are involved in the pathological process of depression.[41] Studies on the therapeutic effects of exercise intervention on depression have also confirmed that exercise can be a safe alternative effective, non-toxic antidepressant therapy.[9] Exercise can not only improve the energy metabolism of skeletal muscle and promote the adaptive development of skeletal muscle, at the same time, skeletal muscle is also a "regulator" of secretory organ and system metabolism, which indirectly promote the synthesis, secretion of regulatory peptides, growth factors and other biological active molecules.[42] And this active molecules play an important role in regulating depression.

The result of this study indicated that exercise interventions can significantly decrease depressive symptoms of depressed under-

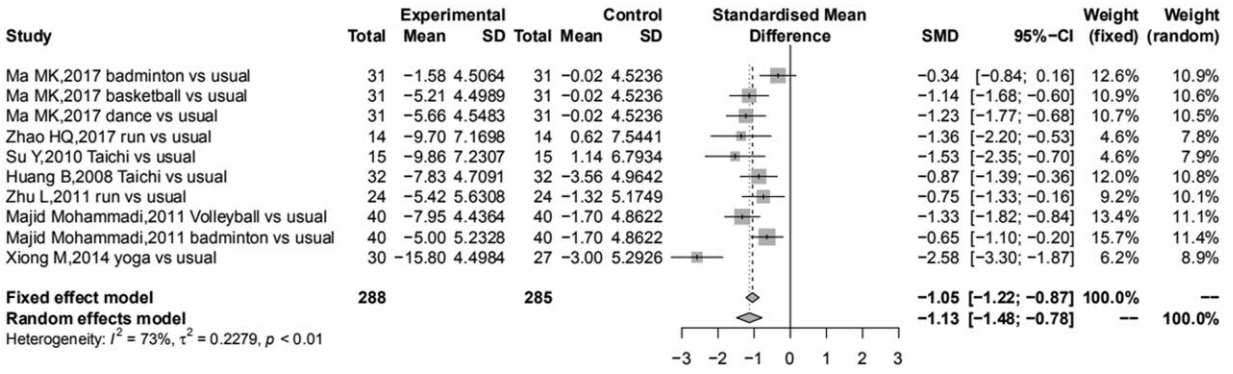

Figure 3. The forest plot of the effect of exercise interventions versus usual care.

