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Effects of Physical Activity on College Students' Positive Psychology:
A Meta-Analysis

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ABSTRACT

Physical activities are increasingly practiced among college students and may be effective in improving positive psychology. This article conducted a meta-analysis of RCTs to systematically evaluate the effects of physical activities on positive psychology in college students. Two authors conducted independent literature searches in electronic databases from the first available date to December 2023. Then, eligible studies were selected, data for meta-analysis were extracted, and the risk of bias was evaluated. Eight independent RCTs with 697 participants were included. Meta-analysis showed that physical activities significantly improved the level of self-efficacy, positive emotion and well-being among college students. However, physical activities did not significantly enhance the resilience in college students. Clinical evidence from current RCTs indicates that physical activities could enhance the positive psychology in college students.

KEYWORDS

College Students, Fuzzy Evaluation, Meta-Analysis, Physical Activity, Positive Emotion, Resilience, Self-Efficacy, Well-Being

INTRODUCTION

Nowadays, due to the constantly changing environmental conditions and increasingly fierce competition, college students are facing more and more pressure in terms of academics, employment, and interpersonal issues, and mental health problems have gradually come to the fore (Ningning et al., 2020). The mental health of college students has become a key topic in college education. At present, the focus of attention on college students' mental health is mostly on the problem-oriented traditional pathology. However, with the rise of positive psychology in recent years, scholars have pointed out that mental health education should not only focus on psychological crises but also explore the potential positive psychological indicators of the individual to help students to obtain a higher positive experience (Di et al., 2022; Liang, 2023).

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Resilience, which means adapting well in the face of adversity, trauma, or significant sources of stress, could be regarded as an indicator of positive psychology (Masten, 2001). Previous studies have suggested that college students with higher levels of resilience were able to call upon positive psychological resources to cope with stress in a timely manner, resulting in more positive experiences (Zhen et al., 2023). Similar to resilience, self-efficacy could also be viewed as an indicator of positive psychology; self-efficacy represents a subjective judgment made by an individual as to whether or not they are successful in engaging in a particular achievement goal (Bandura et al., 1999). Individuals with a higher level of self-efficacy are likely to be more affirmative and proactive in their lives (Putwain et al., 2013). Similarly, positive emotions are the pleasant feelings that arise when something meaningful to an individual is positively evaluated in the process of its realization (Garland et al., 2010; Tong, 2015). Some scholars have found that positive emotions are linked to satisfaction, and higher positive emotions increase an individual's positive feelings and positive behaviors (Rui et al., 2013). In addition, the dual-factor model of mental health states that well-being is an important positive indicator of an individual's mental health (Greenspoon & Saklofske, 2001). Taken together, resilience, self-efficacy, positive emotion, and well-being are important in enhancing the level of positive psychology among college students.

Current research indicates that physical activities may be effective in improving positive psychology, such as yoga, running, running exercises, aerobics, and tai chi. For instance, one randomized controlled trial (RCT) study of college students demonstrated that both low and moderate intensity exercise had a positive effect on resilience and subjective well-being (Yuqing, 2023). Another RCT study in female college students suggested that aerobics was conducive to improving the level of self-efficacy (Yanan, 2022). However, an RCT conducted during a global pandemic revealed that aerobic–strength training exercise did not have an impact on resilience levels among college students (Marenus et al., 2023). Inconsistent results may be attributed to different types of participants, measurement tools, outcome indicators, and timing of interventions. Therefore, a meta-analysis was conducted to quantify the effects of physical activity on positive psychology among college students.

To the best of our knowledge, there have been some systematic analyses to date that have explored the effects of physical activity on anxiety, depression, and sleep quality in college students, but positive psychology (resilience, self-efficacy, positive emotion, and well-being) has not been included. We conducted an up-to-date, comprehensive, systematic review and meta-analysis of the effects of physical activity on positive psychology (resilience, self-efficacy, positive emotions, and well-being) among college students from the inception of the database through December 2023 to achieve the following objectives:

- To identify and summarize the study of physical activities for college students systematically in terms of methodology, design, participant types, interventions, and assessment tools; and
- To assess the impacts of physical activities on the level of resilience, self-efficacy, positive emotion, and well-being among college students through a meta-analysis by combining RCTs.

