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## ORIGINAL

# EVALUATING THE IMPACT OF TRADITIONAL CHINESE HEALTH EXERCISES ON ADOLESCENT MENTAL HEALTH: A SYSTEMATIC REVIEW AND META-ANALYSIS

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## ABSTRACT

Under the background of the rapid development of The Times, the material conditions, living standards and education level of teenagers have been greatly improved, so the healthy development of teenagers is easily affected by the external environment. In a rapidly developing society, adolescents are affected by academic burden, changes in lifestyle, and stress from family patterns, which bring major challenges to the development of adolescent mental health. Psychological problems such as depression, anxiety and social phobia are on the rise among teenagers. Early educators pay more attention to the development of adolescent mental health, but with the increasing prominence of adolescent mental health problems, mental health is a special aspect of today's society and the country pays more attention to. To this end, promoting the development of adolescent mental health has become the research direction of many experts and scholars, many of which will focus on the field of sports, because sports have better operability, mass and fun, experts and

scholars expect to improve the mental health problems of adolescents through sports. Cuju is a traditional Chinese health sport, which consists of kicking, touching and kicking. Based on the integration of systematic review and meta-analysis, this paper reviewed the research on the influence of Cuju on adolescents' mental health, and confirmed the intervention effect of traditional Chinese ball games on adolescents' mental health through research. Objective: To explore the influencing factors of the effect of ball game intervention on adolescent mental health.

**KEYWORDS:** teenagers; Mental health; Exercise; Systematic evaluation; meta-analysis

## 1. INTRODUCTION

Mental health is not only the absence of mental illness related problems, but also the existence of positive experiences such as life satisfaction and subjective well-being. Mental health problems will affect the healthy development of adolescents. Adolescent mental health is a subject of great concern to society and the country, and mental health problems are also the focus of adolescent health research. The research on emotion is the earliest in the research on adolescent mental health, and it is constantly improved with the development of the academic circle. The negative emotion problem of adolescents is an important factor in the increase of the global adolescent health burden. Adolescents' mental health problems such as depression, anxiety, self-esteem and autism will cause them to have negative reactions. However, adolescents' positive psychological experiences such as positive emotions, prosocial behaviors and subjective well-being can guide adolescents to establish positive mental states, offset the influence of negative emotions, and improve their happiness and satisfaction. It can also improve the ability of individuals to cope with stress (Hendriks, De Jong, & Cramer, 2017).

Nordic physiologists Professor Pedersen and Professor Saltin proved that exercise is the basis for improving lifestyle and preventing non-medicated diseases. Dr. Sallis, president of the American College of Medicine, has also provided sufficient evidence to demonstrate that "Exercise Is Medicine", and the release of these studies has influenced health authorities and governments around the world to incorporate exercise into the prevention and treatment system of chronic diseases (Berryman, 2010). With the proposal of "exercise is medicine", people gradually realize the beneficial effects of exercise. The theory of "Exercise is Medicine" provides a new channel to help solve public health problems and promote healthy development. In the field of ball scientific research, ball games have always been regarded as the most influential and popular sport. As early as the Warring States Period, Cuju games were popular and entertaining among Chinese people. Cuju is a traditional sport with a long history and great influence in ancient China. Since 2000, Chinese ball scientific

research has put forward the research idea of using ball games to promote public health. In June 2018, Professor Peter Krstrup, a well-known European research scholar, proposed a research model of "Football is Medicine" under the theoretical concept of "Exercise is Medicine". Under this model, In the field of international ball research, a lot of research has been done on the concept of ball as a good medicine, and it has been constantly improved (Krstrup & Krstrup, 2018).

Ball games have been widely used as an intervention in the study of promoting adolescent health (X. WANG et al., 2014). There is a lot of research evidence on the physical health of young people to prove that Cuju has a significant effect. In terms of adolescent mental health, there is little evidence. Only empirical studies have confirmed the potential effect of ball sports on adolescent mental health, and the specific effect of ball sports intervention on adolescent mental health cannot be clearly explained. Therefore, systematic review and meta-analysis were used to conduct an integrated analysis of relevant literatures to evaluate the effect of Cuju, the traditional Chinese health sports, on adolescent mental health, hoping to provide corresponding evidence for clinical practice (Coma-Bau, Baiget, & Segura-Bernal, 2023).

## **2. Research Objects**

Experimental research results and academic papers on the impact of Cuju sports (ball games) on adolescent mental health were collected through searching and collecting, and this paper took this as the research object.

## **3. Research data and methods**

This paper and the standardization of the report, this study based on meta-analysis and Systematic review will strictly follow the PRISMA statement, Various analysis processes in PRISMA were carried out to reduce the bias of research results and increase the transparency and credibility of the article (J. ZHANG et al., 2015). For detailed evaluation details of each process of meta-analysis and systematic evaluation in this paper, please refer to the appendix PRISMA2020 item list and PRISMA2020 abstract list.

### **3.1 Inclusion and exclusion criteria for references**

The studies included in this paper are all journals or papers in Chinese or English, and the full text can be obtained, and the inclusion and exclusion criteria set by PICOS principles formulated by the Cochrane Society are met.

(1) Inclusion criteria: P (patient/population) Research objects: The subjects included in the study were mainly adolescents. The age definition of the included adolescents combined with the research of adolescent developmental psychology defined the age of the included adolescents as

social groups between 11 and 12 years old and 24 and 25 years old, regardless of gender, race, country or disease.

I(intervention): The intervention measures included in the literature in this paper are mainly ball sports, such as campus ball teaching, ball teaching and training, ball sports games, ball classroom teaching, leisure ball games, small team ball games and ball games, etc. The intervention plan of ball sports included in the study should be described in detail.