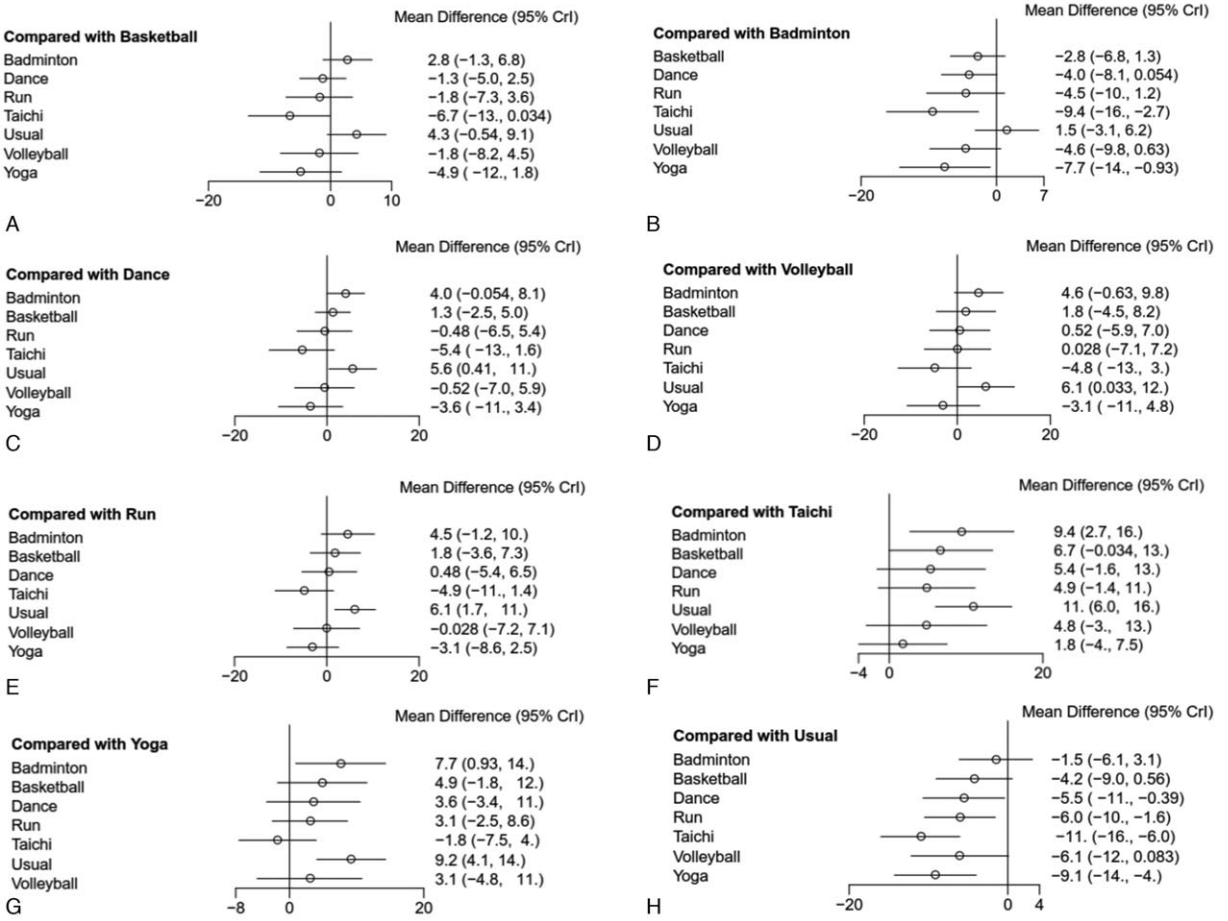

Figure 4. The forest plot of network results, A: comparisons between basketball and other 6 interventions, B: comparisons between badminton and other 6 interventions, C: comparisons between danc and other 6 interventions, D: comparisons between volleyball and other 6 interventions,E: comparisons between run and other 6 interventions, F: comparisons between Tai chi and other 6 interventions, G: comparisons between Yoga and other 6 interventions, H: comparisons between usual care and other 6 exercise interventions,.

graduates when compared usual care, which is consistent with previous studies on other different age groups.[43] Exercise interventions can reach high magnitude of treatment effect to depressive symptoms of depressed college students, the SMD of exercise treatments vs usual care was -1.13. A previous meta-analysis by Sukhato et al[44] has concluded that the SMD of exercise intervention versus usual care was −0.73, which is less than our result. They mainly focused on depression in adults, which was different from the present study. Moreover, samples of included studies were not clinically diagosed with depression, although they had depressive symptoms. So, exercise interventions may be more effective in depressed college students than in other depressed people, but more randomized controlled trials are needed to confirm this conclusion.

In our study, the results of NMA indicated that compared with Badminton intervention, Tai chi and Yoga both has a significant effectiveness on decreasing depressive symptoms of depressed undergraduates. Some researchers do not think Tai chi is only a

Table 3

Rank probability of Exercise interventions Rank probability, preferred direction = 1.

Drugs	1	2	3	4	5	6	7	8
Badminton	0.00013	0.00060	0.00240	0.00828	0.02938	0.10748	0.61832	0.23337
Basketball	0.00345	0.01440	0.04986	0.14037	0.29367	0.41851	0.06710	0.01262
Dance	0.02321	0.06747	0.18426	0.28651	0.28787	0.12511	0.02101	0.00453
Run	0.01816	0.07075	0.31185	0.25448	0.17705	0.12491	0.03976	0.00302
Taichi	0.67332	0.22445	0.05948	0.02292	0.01148	0.00616	0.00195	0.00021
Usual	0.00000	0.00005	0.00022	0.00297	0.01127	0.03918	0.21198	0.73430
Volleyball	0.06348	0.11587	0.24301	0.22091	0.15460	0.15837	0.03275	0.01098
Yoga	0.21822	0.50640	0.14890	0.06352	0.03465	0.02025	0.00711	0.00093