METHODS

This study was conducted according to the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines.

Search Strategy

Databases included were Web of Science, PubMed, Cochrane Library, Scopus, China National Knowledge Infrastructure, Wanfang Data, and China Science and Technology Journal Database. All searches were conducted from inception through December 2023 with keywords and subject headings such as physical activity, exercise interventions, college students, resilience, self-efficacy, positive

emotions, and well-being. There were no restrictions on language or year of publication. In addition, in order to identify more potentially relevant literature, we manually searched the reference lists of relevant articles, reviews, and related comments.

Inclusion and Exclusion Criteria

Inclusion Criteria

The inclusion criteria were:

- participants—students who are currently enrolled in a university, with no restrictions on grade or gender;
- intervention—RCTs of physical activity or intervention;
- controls—the control group was given conventional non-exercise interventions or no interventions; and
- outcomes—resilience, self-efficacy, positive emotion and well-being.

Exclusion Criteria

The exclusion criteria were:

- repetitive publications; and
- studies with insufficient data, inability to obtain data from the original authors, or unavailable full text.

Selection Procedure and Data Extraction

Two reviewers screened the literature and extracted and cross-checked data independently. If there were disagreements, a third partner was asked to assist in the judgment. The authors of the original study were contacted to supplement missing data adequately. First, the title and abstract were read. After excluding irrelevant literature, the full text was further read. Finally, the decision to include or exclude a study was made based on inclusion and exclusion criteria (Provost, 2007). Data extraction mainly included: authors of included literature, year of publication, sample size, intervention protocols for experimental and control groups, and outcome indicators.

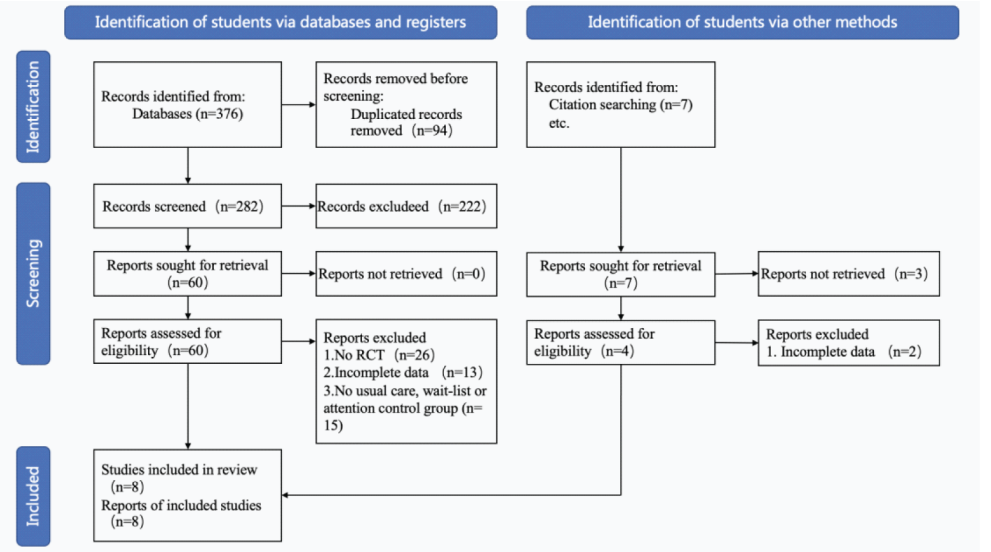
Risk of Bias Assessment

Study quality was independently assessed by two reviewers using the Cochrane Risk of Bias Tool (Higgins et al., 2011). The tool assessed risk of bias for (a) random sequence generation; (b) allocation concealment; (c) blinding of participants and personnel; (d) blinding of outcome assessment; (e) incomplete outcome data; and (f) selective reporting (Higgins et al., 2011). When there was disagreement on data extraction and quality assessment, another author examined the original study and drew independent conclusions.

