

Family Sports Interventions for the Treatment of Obesity in Childhood: A Meta- A Nalysis

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1 **Family sports interventions for the treatment of obesity in**
2 **childhood: A meta-analysis**

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28 **ABSTRACT**

29 **Background**

30 Obesity in children has become one of the key concerns of the World Health
31 Organization (WHO), and the incidence of related non-communicable diseases is also
32 rising.

33 **Objective**

34 This study evaluates the effect of family sports participation on the treatment and
35 prevention of obesity in children aged 0–14 years old by systematic analysis.

36 **Study Design**

37 Systematic analysis;Level of Evidence,4.

38 **Date Extration**

39 according to PRISMA-IPD (Preferred Reporting Items for MetaAnalyses of
40 individual participant data) guidelines.The two researchers independently assessed the
41 risk and bias of the articles, obtained a comprehensive, high-quality result,and
42 extracted the data based on the Cochrane intervention system review manual.

43 **Data Sources**

44 The databases used to search for literature are Google Scholar,CNKI, VIP,
45 Scopus,Embase,SpringerLink,Sciencedirect,Cochrane Library,Wanfang, PubMed, and
46 Web of Science. The last document search date was November 6, 2020.

47 **Study Selection**

48 Selection criteria following:Randomized controlled trials (RCTs) were selected from
49 the searches that used family sports interventions or family sports combined with
50 dietary adjustments and behavioral habits change. Only studies targeting overweight
51 or obese children aged 0–14 years were included.

52 **Main Results**

53 The search resulted in a total of 16 studies. Across all 16 studies, there were a total of
54 1,680 participants in the experimental groups and 1,701 participants in the control
55 groups. The results are as follows:body mass index (BMI)(SMD-RE = -4.10, 95% CI
56 (-0.84 ~ 0.02), Z = 1.88, P = 0.06); Body weight (SMD-RE = -0.77, 95% CI (-1.53 ~
57 -0.01), Z = 2.00, P = 0.05); Waist circumference (SMD-RE = -0.45, 95% CI (-1.36 ~
58 0.47), Z = 0.96, P = 0.34); Body fat rate (SMD-FE = -0.06, 95% CI (-0.22 ~ 0.11), Z =
59 0.69, P = 0.49). Hence, through family sports intervention among obese children,
60 juvenile and obese body composition—BMI, body weight, waist circumference, and
61 body fat rate—are all reduced.

62 **Conclusions**

63 Compared with the samples without family sports, the weight, BMI, body fat rate
64 and waist circumference of obese children participating in family sports decreased

65 **Keywords:** family sports, children, obesity, meta-analysis

66 **1. Introduction**

67 Over the last 40 years, childhood obesity has increased tenfold. The World
68 Health Organization (WHO) predicts that the number of obese children will increase
69 from 41 million in 2018 to a staggering 70 million by 2025, and the proportion of
70 overweight or obese people is worrying.¹ Obese children (aged 0–14) are the research
71 objects of pediatric obesity in the field of medicine.² Obesity has been linked to
72 internal environment disorder, gene variation, organ mutation, iatrogenic conditions,
73 viruses, environmental and behavioral characteristics, and performance genetics.³
74 However, the main mechanisms underlying childhood obesity are the consumption of
75 high-caloric food, remaining sedentary for extended periods of time, and
76 nonparticipation in physical activity and exercise⁴. When caloric intake is higher than
77 consumption, excess calories are stored in the body in the form of fat, which leads to
78 the imbalance of energy metabolism that results in obesity.^{5,6}

79 Presently, pediatric obesity treatment mainly attempts to limit energy intake by
80 changing a child's lifestyle.⁴ One of these lifestyle changes is engagement in family
81 sports. Family sports are organized and selected by family members to satisfy their
82 family's enjoyment of life and health needs through physical exercise activities,
83 effectively correcting children's bad habits and cultivating the participation in lifelong
84 sports⁷. Family sports intervention is commonly used in clinical medical experiments
85 for physical therapy aimed at certain diseases.⁵ Long-term family physical exercise
86 can reduce the incidence of cardiovascular diseases and chronic diseases in children.⁹