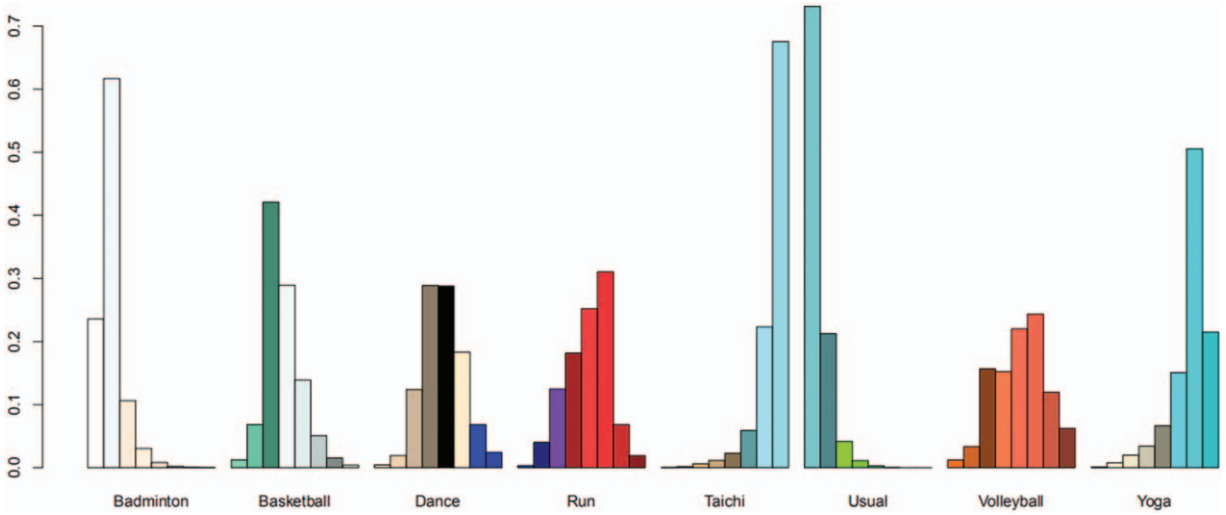

Figure 5. The Efficacy ranks of Exercise interventions.

Table 4

Results of consistency analysis by node-splitting plot.

Comparision	*P* value	SMD (Crl)
Basketball. Badminton		
direct	.642	−3.2 (−9.1, 2.7)
indirect		−0.23 (−14., 13.)
network		−2.7 (−6.8, 1.3)
Dance. Badminton		
direct	.851	−4.2 (−10, 1.9)
indirect		−2.8 (−20., 14.)
network		−4.0 (−8.1, 0.087)
Usual. Badminton		
direct	.559	2.4 (−4.3, 9.1)
indirect		−1.3 (−14., 12.)
network		1.5 (−3.1, 6.3)
Basketball.Run		
direct	.516	−3.5 (−12., 4.5)
indirect		−0.11 (−8.0, 7.6)
network		−1.7 (−7.2, 3.7)
Usual. Basketball		
direct	.790	5.2 (−3.6, 14.)
indirect		3.8 (−3.5, 11.)
network		4.3 (−0.47, 9.2)
Usual. Dance		
direct	.956	5.6 (−3.1, 14.)
indirect		5.4 (−2.7, 13.)
network		−5.6 (0.48, 11.)
Usual. Run		
direct	.646	6.9 (0.92, 13.)
indirect		4.9 (−2.4, 12.)
network		6.0 (1.6, 11.)
Run.Yoga		
direct	.204	−6.4 (−14., 1.2)
indirect		0.21 (−7.5, 8.1)
network		−3.2 (−8.7, 2.5)
Usual. Taichi		
direct	.0002	6.4 (3.7, 9.6)
indirect		22. (17., 27.)
network		11. (6.0, 16.)
Taichi.Yoga		
direct	.0002	8.9 (4.9, 13.)
indirect		−6.8 (−11., −2.4)
network		1.8 (−3.9, 7.6)
Volleyball. Usual		
direct	.982	−6.2 (−15, 2.6)
indirect		−6.4 (−17, 4.5)
network		−6.1 (−12, −0.036)
Yoga. Usual		
direct	.199	−13. (−20, −5.0)
indirect		−6.5 (−13, −0.067)
network		−9.2 (−14, −4.0)