Statistical Analysis

Data were analyzed using Review Manager software (version 5.3). If three or more RCTs reported the same results, tests for heterogeneity were performed first (Fleiss, 1993). Mean difference (MD) was used for combined analyses if the same instrument was used to assess the results; otherwise, standardized MDs (SMDs) were used. Between-group MDs or SMDs and their accompanying 95% confidence intervals were used as effect estimates. If the outcome was assessed more than once, the first assessment after the end of the intervention was chosen. Formulas were calculated with reference to the Cochrane Handbook of Guidelines for Systematic Evaluation. If there was heterogeneity of results ($I^2 > 50\%$), a random effects model was used; otherwise, a fixed effects model was selected

Figure 1. PRISMA Flowchart of Study Selection



($I^2 < 50\%$) (Higgins et al., 2003). A two-sided $P < 0.05$ indicated a statistically significant difference in overall effect. The stability of the meta-analysis results was evaluated by sensitivity analysis. Funnel plots were not reported in this article. According to Jonathan et al. ([date]), funnel plot asymmetry tests should not be used when fewer than 10 studies are included in a meta-analysis because the test power is usually too low to distinguish between chance and true asymmetry (Sterne et al., 2011).

RESULTS

Study Selection

The search identified 376 articles. An additional seven citations were identified through references in published articles or related websites. A total of 94 duplicate articles were eliminated through Endnote software. Next, 282 records were filtered by screening titles and abstracts. Screening of the full text excluded 222 articles that did not meet the selection criteria. The remaining 64 papers were assessed for eligibility and methodological quality. Finally, eight articles were included in the meta-analysis. Figure 1 illustrates the retrieval and selection of these studies.

Characteristics of Included Studies

In total, 697 participants were included in eight articles, including 370 in the intervention group and 327 in the control group. Among them, there are three papers with *resilience* as an outcome indicator (Friedman et al., 2022; Marenus et al., 2023; Yuqing, 2023), two papers with *positive emotion* as an outcome indicator (Shali et al., 2022; Tao, 2018), two papers with *self-efficacy* as an outcome indicator (Yanan, 2022; Yujiao, 2020; Yusheng, 2014), and two papers with *well-being* as an outcome indicator (Tao, 2018; Yuqing, 2023). One article categorized university students into three groups: a moderate-intensity exercise group (100-140 repetitions/min), a higher-intensity exercise group (140-160 repetitions/min), and a control group (no systematic intervention); both RCT studies were included in this study (Yuqing, 2023). One article divided the students into the susceptible, the symptomatic and satisfied, and the totally ill groups, and an RCT intervention was conducted in each group, all of which were included in this study (Tao, 2018). The main characteristics of the selected studies are listed in Table 1.