87 Families bear the basic social responsibility of raising and educating children.
88 Family sports is a supplement to school sports and plays an irreplaceable role. The
89 intervention object of family sports is not only for children, but also for parents.⁸
90 Parents play a key role in enabling their children's fitness, as they are responsible for
91 directly supervising and managing children's behavior. Parenting behavior (e.g., role
92 model behavior for imitation by children; setting rules and boundaries; etc.)
93 influences children's behavior and eating habits.⁹ Childhood behavior plays a
94 significant role in determining lifelong preferences and healthy behaviors, so it is
95 necessary to shape and form a good lifestyle as soon as possible.¹⁰

96 Parents or supervisors directly organize and enact physical activity plans to
97 realize off-campus sports activities. School sports supervision and organization of
98 children's physical activities are limited in time and space.⁸ The implementation of
99 school sports and community sports requires family sports to assist: The community

100 provides sports facilities and logistical support,¹¹ and relevant education departments
101 should continue to provide children and their families with opportunities for sports
102 and health education, improve their self-efficacy in participating in sports activities,
103 and support the ability of families to organize sports activities independently.^{11,12} The
104 organic integration of family-, school-, and community sports cultivates engagement
105 with sports resources inside and outside the school, creating a convenient environment
106 for children to participate in physical activities.¹³

107 In summary, the occurrence of obesity is closely related to lifestyle and
108 behavior habits³. Scientific family sports intervention is one of the most important
109 methods for treating and intervening in children's obesity.⁹ However, there is no
110 meta-analysis on children's obesity by family sports intervention, and it is impossible
111 to get a clear result analysis.

112 **2. Objective**

113 This paper uses a meta-analysis method to systematically evaluate the
114 intervention effect of family sports participation (single factor and multi-factor
115 assistance) on children's obesity through a meta-analysis. Specifically, we examine
116 how family sports intervention affects four key outcome indicators of obesity: body
117 mass index (BMI), weight, waist circumference, and body fat rate.

118 **3. Methods**

119 3.1 Data Sources and Searches

120 Example keywords searches include “Family Sports”, “Children”, “Obesity”,
121 and “Family Sports”, among others. The following databases were searched: China
122 National Knowledge Infrastructure (CNKI), VIP, Scopus, Wanfang, PubMed,
123 Embase, SpringerLink, Sciencedirect, Google Scholar, Cochrane Library and Web of
124 Science. The time period during which we searched the literature was 2006–2020.

125 We use the Web of Science search as an example in Table 1 to illustrate our
126 study's search strategy. In the basic search, each subject word was searched separately
127 from the free word, and then a combination search in the historical search was
128 performed. The index system included science citation index-expanded (SCI-E),
129 social sciences citation index (SSCI), arts and humanities citation index (A&HCI),
130 conference proceedings citation index-science (CPCI-S), conference proceedings
131 citation index-social sciences and humanities (CPCI-SSH), emerging sources citation
132 index (ESCI), current chemical reactions-expanded (CCR-E), and index chemicus
133 (IC). The time span reflected all active years of research.

134 The results were exported and supplemented with literature tracing, manual
135 search, and other methods to collect the text. A total of 4,311 documents were
136 retrieved. We used the endnoteX8 document management software to organize and

137 review the documents. After reading the document titles, keywords, and abstracts, we
 138 excluded documents that were not related to the research intervention method,
 139 population, or research purpose of this topic, resulting in a sample of 125 papers.
 140 Finally, we excluded the data that did not sufficiently meet our statistical requirements
 141 for analysis. This resulted in a final sample of 16 papers.

142 Across all studies, the baseline of the experimental group and the control
 143 group were parallel and comparable, and all were clearly described.

144 **Table 1. Web of science keyword search information statistics.**

Retractable	Search results	Keywords
#4	3915	#1AND#2AND#3
#3	1897272	Child* OR Adolescent
#2	58718	Family physical OR Family is sport OR Family physical education
#1	511120	Obesity OR Appetite depressants OR Body weight OR Lipectomy OR Bariatrics OR Skinfold thickness OR Anti-obesity

145

146 3.2 Inclusion Criteria

147 Next, we looked to incorporate the literature in the PICOS paradigm, which is
 148 reflected as follows:

149 (P) Population. The research population is children (0–14 years old) with
 150 obesity. There are no restrictions on the gender and race of the study
 151 population.