kind of exercise, when practice it, the meditation can play a role in the relieveing of depressive symptoms,[45] which is the same to Yoga.[46] And both of Tai chi and Yoga have show their significant effectiveness on prenatal depression, anxiety and sleep disturbances.[47] When compared with usual care, exercise interventions except basketball all show better effect to depressive symptoms of depressed college students. Previous studies have confirmed that basketball, as a team sport, has a good therapeutic effect on depression,[48] our results contradict this, possibly due to publication bias. We also ranked these exercise interventions with respect to their Efficacy in depressed college students, so can provide potential guidence to college psychological counselors and other university administrators. In the present study, the result of NMA showed that students treated by Tai chi was associated with a significant relieving of depressive symptoms compare to other 6 exercise interventions, and Yoga was the second most effective exercise. In our analysis, the effect of dancing on depressive symptoms was ranked third among all interventions, higher than volleyball, running, basketball, and badminton. A systematic review about the effectiveness of dance for people with a diagnosis of depression has been conducted by Mala et al,[49] and they concluded that dancing has positive effects on depression duo to it contains some characteristics of art therapy. Among other comparions, volleyball and basketball are better than badminton in treating depression. This conclusion is consistent with previous study,[50] which suggest that volleyball and basketball belong to team sports, and indicated they were better at alleviating depression symptoms than individual sports such as badminton.

As one of the most widely prescribed interventions for depressed college students, dispute about the efficacy of exercise has been existed, it is especially difficult for university administrators to determine which exercise intervention is most effective.

As the first NMA study, the present study can provide valuable information for psychological counselors when they faced to depressed college students, and may be beneficial to effectively improve the depression symptoms of college students, reduce the risk of further worsening of symptoms. However, some limitations should be noted, for the first, though we had