Table 1. Characteristics of Included Studies

Reference	Type of cancer	Participants	Missing of following	Experiment intervention	Control	Duration of intervention	Outcome
Friedman et al. (2022)	College students	T:31 C:24	Yes	WeActive program focused on aerobic and strength training exercises, which included the first four weeks and then high-impact aerobic movements in the last four weeks and dynamic stretches. The intervention group participated in two 30-minute aerobic and resistance training sessions (WeActive) per week for eight weeks.	The other group participated in two 30-minute mindful exercise sessions (WeMindful) per week for eight weeks.	Eight weeks	Resilience
Marenus et al. (2023)	College students	T:44 C:28	Yes	In the WeActive intervention group, students engaged in two, 30-minute virtual aerobic and strength exercise lessons each week. The exercise lessons were taught by a student instructor, who is a certified strength and conditioning specialist.	In the WeMindful intervention group, students attended two 30-minute virtual mindful yoga exercise lessons per week. The mindful yoga exercise lessons were taught by a student yoga instructor who had more than two years of experience in the practice.	Eight weeks	Resilience
Yusheng et al. (2014)	College students	T:101 C:105	Yes	The experimental group was led by a physical education teacher with coaching qualifications to practice Baduanjin. The experimental group practiced intensively for 60 minutes each time, five times a week for 12 weeks.	Maintain the original lifestyle in its natural state without any intervention.	12 weeks	Self-efficacy
Shali et al. (2022)	College students	T:19 C:19	Yes	The high-intensity interval exercise group performed a single 20-minute high-intensity interval exercise session on an indoor treadmill.	The control group sat for 20 minutes.		Positive emotion
Yanan et al. (2022)	College students	T:30 C:30	No	College students in the experimental group participated in the experimental intervention of aerobics for 12 weeks, with two 45-minute sessions per week.	The control group ensured that they did not participate in any form of aerobics.	12 weeks	Self-efficacy
Yuqing et al. (2023)	College students	T:20 C:20	No	The experimental group received the moderate intensity fitness and bodybuilding exercises, twice a week for 20 minutes, and the intervention lasted for 12 weeks.	The control group received no intervention and lived the same daily life as the experimental group.	12 weeks	Sesilience, well-being

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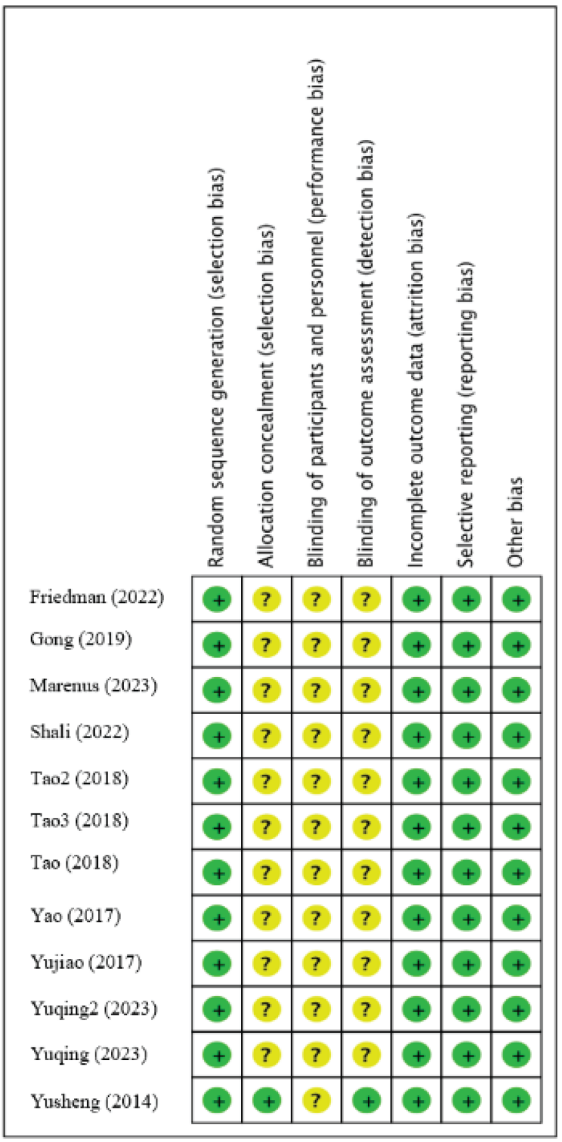
Table 1. Continued