152 (I) Intervention. The purpose of physical exercise through the family sport
 153 intervention is to meet a given family's needs for both enjoyment and, more
 154 importantly, physical health. Examples of family sport intervention. includes
 155 aerobic exercise, confrontation training, high-intensity interval training and
 156 continuous training, low-intensity large-volume exercise, etc.

157 (C) Control. The experimental structure relies on the intervention of family
 158 sports participation or family sports combined with other interventions (diet
 159 adjustment, behavioral habits intervention). The control groups saw no
 160 interventions.

161 (O) Outcomes. The outcome index of treatment effects includes one or more
 162 of the following four obesity indicators: BMI, weight, waist circumference,

163 and body fat rate.

164 (S) The experiments were designed as randomized controlled trials.

165

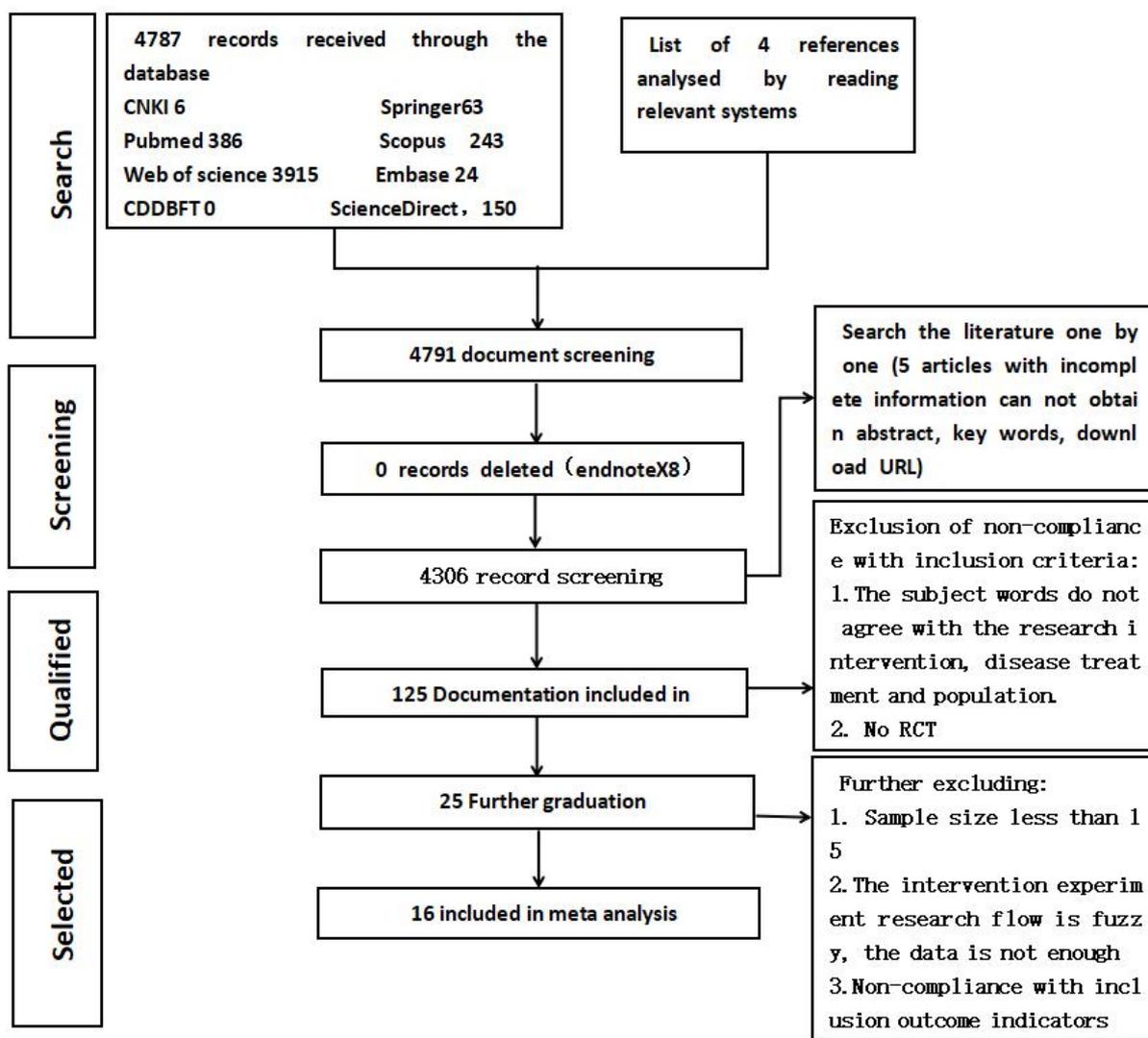
166 3.3 Exclusion Criteria

167 The process of document selection and inclusion is shown in Figure 1.
168 EndnoteX8 document management software was used to organize and review the
169 documents, read the document titles, keywords, and abstracts, and exclude documents
170 that were irrelevant to the research intervention method, population, or research
171 purpose of this topic. The Chinese literature search was restricted to core journals,
172 SCI, CSCI, CSCD. Non-Chinese studies was assembled from SCI-E, SSCI, A&HCI,
173 CPCI-S, CPCI-SSH, ESCI, and CCR-E.

174 Studies that emerged from the search results were excluded if they were not
175 RCTs, had a sample size of less than 15, or whose research flow with regard to the
176 intervention experiment was vague. Additionally, studies were excluded whose
177 outcome indicators did not have one of the four indicators of BMI, weight, waist
178 circumference, and body fat rate. There are no four indicators in the outcome
179 indicators of the study. There are baseline data, lack of outcome data and incomplete
180 data in the research results.

181 3.4 Incorporate basic literature information

182 After screening, there were 16 documents that met the inclusion criteria. Table
183 2 provides an overview.



184

185

Figure 1. Flowchart of literature screening