C(comparison/control): The control measures included in the study were health education, normal physical education, traditional physical education, cultural teaching, blank control or other non-ball sports related courses.

O(outcom) outcome measures: The relevant outcome measures of the studies included in this paper are mainly indicators to assess mental health. It mainly includes: Attention, hyperactivity, fear, terror, memory, depression, personality disorders, anxiety, autism, hostility, bipolar disorder, bipolar disorder, eating disorders, learning disabilities, self-harm, cognitive impairment, mental retardation, mood disorders, compulsion, mental disorders, paranoia, somatization, adjustment disorders, interpersonal relationships, loneliness, self-esteem, psychological resilience, life satisfaction, happiness, etc The full text can be obtained, the data is complete, and the accurate data of the outcome required for analysis can be extracted, including the mean, standard deviation and sample size.

S (study design): According to the purpose of this study, the Randomized Controlled Trials (RCT) must be the experimental design of the included studies.

(2) Exclusion criteria: P(patient/population) Study subjects: Excluded studies involving subjects other than adolescents, and studies involving subjects other than 11 or 12 to 24 or 25 years of age.

I(intervention) intervention measures: exclusion intervention measures refer to the comprehensive intervention of ball sports combined with other sports at the same time, exclusion of ball theory course intervention and other interventions unrelated to ball sports.

C(comparison/control): comprehensive interventions that involve multiple interventions in the same group at the same time and studies without control groups (single-group experiments) are excluded.

O(outcom) outcome measures: Excluded studies that did not assess mental health-related outcomes, excluded studies with incomplete data, and studies with raw data that could not be translated, and studies with complete data that were not available by contacting the authors.

S (study design): non-RCT-related research literature, such as review studies, case studies, multi-baseline studies, and single-group pre and post-tests, were excluded, and only clinical trial registration studies and conference abstracts were excluded.

In addition, studies in which the baseline difference between the intervention group and the control group is too large, studies in which the same article or the same study is repeated are excluded, duplicate data in the studies are excluded, only research literature that can be used for the data related to the outcome indicators of this paper is included, and research articles with loose experimental design are excluded.

## **3.2 Strategies for literature retrieval**

### **3.2.1 Selection of database**

The most important thing in systematic evaluation and meta-analysis is the acquisition of literature, which affects the accuracy of research results. In order to ensure the reliability of the obtained literature, this paper uses the systematic evaluation manual of Cochrane Collaboration Network to develop a search strategy that conforms to this paper, and adopts computer search and manual search to obtain literature.

### **3.2.2 Retrieval strategy**

In this paper, the detection languages are Chinese and English, and the search strategies are modified according to the characteristics of different databases. According to the research topic and PICOS principles, Chinese search terms include: Adolescents, ball games, mental health, attention, hyperactivity, fear, terror, memory, depression, personality disorders, anxiety, autism, hostility, bipolar disorder, bipolar disorder, eating disorders, learning disabilities, self-harm, cognitive impairment, mental retardation, mood disorders, obsessiveness, mental disorders, paranoia, somatization, adjustment disorders, interpersonal relationships, loneliness, self-esteem, mental toughness Sex, life satisfaction, happiness, etc. English search terms include: Teenagers, Football, Soccer, Sports, Mmental health, Attention, Hyperactivity, Fear, Tterror memory, Depression, Personality disorder, Anxiety, Autism, Hostility, Bidirectional emotional disorder, Bipolar disorder, Bipolar disorder, Eating disorder, Learning disability, Self-harm, Cognitive impairment, Mental retardation, Mental retardation, Emotional disorder, Compulsive, Mental disorders, Paranoia, Somatization, Adaptive disorder, Interpersonal sensitivity, Loneliness, Selfesteem, Psychological resilience, Life satisfaction, Happiness, Impulse tendency and Addiction.etc uses Boolean logic, truncated words and other methods to search the combination of subject words and free words, develop a reasonable search strategy that is consistent with this paper, in order to ensure that there is no omission, search a variety of synonyms, set up a

warning track for the included literature, and try to comprehensively search the research articles related to the purpose of this paper. Timely supplement relevant information and obtain valuable references for the specific search keywords in both Chinese and English of this paper are shown in Table 1 and Table 2. For the detailed search strategy of this paper, refer to the appendix Embase search Strategy as an example.

**Table 1:** Keywords of literature retrieval

<b>SUBJECT TERM</b>	<b>FREE WORD</b>
<b>TEENAGER</b>	Junior high school students, students, college students, middle school students, adolescents, male, male adolescents, adolescent, adolescent, adolescent, adolescent, female, female adolescents
<b>BALL GAME</b>	Ball games, English ball games, English ball games, school ball games, ball teaching, ball training
<b>MENTAL HEALTH</b>	Attention, hyperactivity, fear, terror, memory, depression, mood depression, depressive symptoms, personality disorders, anxiety, neuroticism, hypervigilance, autism, hostility, bipolar disorder, bipolar disorder, eating and drinking disorder, learning disability, self-harm, cognitive impairment, mental retardation, mood disorder, compulsion, psychosis Disorder, paranoia, somatization, adjustment disorder, interpersonal relationship, loneliness, homesickness, self-esteem, mental resilience, life satisfaction, happiness, self-concept, self-perception, self-perception, self-respect, fatigue, social relationship, social interaction, psychosis, psychological tolerance, Social intelligence, Social intelligence, Emotional intelligence
<b>RANDOMIZED CONTROLLED TRIAL</b>	Random assignment, double blind, single blind method, assignment

### 3.3 Literature screening

According to the requirements of Cochrane manual for literature screening (Cumpston et al., 2019), the retrieved literatures were first imported into EneNote X9 software for management, a literature management database was established, and repeated literatures were eliminated using the database, and then screened according to the requirements of the manual:

### **3.3.1 Preliminary literature screening**

After removing duplicate publications through EneNote X9 software, preliminary literature screening is carried out, the purpose of which is to obtain as many literatures related to this paper as possible. Preliminary screening is mainly to read the title and abstract of literatures. In order to avoid selection bias, during preliminary screening, two researchers with appropriate training were selected independently according to the relevant content and inclusion and exclusion criteria of this study. After the screening, the two researchers were cross-compared, and the differences were discussed at the same time to decide whether to include in the study. Finally, the titles and abstracts of the selected literatures are imported into EneNote X9 software for management.