Reference	Type of cancer	Participants	Missing of following	Experiment intervention	Control	Duration of intervention	Outcome
Yuqing2 et al. (2023)	College students	T:20 C:20	No	The experimental group did low intensity fitness and bodybuilding exercises, twice a week for 20 minutes, and the intervention lasted for 12 weeks.	The control group received no intervention and lived the same daily life as the experimental group.	12 weeks	Resilience, well-being
Tao et al. (2018)	College students (the susceptible population)	T:13 C:13	Yes	The experimental group selected jogging, yoga, basketball and other activities according to their personal preferences for aerobic exercise intervention. In addition to jogging, the activity time and frequency were recorded by APP punching, and other items were carried out by group activities. The duration of intervention was 40 to 60 minutes, three times a week for eight weeks.	The control group did not participate in aerobic exercise intervention and did not carry out long-term regular physical exercise.	Eight weeks	Well-being, positive emotion
Tao et al. (2018)	College students (the symptomatic and the satisfied population)	T:10 C:10	Yes	The experimental group selected jogging, yoga, basketball and other activities according to their personal preferences for aerobic exercise intervention. In addition to jogging, the activity time and frequency were recorded by APP punching, and other items were carried out by group activities. The duration of intervention was 40 to 60 minutes, three times a week for eight weeks.	The control group did not participate in aerobic exercise intervention, basically did not carry out long-term regular physical exercise.	Eight weeks	Well-being, positive emotion
Tao et al. (2018)	College students (the totally ill population)	T:12 C:12	Yes	The experimental group selected jogging, yoga, basketball and other activities according to their personal preferences for aerobic exercise intervention. In addition to jogging, the activity time and frequency were recorded by APP punching, and other items were carried out by group activities. The duration of intervention was 40 to 60 minutes, three times a week for eight weeks.	The control group did not participate in aerobic exercise intervention, basically did not carry out long-term regular physical exercise.	Eight weeks	Well-being, positive emotion
Yujiao et al. (2017)	college students	T:60 C:60	Yes	The experimental group did cha-cha-cha exercise for 12 weeks.	The control group did not do any physical intervention.	12 weeks	Self-efficacy

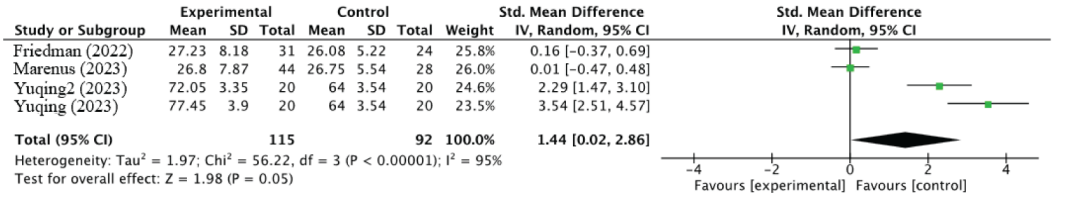
Figure 2. Risk of Bias Summary: Review Authors' Evaluations of Each Risk of Bias Item for Each Included Study



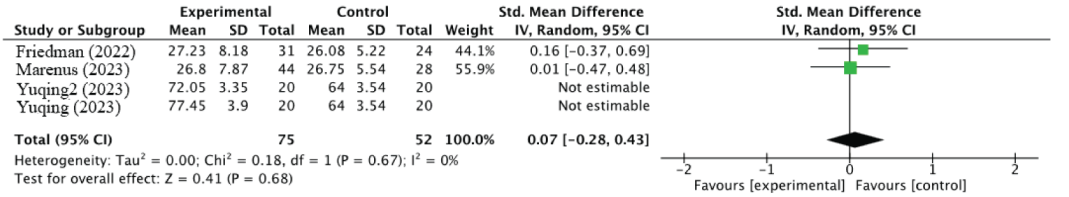
Quality Evaluation of Selected Literature

The Cochrane risk of bias tool was used to assess the risk of bias for each study, and the results are shown in Figure 2. All articles mentioned randomization, and all described the correct method of randomization, including the use of random number tables or computer-generated random number procedures. One paper used and correctly described allocation concealment (Yusheng, 2014). One paper described the implementation of blinding (Yusheng, 2014).