Table 2. Basic information statistics included in the literature

Author, Year	n	Intervention/Control details	Age	Intervention	Outcome variable(S)
Rong Xiujuan et al. 2007	140	Intervention group, n=70 Control group, n=70	3-6	Family sports, diet adjustment, behavior habits intervention	weight
Zeng Ting et al. 2013	70	Intervention group, n=35 Control group, n=35	3-6	Family sports, diet adjustment, behavior habits intervention	waist circumference BMI
Luo Juanjuan et al. 2017	92	Intervention group, n=42 Control group, n=50	0-6	Family sports, diet adjustment,	BMI
Wang Zhen 2016	120	Intervention group, n=60 Control group, n=60	3-6	Family sports, diet adjustment, behavior habits intervention	weight
Saelens et al., 2011	29	Intervention group, n=15 Control group, n=14	7-11	Family sports, diet adjustment	weight, body fat rate BMI, waist circumference

Rodearmel et al. 2015	218	Intervention group, n=116 Control group, n=102	7–14	Family sports, diet adjustment	weight, body fat rate BMI, waist circumference
Anthony D. Okely, et al. 2010	102	Intervention group, n=60 Control group, n=42	5.5–9.9	Family sports, diet adjustment,	weight, BMI, waist circumference
Ahmad et al. 2018	122	Intervention group, n=64 Control group, n=58	8-11	Family sports, diet adjustment, behavior habits intervention	body fat rate
Abbey Alkon et al. 2014	552	Intervention group, n=260 Control group, n=292	3-5	Family sports, diet adjustment	BMI
Döring et al. 2016	1014	Intervention group, n=458 Control group, n=556	0-4	Family sports, diet adjustment, behavior habits intervention	BMI, waist circumference
Nyström et al. 2018	263	Intervention group, n=133 Control group, n=130	4.5	Family sports, diet adjustment	weight
Sacher et al. 2010	116	Intervention group, n=60	8-12	Family sports, diet adjustment	body fat rate BMI, waist circumference

		Control group, n=56			
Oliva et al. 2014	306	Intervention group, n=168 Control group, n=138	2-5	Family sports, diet adjustment	BMI
Jyu-Lin Chen et al. 2009	67	Intervention group, n=35 Control group, n=32	8-10	Family sports, diet adjustment,	BMI
Amy L et al. 2015	80	Intervention group, n=59 Control group, n=21	8-12	Family sports, diet adjustment,	Waist circumference、 BMI
Epstein et al.	90	Intervention group, n=45 Control group, n=45	8-12	Family sports, diet adjustment, behavior habits intervention	Weight、 Body fat rate