### **3.3.2. Obtaining the full text of literature**

The literature obtained from the preliminary screening will be refined and re-screened according to the guidance of the research content, inclusion and exclusion criteria, and the full text will be obtained after identifying potential literature, and the full text will be obtained by computer retrieval. If the full text is not available, the full text will be obtained by manual retrieval or library transmission. If not, the author of the article will be contacted as far as possible to obtain the full text. At the same time, the title, abstract and full text of potentially relevant literature were imported into EneNote X9 software for literature management.

### **3.3.3 Literature was finally included**

The re-screened literature was finally included and screened, and the guidance was given according to the inclusion and exclusion criteria of the literature in this paper. The full text of the literature was read, focusing on the information described in the full text of the research object, intervention measures, outcome indicators and study design types, and then the relevant literature that could be included in the study was determined. The relevant literature finally included will be counted according to the first author of the study and the time of publication. This process is completed by two researchers alone. If there is any difference in opinion, a third-party researcher will analyze it to determine whether to include it in this paper.

## **3.4 Literature quality evaluation**

Systematic review and meta-analysis are the re-integrated analysis and evaluation of the published relevant research literature, and the quality of this paper is limited by the quality of the included literature. On the one hand, strict and high-quality systematic evaluation can evaluate, integrate and analyze multiple controversial or contradictory original clinical studies in a standardized and systematic way, so as to resolve disputes and contradictions, which has



important guiding significance for clinical practice. On the other hand, the poor quality of the included literature will affect the results of the systematic review and meta-analysis, which will provide incorrect information and lead to misleading. Therefore, the correct evaluation of the quality of the original data is a necessary measure to ensure the reliable results of systematic evaluation and meta-analysis. If the quality evaluation of the finally included relevant studies is poor, it indicates that the literature data and research methods of the original research are flawed and not rigorous, which will lead to the deviation of the results and even draw wrong conclusions. Contrary to the original intention of meta-analysis (Xie, 2019).

The main evaluation aspects include: (1) evaluation of random allocation method; (2) Evaluation of hidden allocation schemes; (3) Evaluation of the blind method used in the study; ④ Evaluation of the integrity of the resulting data; (5) Evaluation of selective reporting of research results; ⑥ Evaluation of other biased sources (Y. Wang, 2019). According to the six aspects of evaluation, the Review Manager 5.3 software is used to perform grade evaluation according to high risk, low risk and unclear. In order to ensure the accuracy of the quality assessment in this paper, two researchers are required to complete the evaluation independently during the evaluation of the included literature, and the evaluation results are cross-checked. If there are different opinions, a third-party researcher will intervene in the discussion and make a decision after in-depth discussion.

### **3.5 Literature data extraction**

The original data in systematic evaluation and meta-analysis are all derived from literature to ensure the accuracy of data extraction (Shen, 2017). In this paper, two researchers with corresponding training were used to independently complete the data extraction, and then the results were cross-compared for verification. In case of disagreement, a third researcher was involved and confirmed through in-depth discussion, so as to reduce the bias in data extraction.

In the process of data extraction, the data extraction table should first be formulated according to the content of this paper and the inclusion and exclusion criteria. The main contents extracted include the title, author, publication date and country of the literature, etc. Secondly, the experimental features should be extracted. The grouping method of the experiment, the situation of the assignment hiding, the situation of the blind method of the experiment, the basic characteristics of the research object, the specific implementation measures of the intervention, the report of the outcome, the baseline situation, the calculation of the sample content, the statistical method, etc. The original data extraction in the paper also includes: The content of outcome and secondary outcome indicators, the situation of intervention group



and control group, the time, cycle, frequency and intensity of intervention, etc. After the original data is extracted, Excel software is used to draw a table for management.

### 3.6 Statistical Analysis

The data of outcome indicators extracted in this paper were mainly analyzed by Stata.16 and RevMan5.3 software. In the extracted data, depression, anxiety, self-esteem, interpersonal relationship, somatization, terror, impulsivity and self-blame related to mental health were all continuous variables. Therefore, the original data extracted from the outcome indicators are the pre-test and post-test data of the intervention group and the pre-test and post-test data of the control group. At the same time, if there are multiple subgroups of data extracted, the subgroup data will be combined for analysis; if the complete data cannot be obtained, the descriptive method will be used for integrated analysis. The formula (Zhu & Li, 2019) for combining subgroup data of continuous variables is as follows:

$$SD = \sqrt{\frac{(N_1 - 1)SD_1^2 + (N_2 - 1)SD_2^2 + \frac{N_1 N_2}{N_1 + N_2} (M_1^2 + M_2^2 - M_1 M_2)}{N_1 + N_2 - 1}}$$