Figure 3. Forest Plot of Meta-Analysis on Impacts of Physical Activities on Resilience



(a)



(b)

Meta-Analysis Results

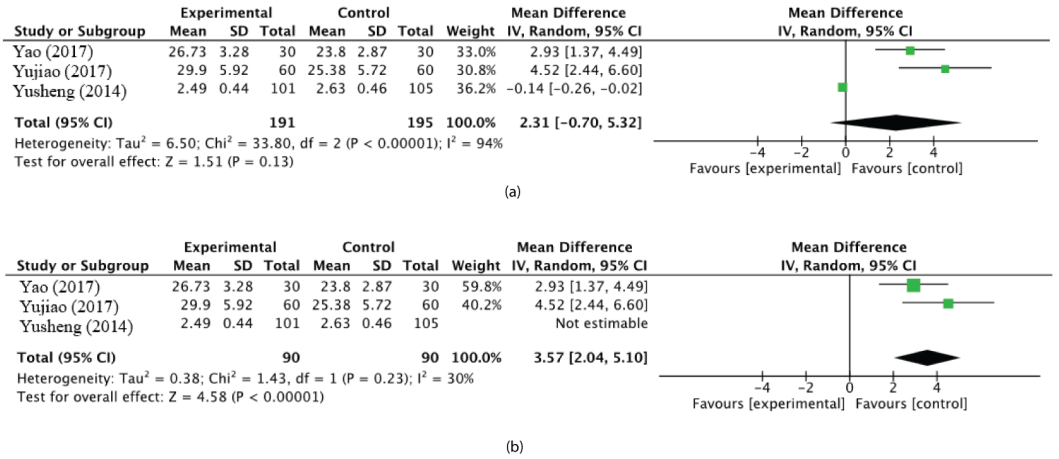
Impacts of Physical Activity on the Resilience of College Students

Three studies ($n = 115$) reported changes in resilience scores before and after the implementation of physical activities (Friedman et al., 2022; Marenus et al., 2023; Yuqing, 2023). The total sample size was 115 students in the experimental group and 72 students in the control group. The results of the heterogeneity test showed significant heterogeneity ($P<0.00001$, $I^2 = 95\%$) in all four studies (Figure 3a), so we used a random effects model for our analysis. Sensitivity analyses were required to identify sources of heterogeneity. First, we removed the study that differed most from the others, but we found that the difference continued to exist (Yuqing, 2023). Then, using a reduction of one document at a time, we examined whether each document had a significant effect on the results of the combined effect (Yuqing, 2023). After the exclusion of two studies, heterogeneity was low ($P = 0.67$, $I^2 = 0$) (Figure 3b). The results of the forest plot showed that there was no statistically significant difference in the level of resilience of the college students after the exercise intervention compared to the control group (SMD = 0.07, 95% CI [-0.28-0.43], $P = 0.68$).

Impacts of Physical Activity on the Self-Efficacy of College Students

Three of the included studies assessed changes in self-efficacy in college students after physical activities ($n = 386$) (Yanan, 2022; Yujiao, 2020; Yusheng, 2014). The total sample size was 191 students in the experimental group and 195 students in the control group. The results of the heterogeneity test showed significant heterogeneity in all four studies ($P<0.00001$, $I^2 = 94\%$) (Figure 4a), so we used a random effects model for our analysis. Heterogeneity was significantly reduced by sensitivity analysis with the exclusion of one study ($P = 0.23$, $I^2 = 30\%$) (Figure 4b). Meta-analysis indicated that college students' level of self-efficacy increased after doing exercise (Yusheng, 2014), and the difference was statistically significant when compared to the control group (MD = 3.57, 95% CI [2.04-5.10], $P<0.00001$).

Figure 4. Forest Plot of Meta-Analysis on Impacts of Physical Activities on Self-Efficacy



Impacts of Physical Activity on the Positive Emotion of College Students

Four studies compared positive emotion scores in control and experimental groups (Shali et al., 2022; Tao, 2018). The sample size of both the experimental and control groups was 59. The results of the four studies were heterogeneous ($P = 0.03$, $I^2 = 67\%$) (Figure 5a) and therefore were analyzed using a random effects model. After sensitivity analysis (Tao, 2018), the results demonstrated a statistically significant enhancement of positive emotion in college students by the physical activities (SMD = 0.85, 95% CI [0.43-1.26], $P< 0.0001$)—see Figure 5b.