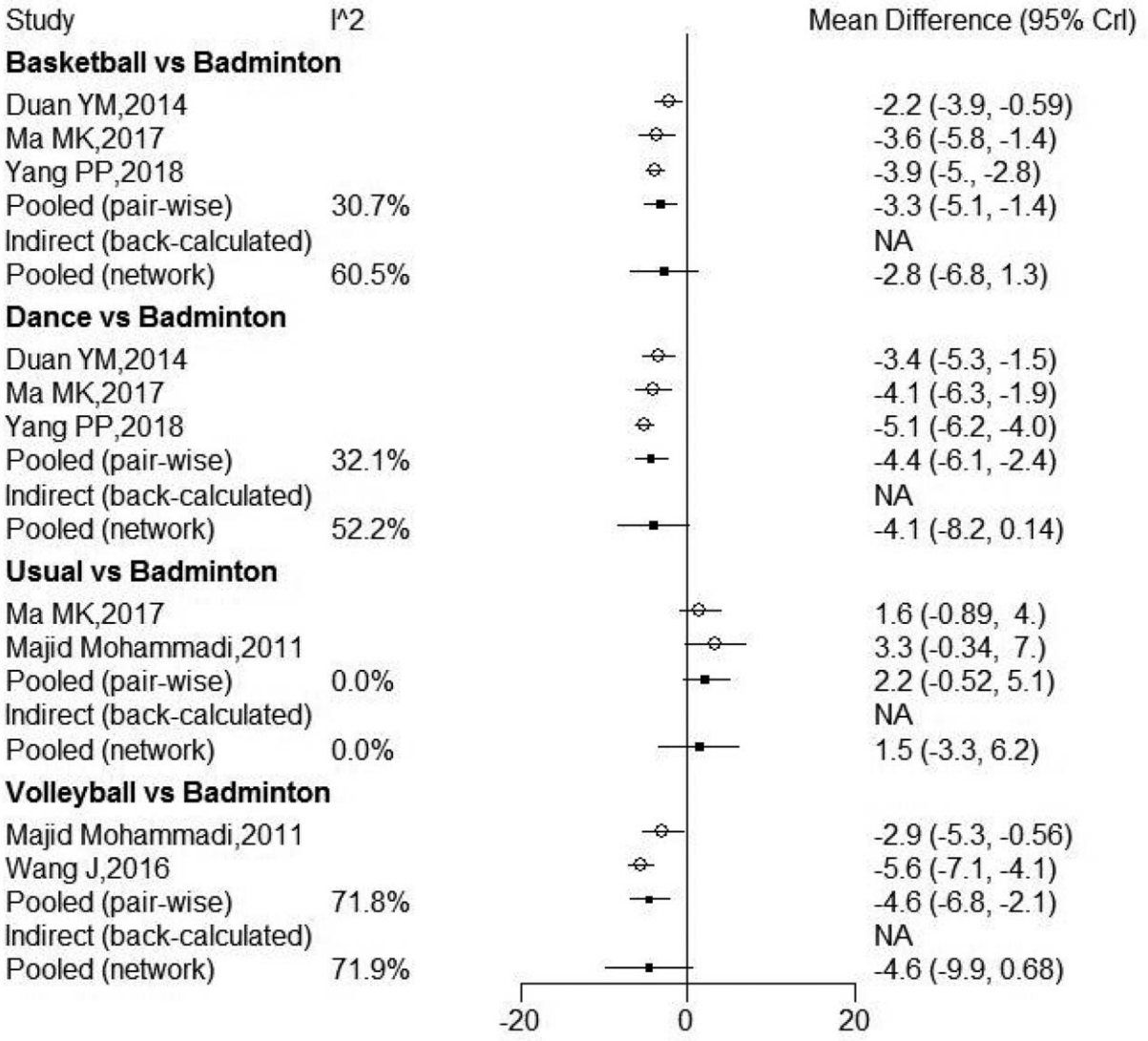

Figure 6. The heterogeneity of the included studies.

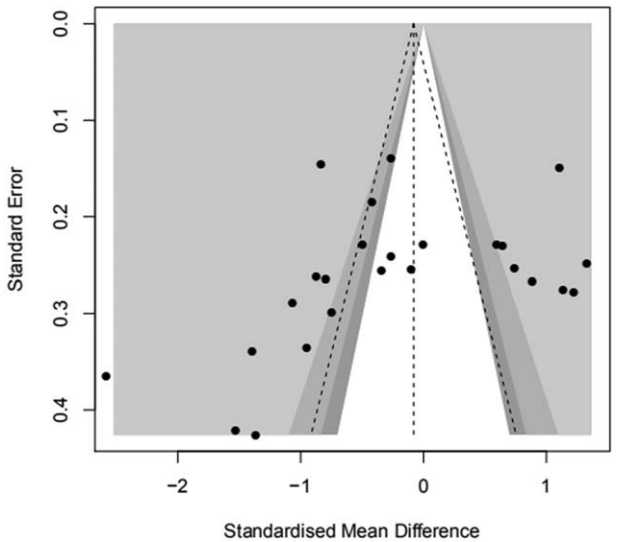

Figure 7. Funnel plot of publication bias.

conducted a thorough literature search, most included studies still were published in Chinese, which may be exist publication bias. Second, symptoms of depression were not a predefined outcome, and therefore may not have been accurately evaluated, and among the included studies, there were 3 evaluation scales, they were BCD-II, HAMD, and SDS, which may influence the result. Third, significant variation existed in the number of studies with respect to each comparison, for example, there were 4 trials compared the efficacy of Badminton and Basketball, only one trial of Tai chi and Yoga, one trial of comparison between Run and Yoga. So, this may result in a wide confidence interval for summary statistics.

5. Conclusion

Tai chi exhibited the highest probability that became the most efficacy intervention among the comparions, and Yoga showed the second most effectiveness to alleviate depressive symptoms of depressed college students, and dance ranks the third, followed by run, volleyball, basketball, and badminton respectively.

Acknowledgments

The authors thank all the reviewers for their helpful comments.

Author contributions

Conceived and designed the analysis: SG, YY. Performed the analysis: SG, YN, FL. Wrote the paper: GS, YY.
Data curation: Feiyue Liu, Jing Shen, Yan Yang.
Formal analysis: Min Wei, Yan Yang.
Funding acquisition: Shengyu Guo.
Software: Shengyu Guo.
Writing – original draft: Shengyu Guo.