The resulting data is combined with a third subgroup, and so on. Meta-analysis needs to combine or summarize the results of multiple studies of the same type into a single effect size or effect scale (Wei & Duan, 2006). Therefore, when sorting out the outcome indicators related to mental health, it was found that due to the different dimensions of mental health measurement, the scales used were different and could not be unified. Therefore, standardized mean difference (SMD) was used to combine statistics in the outcome indicator data in this paper to eliminate the effect of absolute values and unit differences in multiple studies. At the same time, 95% confidence interval (CI) is used to estimate that the sample statistics have a 95% probability of falling into the interval of the population parameter. The meaning of SMD is that the value divides the difference between two means by the quotient of the combined standard deviation. standardized mean difference (SMD) is calculated by:

$$SMD = \frac{\bar{X}_1 - \bar{X}_2}{S_c} \left(1 - \frac{3}{4N - 9}\right)$$

The calculation formula of  $S_c$  is as follows:

$$S_c = \sqrt{\frac{S_1^2(n_1 - 1) + S_2^2(n_2 - 1)}{(n_1 + n_2 - 1)}}$$

In terms of heterogeneity detection, Cochran Q test was adopted in this

paper to measure the degree of heterogeneity among multiple research results through the value of  $I^2$  (Carvalho, Silva, & Grande, 2013). If the value of  $I^2$  obtained in statistical analysis is less than or equal to 50% and the value of  $P$  is greater than or equal to 0.1, it indicates that the data of outcome indicators are homogenous. Therefore, the fixed-effect model can be used to conduct the combined effect size. If the value of  $I^2$  is greater than 50% or the value of  $P$  is less than or equal to 0.1 through Cochrane  $Q$  test, the results indicate that there is heterogeneity in the outcome indicators data of relevant studies, so it is necessary to find the source of data heterogeneity and analyze the causes of heterogeneity, and use the random effects model when analyzing the integrated effect size of the outcome indicators of relevant studies.

The method to explore the causes of heterogeneity of related studies is to use subgroup analysis and sensitivity analysis of related studies. If the causes of heterogeneity cannot be found through subgroup analysis and sensitivity analysis, descriptive analysis should be used for research. Funnel plot or Egger test is used to detect publication bias in the final included literature. Funnel plot and Egger test require that there must be more than 10 literatures, otherwise the research results have little reference significance.

Sensitivity analysis was used to evaluate the robustness of the results of meta-analysis and systematic review in this paper. The principle is to eliminate the included literatures one by one, and conduct an integrated analysis of the remaining literatures again. The evaluation criterion is to observe the integration results obtained after the deletion and compare them with the original results of the total effect size. If there is no significant change or essential change in the integrated results after elimination, it indicates that the results of this paper are robust, and the results of Met analysis and systematic evaluation are credible. If the analysis results change significantly, it indicates that the research results are unstable, and the reasons for the changes need to be considered and the sources of heterogeneity discussed (Iyengar & Greenhouse, 2009). If there are less than 3 literatures in meta-analysis and systematic review, the model transformation of sensitive analysis should be carried out for analysis.

The common method to analyze the sources of heterogeneity is to use subgroup analysis, which is to divide the results into different subgroups according to the characteristics of the factors that may influence prognosis of the included literature, and analyze the results according to the characteristics of the influencing factors. The results of the study will be different due to the existence of these factors, which has important guiding significance for the individualized clinical guidance (Thompson & Higgins, 2002).

In this paper, subgroup analysis is mainly carried out according to the influence of factors such as the time of a single intervention, the frequency of

intervention, the cycle of intervention and different dimensions of mental health, so as to judge the source of heterogeneity in this paper. Although meta-analysis and systematic review are highly normative and reliable, statistical methods can be used to increase the sample size of relevant studies to make the results of the studies close to the true value, but at the same time, the results of meta-analysis and systematic review may deviate from the real situation due to various risks of bias in the studies (Sterne, Gavaghan, & Egger, 2000).

In order to ensure that the results of this paper can be close to the true value and increase the accuracy of the effect size, it is necessary to detect the publication bias of the included literature in the study, and the funnel plot or Egger test is mainly used to evaluate and verify. The funnel diagram mainly presents the shape of a symmetrical inverted funnel (Godavitarne, Robertson, Ricketts, & Rogers, 2018).

The main way to detect publication bias in the funnel plot is to observe whether the sample points of each study spread out symmetrically around the median line and are concentrated at the top of the funnel plot. Since the detection of the funnel plot is mainly by observing the symmetry of the sample points, there is subjectivity in judging publication bias. The standard normal deviation and accuracy of each study included in the meta-analysis and systematic review are determined by the Egger detection method (Shi & Wang, 2009).

The criterion is to observe whether the intercept of the regression line spans 0. If the straight line obtained from the Egger test does not cross the 0 point, the larger the intercept indicates the higher degree of bias. Meanwhile, the judgment is made based on whether the P-value is greater than 0.05. If it is greater than 0.05, the degree of bias is also high; otherwise, the degree of bias of the research results is indicated. Therefore, Egger test method is used to verify the accuracy of publication bias detection in this paper.

#### **4. Results**

At the end of the study, the publication bias of statistical results is detected by funnel plot, which is subjective and the symmetry of funnel plot is affected by other factors. Therefore, the Egger test method is adopted to detect publication bias of statistical results. In Egger test, the judgment criteria mainly observe whether the intercept of the regression line is across 0 points, and judge it in combination with the P value.

Based on the Egger detection of 25 literatures, it is found that the 95% confidence interval of intercept is -1.25378 and 3.805334, and the intercept line segment spans 0 points. At the same time, combined with the P-value analysis, the detection result is  $P > 0.308$ , suggesting that there is no obvious bias in this paper, as shown in FIG. 1 and Table 3.