Table 3. Statistics of basic information of family sports

Aged 0–6 years				
Author	Frequency, Times/Week	Time (min)	Intensity	Program
Zeng ting et al.	≥5	>20	Low to medium intensity	Aerobic exercise such as cycling, jogging, climbing stairs, walking, etc.
Luo Juanjuan et al.	No	No	No	Implementation according to sports training plan
Abbey et al.	7	60	Medium to high strength	Moving sports balls, tricycles
Gloria et al.	7	120	No request	Running, jumping, walking, playing ball, swimming, dancing, etc.
Christine et al.	7	>60	Medium to high strength	Physical activity, mobile wear accelerometer for recording
Nora et al.	7	60	Medium to high strength	Physical activity, no specific sports regulations, the physical activity boundary is 3908cpm, light physical activity of 820 to 3907cpm.
Rong Xiujuan et al.	7	60	Medium intensity	Walk, run, jump, kick, climb stairs

Wang Jian	7		Stop after completing the target task	Low to medium intensity	Walking, running, jumping, climbing stairs
Aged 7–14 years					
Saelens et al.	6	60-90		Medium to high strength	Wear an acceleration calculator to calculate physical activity
Susan J. Rodearmel, et al	7		Stop after completing the target task	Low to medium intensity	Record with pedometer, Walking more than 22,000 steps a day
Anthony D, et al.	Not explained		Not explained	Not explained	Physical activity skills
Norliza ,et al.	4	30		Medium to high strength	Sports skills training
Paul M, et al.	7	25		High strength	Sports activities ,no specific sports regulations
Jyu-Lin Chen,et al.	No	15		No request	Game-based sports activities ,including non-competitive dance, brisk walking and skipping
Amy L,et al.	5	60		No request	Physical exercise games/traditional sports ,for example yoga, body pumps, spinning classes and group sports games

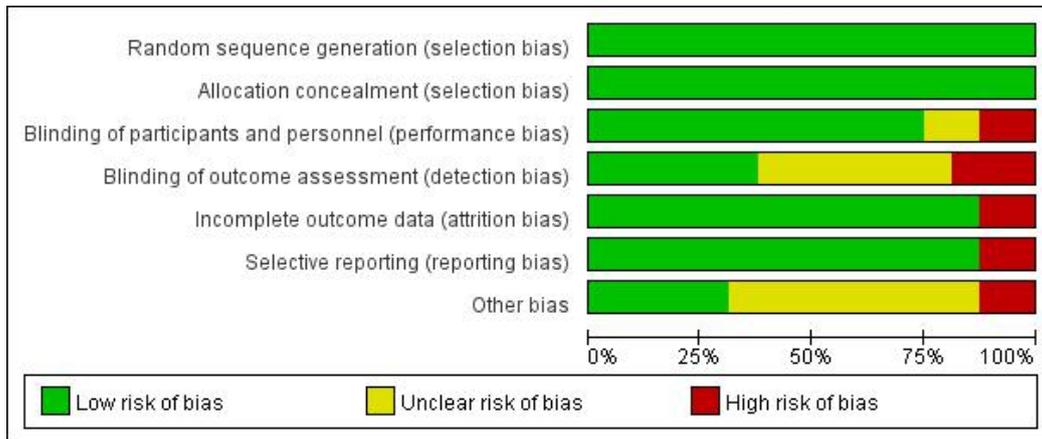
Epstein et al.	7	≥ 30	Medium to high strength	16.1 or 32.2 kilometers , 10 or 20 miles per week
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1 3.5 Literature risk and assessment

2 The literature risk quality evaluation of the 16 studies include:

- 3 • the selection of random methods;
- 4 • whether there was implement allocation concealment;
- 5 • whether the participants and staff were blind;
- 6 • whether the results were assessed using a blind method;
- 7 • whether there were incomplete reporting outcomes;
- 8 • whether there were selective reporting and other deviations.

9 Figures 2-1 and 2-2 show that the overall quality risk from the literature is low.
10 The risk bias summary chart shows that two of the articles (Döring et al. 2016, and
11 Sacher et al. 2010) have high risk bias. We document that because of the close
12 interaction between family members and research members, participants were aware
13 of the measurement method, which directly precludes blind measurement.