References

[1] Walker ER, Mcgee RE, Druss BG. Mortality in mental disorders and global disease burden implications: a systematic review and meta-analysis. JAMA Psychiatry 2015;72:334.
[2] Singleton SS. Depression and quality of life: a patient's perspective. J Clin Psychiatry 2001;62(Suppl 26(4)):244–51. 264.
[3] Kisch J, Leino EV, Silverman MM. Aspects of suicidal behavior, depression, and treatment in college students: results from the spring 2000 national college health assessment survey. Suicide Life-Threatening Behavior 2015;35:3–13.
[4] Rincon HG, Granados M, Unutzer J, et al. Prevalence, detection and treatment of anxiety, depression, and delirium in the adult critical care unit. Psychosomatics 2001;42:391–6.
[5] Kumar G, Jain A, Hegde S. Prevalence of depression and its associated factors using Beck Depression Inventory among students of a medical college in Karnataka. Indian J Psychiatry 2012;54:223.
[6] Reisbig AM, Danielson JA, Wu TF, et al. A study of depression and anxiety, general health, and academic performance in three cohorts of veterinary medical students across the first three semesters of veterinary school. J Vet Med Educ 2012;39:341–58.
[7] Daniel F Brown, David Fletcher. Effects of psychological and psychosocial interventions on sport performance: a meta-analysis. Sports Med 2017;47:77–99.
[8] Field LD, Elliott MS, Korn PR. A successful community-based intervention for addressing college student depression. J College Student Develop 2006;47:105–9.
[9] Kim KB, Cohen SM, Oh HK, et al. The effects of meridian exercise on anxiety, depression, and self-esteem of female college students in Korea. Holist Nurs Pract 2004;18:230.
[10] Ben MB. Depressed college students and tricyclic antldepressant therapy. J Am Coll Health Association 1978;27:79–83.
[11] Pinkerton RS, Rockwell WJ. Very brief psychological interventions with university students. J Am Coll Health 1994;42:156–62.
[12] Özdemir RA, Çelik Ö, Aşçı FH. Exercise interventions and their effects on physical self-perceptions of male university students. Int J Psychol 2010;45:174–81.
[13] Gronholm PC, Elizabeth N, Daniel M. Stigma related to targeted school-based mental health interventions: a systematic review of qualitative evidence. J Affect Disord 2018;S0165032718306219.
[14] Wagner D, Dale R. ACSM's resource manual for guidelines for exercise testing and prescription 5th edition. MedSci Sports Exercise 2005;37:2018.
[15] Manger T, Motta R. The impact of an exercise program on posttraumatic stress disorder, anxiety, and depression. Int J Emerg Ment Health 2005;7:49–57.
[16] Ólafsdóttir K, Kristjánsdóttir H, Saavedra J. Effects of exercise on depression and anxiety. A comparison to transdiagnostic cognitive behavioral therapy. Community Ment Health J 2017;54:1–5.
[17] Beesley S, Mutrie N. Exercise is beneficial adjunctive treatment in depression. BMJ 1998;315:1542–3.
[18] Craft L, Landers D. The effect of exercise on clinical depression and depression resulting from mental illness: A meta-analysis. J Sport Exercise Psychol 2010;20:339–57.
[19] Rethorst C, Wipfli B, Landers D. The antidepressive effects of exercise: a meta-analysis of randomized trials. Sports Med 2009;39:491.
[20] Elbe AM, Lyhne SN, Madsen EE, et al. Is regular physical activity a key to mental health? J Sport Health Sci 2019;8:10–1.
[21] Bafeta A, Trinquart L, Seror R, et al. Reporting of results from network meta-analyses: methodological systematic review. BMJ 2014;348(mar11 5):g1741.
[22] Furlan , Pennick , Victoria , et al. 2009 updated method guidelines for systematic reviews in the cochrane back review group. Spine 2009;34:1929–41.
[23] Caspersen C, Christenson P. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. Public Health Rep 1985;100:126–31.
[24] Barwick M, Urajnik D, Sumner L, et al. Profiles and service utilization for children accessing a mental health walk-in clinic versus usual care. J Evid Based Soc Work 2013;10:338–52.
[25] Gerber M, Brand S, Herrmann C, et al. Increased objectively assessed vigorous-intensity exercise is associated with reduced stress, increased mental health and good objective and subjective sleep in young adults. Physiol Behav 2014;135:17–24.