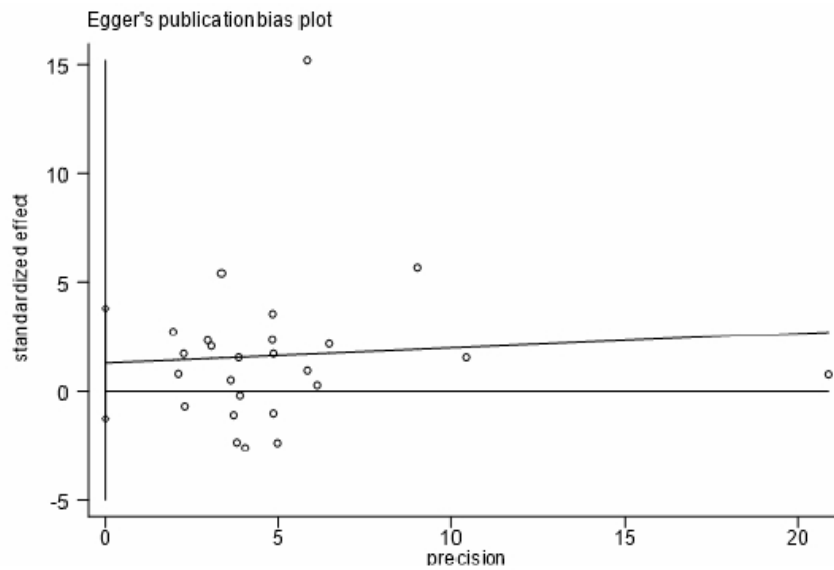


Figure 1: Egger diagram of ball sports on adolescent mental health

Table 3: Evaluation of publication bias in the included literature

STD_EFF	COEF.	STD. ERR.	T	P> T	[95% CONF.	INTERVAL]
SLOPE	.0689815	.190846	0.36	0.721	-.3258135	.4637766
BIAS	1.275777	1.222801	1.04	0.308	-1.25378	3.805334

## 5. Discussion

### 5.1 Evaluation of the intervention effect of ball games on adolescent mental health

#### 5.1.1 Evaluation of overall intervention effect of ball games on adolescent mental health

In this paper, a systematic review and meta-analysis were used to evaluate the intervention effect of ball games on adolescent mental health. A total of 25 relevant literatures were included in this paper. After the overall effect size was combined, it was found that there was a large heterogeneity in the study results. In this paper, sensitivity analysis and subgroup analysis were adopted. Firstly, in order to ensure the robustness and credibility of the study results, the influence of low-quality studies and small sample size studies on the overall effect size was excluded, and sensitivity analysis was adopted for verification. It was found that there was no subversion of the research results, and the results still fell into the 95% confidence interval (95%CI: 0.09, 0.60), indicating that the research results in this paper are robust. According to possible prognostic factors, the included studies were analyzed.

According to the analysis of different intervention cycles in the included literature studies, which were  $\leq 18$  weeks and  $> 18$  weeks respectively. The overall effect size of the two subgroups was analyzed, and the effect size of the

two subgroups was obtained when the intervention cycle of the ball game intervention was > 18 weeks. The study results showed no heterogeneity ( $I^2=0\%$ ). In the analysis of different intervention frequencies, the frequency of weekly intervention exercises was divided into two sub-groups of > 3 times and  $\leq 3$  times. Through the subgroup analysis of different intervention frequencies, it was found that the intervention effect of ball games was optimal when the frequency of weekly intervention exercises was > 3 times, and the results were statistically significant. Subgroup analysis was performed at different times of a single intervention. The study found that the effect was optimal at the duration of 30-60 minutes (SMD=0.50,95%CI:0.12, 0.87), which was statistically significant ( $P < 0.05$ ). Therefore, we found that the main factors affecting the effect of ball sport intervention on adolescent mental health were different cycles, different frequencies and different duration of a single intervention in the experimental scheme. According to this result, we can set up the corresponding ball sports training program to achieve the optimal effect of ball sports in the intervention of adolescent mental health. According to the subgroup analysis, the intervention period of the training implementation program is > 18 weeks, and the frequency of weekly practice is > 3 times. The effect of a single exercise duration of 30-60 minutes on the mental health of adolescents is the optimal exercise program.

Publication bias detection is carried out, and whether the intercept of the regression line crosses the 0 point is judged after the Egger test is adopted. Combined with the size of the P-value, the 5% confidence interval of the intercept of the research results is -1.25378 and 3.805334, and the intercept line segment spans 0 points. Meanwhile, combined with the P-value analysis, the detection result  $P > 0.308$ , indicating that there is no obvious bias in this paper. Through systematic review and meta-analysis, it is found that the intervention effect of ball games on adolescents' mental health has a positive impact, which can effectively reduce adolescents' mental health problems and improve their positive psychology.

### **5.1.2 Evaluation of the intervention effect of ball games on different dimensions of adolescent mental health**

This paper aims to explore the intervention effect of ball games on adolescent mental health. Due to the wide range of mental health involved, the measurement results are inconsistent, and the outcome indicators include: Attention, hyperactivity, fear, terror, memory, depression, personality disorders, anxiety, autism, hostility, bipolar disorder, bipolar disorder, eating disorders, learning disabilities, self-harm, cognitive impairment, mental retardation, mood disorders, compulsion, mental impairment, paranoia, somatization, adjustment disorders, interpersonal relationships, loneliness, self-esteem, mental resilience, life satisfaction Degree, happiness and so on. As a result, the heterogeneity of the included literature in this paper is high. The sub-component

analysis was used to explore the source of heterogeneity and found that the implementation plan of the experiment was different, which is one of the sources of heterogeneity. By combining the outcome indicators of mental health and combining the concept of mental health, the effect of different dimensions of adolescent mental health on the adolescent mental health was discussed.