14

15

Figure 2-1. Risk bias diagram

Study	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Abbey 2014	+	+	+	+	+	+	+
Amanda E2017	+	+	+	+	+	+	+
Amy L 2015	+	+	+	+	+	+	+
Anthony D2010	+	+	+	+	+	+	+
BRIAN E. SAELENS2011	+	+	+	+	+	+	+
Christine 2018	+	+	+	+	+	+	+
Epstein LH, Paluch RA, Gordy CC, Dom J2000	+	+	+	+	+	+	+
Gloria 2014	+	+	+	+	+	+	+
Jyu-lin chen2009	+	+	+	+	+	+	+
Luo Juan Juan2017	+	+	+	+	+	+	+
Nora 2016	+	+	+	+	+	+	+
Norliza 2018	+	+	+	+	+	+	+
Paul M2010	+	+	+	+	+	+	+
Rong Xiu Juan2007	+	+	+	+	+	+	+
Susan J 2015	+	+	+	+	+	+	+
wang Jian2016	+	+	+	+	+	+	+
Zeng Ting2013	+	+	+	+	+	+	+

Figure 2-2. Summary of risk bias

4. Results

4.1 The impact of family sports intervention on children's BMI

From the perspective of clinical analysis, the intervention population of each literature has a relatively large span. Ages are divided into two subgroups of 0–6 years and 7–14 years for data processing and analysis. As can be seen from the forest chart in Figure 3, the participation of family sports has a significant impact on the BMI of obese children.

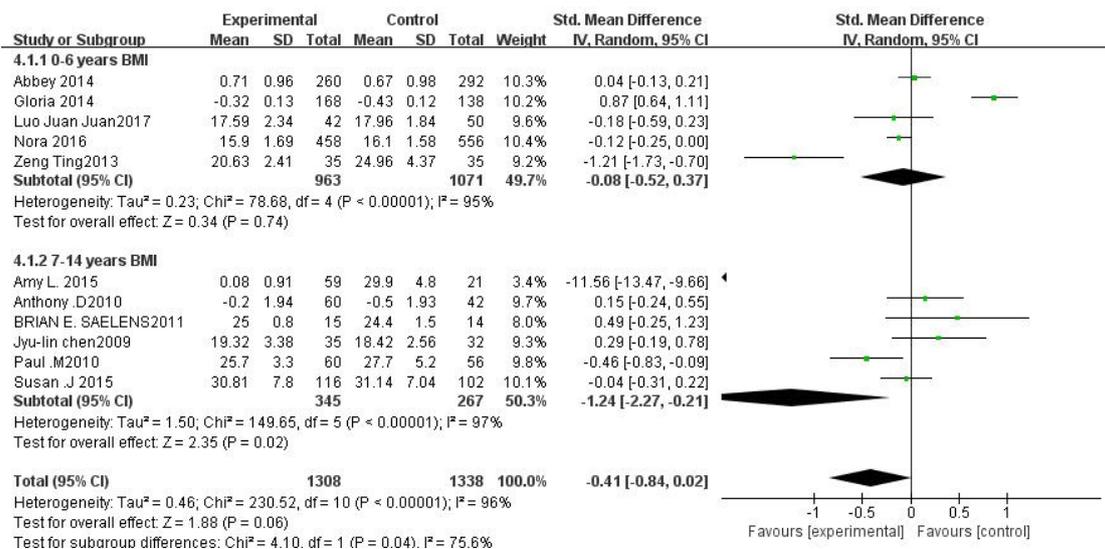
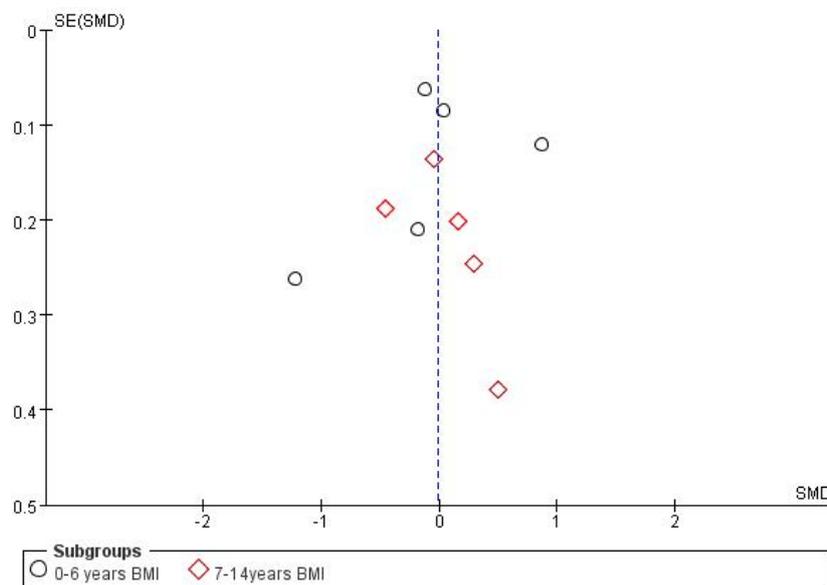