Impacts of Physical Activity on the Well-Being of College Students

Five RCT studies with well-being as an outcome indicator were included (Tao, 2018; Yuqing, 2023). The sample size of both the experimental and control groups was 78. Findings indicated heterogeneity across studies, so a random effects model was used ($P<0.00001$, $I^2 = 87\%$) (Figure 6a). The source of

Figure 5. Forest Plot of Meta-Analysis on Impacts of Physical Activities on Positive Emotion

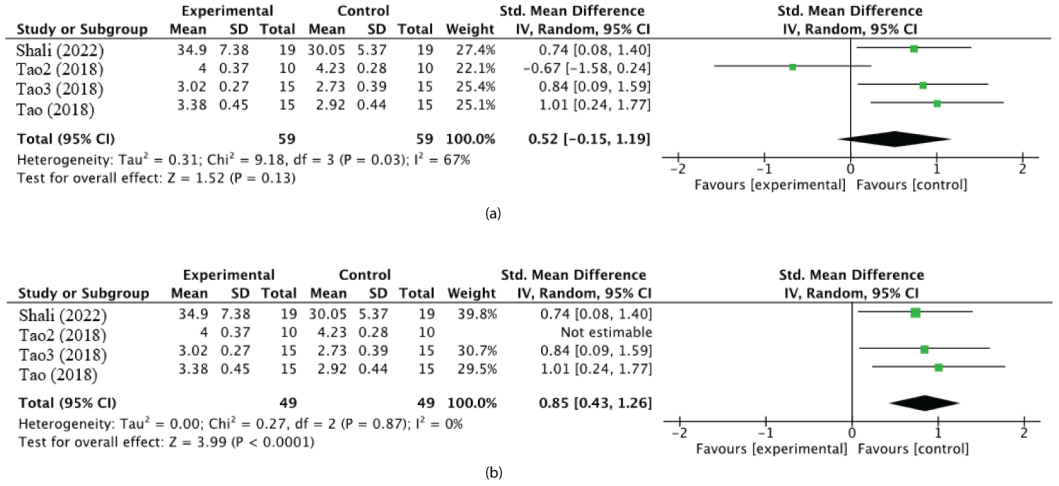
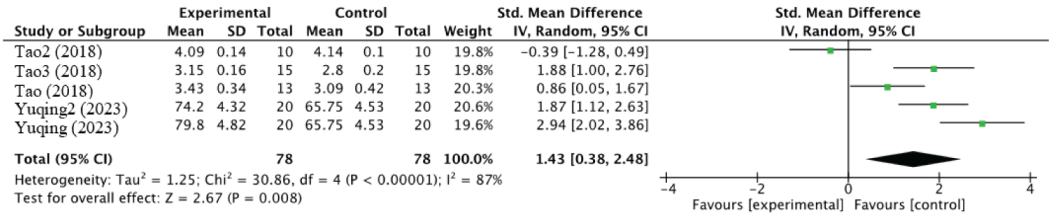
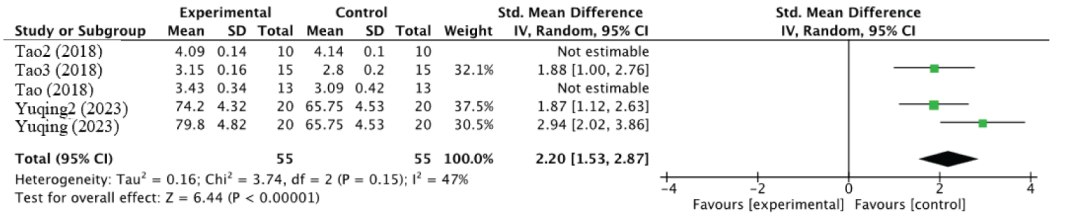


Figure 6. Forest Plot of Meta-Analysis on Impacts of Physical Activities on Well-Being



(a)



(b)

heterogeneity in the effect of physical activities on college students' well-being requires a sensitivity analysis. We found low heterogeneity after excluding two studies sequentially (Tao, 2018) (P = 0.15, I^2 = 47%) (Figure 6b). Meta-analysis showed that the well-being scores of the experimental group doing physical activities were higher than those of the control group, and the difference was statistically significant (SMD = 2.20, 95% CI [1.53-2.87], P<0.00001).