First of all, emotion is a relatively important aspect of mental health research. This paper includes 14 relevant literatures, among which the emotional indicators mainly include depression, anxiety, tension, terror, anger, impulse, panic, loneliness, panic, etc. By subgroup analysis, it was found that the effect size of the influence of ball games on the emotional dimension of adolescent mental health was (SMD=-0.16,95%CI: -0.29, -0.03;  $P < 0.05$ ), and there was statistical significance, indicating that ball games had a positive effect on the adjustment of adolescent mental health, and could effectively help adolescents regulate their emotions and reduce negative emotions. The rate of depression and anxiety among adolescents is increasing, which is an important factor affecting the health of adolescents. There are many reasons for teenagers to have emotional problems. Teenagers are in their school years, during which they are under great academic pressure. At the same time, due to individual differences and other factors, teenagers may have bad emotions. There are many reasons why ball games can regulate teenagers' emotions. When teenagers participate in sports, their bodies will release a lot of hormones, such as the release of brain endorphin, an endogenous polypeptide compound secreted by the pituitary gland, which has the function of regulating stress, pain, emotional changes and neurohormone as a neurotransmitter (S. ZHANG, Zhang, Fu, Zhang, & Wang, 1993). Endorphins can make teenagers feel euphoric and increase their tolerance for pain, which can effectively eliminate depression, anxiety and stress in adolescents. And many studies have shown that compared with the control group that does not participate in ball games, the mood of teenagers is significantly improved.

Secondly, in terms of psychology, a total of 21 literatures are included in this paper, among which the main outcome indicators include self-esteem, self-confidence, cognition, personality and self-efficacy. Subgroup analysis showed that the effect size of ball games on the psychological dimension of mental health was moderate (SMD=0.56,95%CI:0.17, 0.94;  $P < 0.05$ ), and the results were statistically significant. The definition of psychology in this paper is mainly related to the cognitive and behavioral patterns of adolescents. The research proves that the self-confidence and self-efficacy of adolescents who participate in ball games are higher than those who do not participate in ball games in the control group through observation (Guo, 2019), the main reason is that ball games are sports with high skill requirements. Teenagers can greatly improve their self-confidence after completing difficult sports, which is conducive to improving their self-confidence and self-esteem. Participation in sports can enhance the structure and function of prominent cells in the nervous system of



the brain, improve the cognitive function of adolescents, and increase the speed of cognitive processing response of adolescents. Ball games are highly expressive sports. When teenagers complete superb dribbling and wonderful shooting actions, they will be applauded and praised by the audience. Such encouragement is conducive to improving their self-efficacy and shaping a complete personality.

Finally, in the social aspect, this paper included 11 articles, including quality of life, interpersonal relationship, social adaptation and so on. Through subgroup analysis, we found that the effect size of ball games on the social dimension of adolescents' mental health was moderate (SMD=0.43,95%CI:0.17, 0.69;  $P < 0.05$ ), the results were statistically significant. Ball games are team sports, which pursue team consciousness and fighting spirit, pay attention to mutual communication and cooperation among participants, and establish a platform for communication for teenagers, which can help teenagers establish good interpersonal relations. The team characteristics of ball games improve teenagers' communication ability. Experiments have shown that participation in ball games can improve teenagers' social adaptability and life satisfaction (Liu, 2019).

### **5.1.3 Explanation of the research results of ball sports intervention in adolescent mental health**

Through meta-analysis and systematic review, this paper concludes that ball games have a significant effect on adolescent mental health. The main research theories on the influence of ball games on adolescent mental health include physiological hypothesis and psychological hypothesis. Physiological hypotheses include amino acid neurotransmitter hypothesis, monoamine neurotransmitter hypothesis, intracranial neuropeptide hypothesis, and cardiovascular health hypothesis. First, the amino acid neurotransmitter hypothesis holds that exercise can cause changes in the concentration of amino acids in the blood, and peripheral amino acid changes can regulate the excitation and inhibition of the central nervous system, regulate the central nervous system and cognitive status, etc. Ball games can increase the concentration of amino acids in the blood of adolescents, thus affecting their cognitive function. However, more research is needed to confirm the regulatory relationship between specific amino acids and central neurotransmitters. Secondly, monoamine hypothesis, monoamine neurotransmitters mainly include adrenaline and dopamine, etc. Studies have shown that exercise can increase the release of monoamine neurohormones, which can affect the excitement of nerves, thus affecting the mental health of adolescents. Then, the neuropeptide hypothesis in the brain, which suggests that beta-endorphin is a pleasurable hormone associated with mood and also has an analgesic effect, that regular exercise, exercise intensity above 75% to 80% of the maximum oxygen intake or above 80% of the maximum oxygen intake, can trigger the



release of beta-endorphin to improve the mood of adolescents. There is also a neuropeptide Y, which may be the only endogenous anxiety-relieving substance that has a good effect in controlling anxiety and depression problems in adolescents. Finally, there is the cardiovascular system hypothesis, which suggests that ball games also have positive effects on adolescent mental health.

Psychological hypotheses mainly include mood improvement hypothesis, distraction hypothesis, cognitive behavior hypothesis, social interaction hypothesis, psychological control hypothesis and sports pleasure hypothesis. First of all, the hypothesis of improvement of mood state, which is explained in adolescent mental health, is that mood makes the emotional experience of adolescents in a lasting and weak state, and the exercise of ball games can improve this mental state in a short period of time and produce a better mental health state. Secondly, the distraction hypothesis suggests that ball games are highly interesting and confrontational, which can distract teenagers from the current state of worry and frustration and give them an outlet for negative emotions, so that they can devote themselves to sports to divert their attention and regulate their emotions. Then, cognitive-behavioral hypothesis, exercise can induce positive experience, can counter the chicken experience, so that adolescents get a healthy subjective experience, so that their psychological function is transformed, improve self-cognition. The hypothesis of social interaction is that only sports can build a communication platform, and ball games are teamwork and require high teamwork cooperation. Ball games can help teenagers improve their chances of interpersonal communication, which can make them happy, strengthen interpersonal communication and enhance social support. According to the psychological control hypothesis, ball games can provide adolescents with a good external environment, in which they can fully show themselves in ball games, win the applause of the audience, get the attention of parents and teachers, improve the sense of achievement and self-confidence of adolescents, and affect the self-esteem of adolescents, mainly pointing out the impact of environment on mental health.