[26] Higgins PT. Measuring inconsistency in meta-analyses. BMJ 2003;327: 557–60.
[27] Duan YM. Study of different ways of exercise intervention on college students' anxiety and depression. Chin J Health 2014;35:1022–4.
[28] Yang PP, Ling YX, Wu MF, et al. Research on the effect of different exercise methods on depression and anxiety symptoms of college tudents. Curr J Clin Med 2018;31:3763–4.
[29] Wang B. Effect of different exercises on intervention of college students' anxiety. J Chin Rural Health Service Management 2016;36:1593–5.
[30] Ma MK. Evaluation of the effect of different exercise programs on the intervention of zhuang depression and anxiety college students. Chin J Health 2017;38:112–4.
[31] Wang J, Xie X. Analysis the effect of different anti-net sports on anxiety and depression of college students. Chin J Health 2016;37:93–5.
[32] Zhao YF, Shi L. Research on the effect of different exercise interventions on college students with depression. J Guangzhou Sport Univers 2016;36:93–7.
[33] Zhao HQ. Effects of high-intensity intermittent exercise on depression in female college students. J Liao Cheng Univers (Nat Sci) 2017;30:88–92.
[34] Yan J. An experimental study on the influence of three ways of exercise on college students' depressive mood taking Taijiquan, pilates and yoga for case study. Chin Wushu Res 2016;5:85–8.
[35] Song XY, Du B, Du HY. Comparative Taijiquan and aerobic running on female college students with depression. Contemporary Sports Technol 2017;15:107–8.
[36] Su Y. Experimental study on the effect of twenty-four styles of Taijiquan exercise with different frequency on female college students' depression. Beijing Sports Univers 2010;37–9.
[37] Huang B. The influence of simplified 24 - style taijiquan on depression level of female college students. Beijing Sports Univers 2008;61–2.
[38] Zhu l, Yu SB. Experimental study on the effect of middle-distance running exercise on depression symptoms of college students. J Huangshan Univers 2011;13:79–82.
[39] Xiong M, Li YZ. Effects of Yoga training on depression of female undergraduates. China J Health Psychol 2014;22:398–400.
[40] Majid , Mohammadi . A Study and comparison of the effect of team sports (soccer and volleyball) and individual sports (table tennis and badminton) on depression among high school students. Australian J Basic App Sci 2011;5:1005–11.
[41] Baskin KK, Winders BR, Olson EN. Muscle as a "Mediator" of systemic metabolism J. Cell Metabolism 2015;237–48.
[42] Mao HF, Xie J, Chen JQ, et al. Aerobic exercise combined with huwentoxin-I mitigateschronic cerebral ischemia injury. Neural Regeneration Res 2017;12:596–602.
[43] Poyatosleón R, Garcíahermoso A, Sanabriamartínez G, et al. Effects of exercise-based interventions on postpartum depression: a meta-analysis of randomized controlled trials. Birth 2017;30:214–23.
[44] Ukhato K, Lotrakul M, Dellow A, et al. Efficacy of home-based non-pharmacological interventions for treating depression: a systematic review and network meta-analysis of randomised controlled trials. BMJ Open 2017;7:e014499.
[45] Rawtaer I, Mahendran R, Yu J. Psychosocial interventions with art, music, Tai Chi and mindfulness for subsyndromal depression and anxiety in older adults A naturalistic study in Singapore. Asia-pacific Psychiatry 2015;7:240–50.
[46] Woolery A, Myers H, Sternlieb B, et al. A yoga intervention for young adults with elevated symptoms of depression. Altern Ther Health Med 2004;10:60–3.

[47] Field T, Diego M, Delgado J, et al. Tai chi/yoga reduces prenatal depression, anxiety and sleep disturbances. Complement Ther Clin Pract 2013;19:6–10.
[48] Begbie AK. Observation: behavior change in reactive depressed patients following introduction of basketball skills. Am Correct Ther J 1981; 35:107.
[49] Mala A, Karkou V, Meekums B. Dance/Movement Therapy (D/MT) for depression: a scoping review. Arts in Psychotherapy 2012;39:287–95.
[50] Barmi MR. A comparative study of depression level among male athletic students engaged in individual and team sports versus male non-athletic students of schools from the second board of education in karaj, Iran. Procedia - Social Behav Sci 2011;30:352–6.