DISCUSSION

This study presents a systematic review of quantitative data analysis on the effects of physical activities among college students. All RCTs that were eligible have been published. The results indicated that physical activities could significantly improve the self-efficacy, positive emotion, and well-being of these college students. However, the effect of physical activities on the resilience of these students has not been verified in our study.

The results of this review did not show a significant effect of physical activities on the resilience in college students. The lack of observed effects of physical activities on resilience were unexpected. Previous research in sport psychology has shown that long-term participation in regular physical activity could be effective in improving an individual's resilience and that improvements in resilience exhibit an increasing trend over time (Jefferies et al., 2019; Lipowski et al., 2016). This association was not found in the college student population in the present study, possibly due to the limited amount of literature that could be included currently and the fact that, of the included literature, one study was conducted during a global pandemic. It has been suggested that building resilience during stressful life events is not feasible. The fact that there are differences in the operation and intensity of exercise interventions may also have an impact on outcomes. All in all, our study contradicts some of the RCT studies that have shown the benefits of physical exercise on resilience. For future research, we consider exploring and constructing exercise programs that are more applicable to students in the context of their actual situation and further exploring the effects of physical activity on resilience.

The results of this study suggest that physical activity can significantly promote self-efficacy, positive emotions, and well-being among college students and could be used to implement positive psychological interventions. This conclusion is also supported by psychological and biological theories

about the mental health benefits of physical activity. Previous studies demonstrated that regular physical exercise enables individuals to regulate and express their emotions rationally, establish a positive consciousness, and increase their level of self-efficacy (Qin et al., 2017). Furthermore, individuals are prone to muscle tension in the face of stress, and appropriate physical activity could relax the muscles and reduce the physiological response to stress and tension through the brain release of endorphins and the secretion of adrenaline; this could further regulate the individual's mood, effectively buffer stress, and improve an individual's adaptive capacity (Xiadi et al., 2008).

In terms of exercise modalities, the studies included in the analysis mainly used aerobic and strength training, dance, and Baduanjin as interventions. In one of the studies, subjects were allowed to choose activities such as jogging, yoga, and basketball for aerobic interventions based on their personal preferences, and it was found that running and badminton were preferred by both boys and girls (Tao, 2018). This also suggests that, when designing sports intervention programs for college students in the future, we should take into account the actual situation of students and give full consideration to the diversity of activity forms, with the aim of forming a practical and feasible intervention program with a high degree of students' willingness to participate, so that it can be better applied in practice. In terms of intervention duration, except for one study that adopted a single 20-minute high-intensity interval exercise (Shali et al., 2022), the rest of the studies conducted interventions for eight or 12 weeks. The studies also confirmed that the duration of each activity should not be less than 20 minutes, or the psychological benefits will not be realized in most cases; consistency will help to realize the mental health benefits in the long run (Hong, 2005). Therefore, in future programming, it may be more feasible to design an eight or 12-week intervention program based on the experience of previous studies. There are limitations in this meta-analysis. First, some of the papers in the study did not mention allocation concealment and blindness, which may have a certain negative impact on the evaluation results of the system. Second, because unpublished studies were not included, publication bias may have influenced our findings.

CONCLUSION

Physical activities may be valuable ways to improve positive psychology (self-efficacy, positive emotion, well-being) in college students. In the future, the impact of physical activities on resilience needs further validation. In addition, more high-quality RCTs are needed to assess the effectiveness of these interventions.

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CONFLICTS OF INTEREST

The authors have no conflicts of interest to disclose.

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