Finally, sports pleasurable hypothesis, the research confirms that sports can bring good emotional experience to participants, and adolescents can get the pleasurable feeling of sports in ball games, which plays an important role in various positive indicators of adolescent mental health. Sports can improve the mental health of adolescents. Ball games, as the most popular and highly participated sports for adolescents, are in line with the international physical activity guidelines for children and adolescents, and are of great significance as a means to intervene in the mental health of adolescents.

## **5.2 Methodological related discussion**

This paper discusses the intervention effect of ball games on the mental health of adolescents, and obtains relevant studies on the intervention of ball

games on adolescents through database retrieval. The databases comprehensively searched include: China National Knowledge Network (CNKI), VIP database, Wanfang Database, PubMed, Embase, Biomedical Database (CBM), The Cochrane Library database, Web of Science database, etc. The main search method was computer search. Finally, there were 25 literatures that met the criteria included in this paper, but there were still some literatures that might not have been retrieved, such as some gray literatures and unpublished articles, which could not be obtained.

The included studies were evaluated for quality, and 25 original studies were selected for quality evaluation according to the Cochrane Evaluation manual. The evaluation results showed that all the 25 literatures on random allocation were of low risk, and the possibility of selection bias and experimental scheme allocation bias could be reduced by using random grouping. However, only a few studies have explained the method of random grouping, and the quality of random grouping could not be assessed. In terms of allocation scheme hiding, 1 paper is low risk and 24 papers are unclear. In the complete experimental scheme, neither researchers nor participants in the experiment are clear about the specific situation of random allocation, and only part of the relevant literature included in this paper mentions the specific hiding scheme. This has an impact on the evaluation of the correctness of the implementation of the random allocation scheme in the included literature, and there may be a certain selection bias. In terms of the use of blind method, 4 literatures are of low risk, 1 is single blind, 3 is double blind, and 21 literatures do not explain the blind method, which is unclear. The use of blind method in the literatures included in the study is unclear, and the specific implementation of blind method cannot be evaluated. And 21 of them did not mention the use of blindness which would have caused measurement bias; In terms of the integrity of the data results, 3 articles had subjects dropping out, which was a high risk; in the included studies, 3 articles had a high risk, which might lead to follow-up bias if the data were missing; 22 articles had a low risk for data integrity; In terms of selective reporting, 4 literatures were high risk and 21 were low risk, which may cause reporting bias. In terms of other sources of bias, all 25 papers were unclear risk. When the included literature was evaluated as a whole, the overall quality of the possible included studies was not high, so the analysis results of the studies suggested a possible risk of bias. Based on the publication bias detection of the results of this paper, Egger detection result  $P \geq 0.05$  indicates that there is no significant publication bias in this paper and the result is reliable.

After combining effect sizes in this paper, it was found that the I<sup>2</sup> of the overall effect size of the outcome indicators of the included original research literature was > 50%, indicating possible heterogeneity. Subgroup analysis found that this was caused by the intervention program and operating standards, such as the use of ball games as the intervention measure in the experimental group. Different intervention cycles were used at the time of intervention (e.g.

8, 10, 11, 15, 16, 18 weeks). Up to 48 weeks), different frequency of intervention (such as intervention frequency once a week, twice a week, three times a week, and four times a week), different duration of word intervention (such as 30 minutes, 60 minutes, 80 minutes each, 75 minutes each, and up to 120 minutes each), in addition, Different dimensions of mental health may also bring increased heterogeneity (such as emotional, psychological and social). Heterogeneity was explored through sensitivity analysis, and the influence of low-quality studies and small sample papers was excluded. The results of sensitivity analysis showed that the combined effect size results after the elimination of a single study still fell within the 95% confidence interval (95%CI: 0.09, 0.60). This paper showed that heterogeneity had no significant impact on the study results, and the results in this paper were robust and of reference significance.

## 6. Closing remarks

By means of systematic review and meta-analysis, Cuju-ball, a traditional Chinese health sport, was used to evaluate the effect of Cuju-ball on the intervention of adolescents' mental health. The main research results are as follows: (1) Through subgroup analysis, it was found that when ball games were used to interfere with adolescents' mental health, the exercise intervention period was longer than 18 weeks (SMD=0.66; 95% CI: 0.46, 0.87;  $P < 0.05$ ), when the frequency of exercise intervention was more than 3 times per week (SMD=0.57,95%CI: 0.31, 0.83;  $P < 0.05$ ) and exercise were controlled for 30-60 minutes, the ball game intervention program has the best effect on regulating and improving the overall level of adolescent mental health. (2) There are differences in the effects of ball games on the emotional, psychological and social dimensions of adolescent mental health. First, the effect on the psychological dimension of adolescent mental health was the best.

## 7. Conclusion

(1) Studies have shown that ball games can effectively regulate and improve the overall level of adolescents' mental health, and ball games have a positive effect on the overall level of adolescents' mental health. (2) The cycle, frequency, duration of a single intervention and the dimension of adolescent mental health are the factors that affect the effect of ball game intervention on adolescent mental health. Under the research background of "Football is Medicine", To provide evidence for ball games as an adjunct treatment of adolescent mental health. In terms of emotion, teenagers can regulate their emotions by participating in ball games, which provides a way for them to eliminate negative emotions; In terms of psychology, when teenagers participate in ball games, they can master technical movements or make achievements, which can help them get recognition, and thus have a positive impact on improving their self-efficacy. In terms of society, ball games provide

adolescents with a good platform for interpersonal communication, can help adolescents establish and maintain good interpersonal relationships, and improve their social adaptability, which has far-reaching significance. Therefore, in the future, relevant studies on the treatment and improvement of adolescent mental health should pay attention to the mental health benefits brought by ball games.

On the basis of exploring the influence effect, this paper provides suggestions for the formulation of sports programs. Subgroup results show that when the intervention cycle of ball game program design is selected, the effect is the best when the cycle is greater than 18 weeks. In terms of the frequency of intervention, by comparing the frequency of ball games conducted 1-4 times per week, the effect is the best when the cycle is greater than 3 times per week. In terms of the duration of a single intervention, the results showed that controlling the time of 30-60 minutes had the best effect on the adjustment of adolescent mental health. It is found that when the exercise program is designed and the intervention cycle is more than 18 weeks, the frequency of intervention is more than 3 times, and the duration of a single time is controlled within 30-60 minutes, it is the best exercise program to regulate and improve the mental health of adolescents.

## REFERENCE

- Berryman, J. W. (2010). Exercise is medicine: a historical perspective. *Current sports medicine reports*, 9(4), 195-201.
- Carvalho, A. P. V. d., Silva, V., & Grande, A. J. (2013). Avaliação do risco de viés de ensaios clínicos randomizados pela ferramenta da colaboração Cochrane. *Diagn. tratamento*.
- Coma-Bau, J., Baiget, E., & Segura-Bernal, J. (2023). ANALYSIS OF COHESION AND PERCEIVED BEHAVIOR IN PROFESSIONAL HANDBALL PLAYERS. *Revista multidisciplinar de las Ciencias del Deporte*, 23(89).
- Cumpston, M., Li, T., Page, M. J., Chandler, J., Welch, V. A., Higgins, J. P., & Thomas, J. (2019). Updated guidance for trusted systematic reviews: a new edition of the Cochrane Handbook for Systematic Reviews of Interventions. *The Cochrane database of systematic reviews*, 2019(10).
- Godavitarne, C., Robertson, A., Ricketts, D. M., & Rogers, B. A. (2018). Understanding and interpreting funnel plots for the clinician. *British Journal of Hospital Medicine*, 79(10), 578-583.
- Guo, X. (2019). Influence of extra-curricular ball game Training on self-confidence and self-efficacy of Middle school students. *Hubei Sports Science and Technology*, 39(03), 240-244.
- Hendriks, T., De Jong, J., & Cramer, H. (2017). The effects of yoga on positive mental health among healthy adults: a systematic review and meta-analysis. *The Journal of Alternative and Complementary Medicine*, 23(7),

505-517.

- Iyengar, S., & Greenhouse, J. (2009). Sensitivity analysis and diagnostics. *Handbook of research synthesis and meta-analysis*, 417-433.
- Krustrup, P., & Krustrup, B. R. (2018). Football is medicine: it is time for patients to play! In (Vol. 52, pp. 1412-1414): BMJ Publishing Group Ltd and British Association of Sport and Exercise Medicine.
- Liu, C. (2019). Study on the influence of ball games on the general social adaptability of rural left-behind children. *Henan Normal University*. doi:10.27118
- Shen, N. (2017). Comprehensive evaluation of meta-analysis -- statistical analysis and report specification analysis of meta-analysis and its original studies. *PLA Academy of Military Medical Sciences*.
- Shi, X., & Wang, Z. (2009). Comparison of the power difference of egger's test and begg's test and the reason analysis. *Acta Medicinae Universitatis Scientiae et Technologiae Huazhong*, 1, 91-93.
- Sterne, J. A., Gavaghan, D., & Egger, M. (2000). Publication and related bias in meta-analysis: power of statistical tests and prevalence in the literature. *Journal of clinical epidemiology*, 53(11), 1119-1129.
- Thompson, S. G., & Higgins, J. P. (2002). How should meta-regression analyses be undertaken and interpreted? *Statistics in medicine*, 21(11), 1559-1573.
- WANG, X., Guo, Q., Jin, Y., Li, Y., WU, H., & Ji, L. (2014). Theoretical origin and framework construction of Physical fitness promotion for Chinese adolescents. *Science of Sports*, 34(03), 3-14.
- Wang, Y. (2019). Introduction of Cochrane bias risk assessment tools. *Chinese Journal of General Medicine*, 22(11), 1322.
- Wei, L., & Duan, X. (2006). Application and prospect of meta-analysis in scientific research. *Productivity Research*(06), 144-146+210.
- Xie, Y. (2019). Tool rationalism orientation and dilemma of evidence-based medicine. *Journal of dialectics of nature research*, 35(11), 57-61. doi:10.19484/j.carol carroll nki.1000-8934.2019.11.011
- ZHANG, J., GE, L., ZHAO, Y., Wang, Y., ZHANG, J., & Tian, J. (2015). Brief introduction of PRISMA series report specification. *Chinese Journal of Pharmaceutical Evaluation*, 32(05), 257-261.
- ZHANG, S., Zhang, M., Fu, J., Zhang, Y., & Wang, B. (1993). Effect of injection of  $\mu$  or  $\delta$  opioid receptor activator into caudal putamen on operant conditioned reflex in rats. *Basic medicine and clinical*(05), 28-32.
- Zhu, Y., & Li, W. (2019). How clinicians interpret meta-analysis papers. *Concord Medical Journal*, 11(03), 314-319.