Figure 3. Outcome indicators BMI (0-6 years old, 7-14 years old) forest map of two subgroups

28 For the 11 articles included in this analysis, the outcome index BMI system
 29 shows $\chi^2=0.46$, $df=10$, $P<0.00001$, $I^2>50\%$. The heterogeneity of the included
 30 literature is relatively high, and it can be analyzed with a random effects model.
 31 $SMD-RE = -0.41$, 95% CI (-0.84 ~ 0.02), $Z = 1.88$, $P = 0.06$, which is not statistically
 32 significant. Among them, there are 6 subgroups of 0–6 years old and 5 subgroups of
 33 7–14 years old, respectively. There were 1,308 experimental groups and 1,337 control
 34 groups.

35 Meta-results of 11 literature subgroups show $\chi^2 = 4.10$, $df = 1$, $P = 0.04$, $I^2 =$
 36 75.6% , and moderate subgroups differences decreased less. We exclude each article
 37 piecemeal to check the sensitivity and observe the results of the effect size change.
 38 The research results show that the merged results are highly robust. The total statistics
 39 reflect the overall situation of the 11 studies, and the effect differences between the
 40 experimental group and the control group is higher.

41 The results show that the intervention of family sports can reduce the BMI of
 42 obese children. Figure 4 shows two subgroup funnel charts: The white dots and red
 43 dots are concentrated in the middle and top of the vertical axis of the graph, indicating
 44 that the sample size is large, indicating greater accuracy. Hence, it is closer to the true
 45 value, and the distribution of points is relatively concentrated. Specifically, we
 46 observe that the publication bias of the above literature is low.



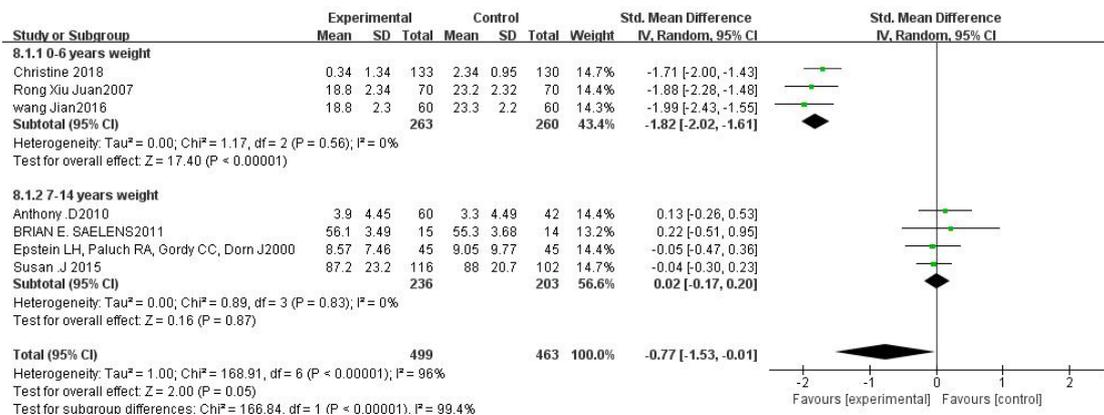
47
 48 **Figure 4.** Funnel chart of two subgroups of outcome indicators BMI (0-6 years old,
 49 7-14 years old)

50

51 **4.2 The effect of family sports intervention on children's weight**

52 The forest chart in Figure 5 shows that family sports participation has a

53 significant impact on the weight of obese children. A total of seven articles were
 54 included in this analysis. The outcome index weight system analysis shows: $\chi^2 = 1.00$,
 55 $df = 6$, $P < 0.00001$, $I^2 > 50\%$. The heterogeneity of the included literature is relatively
 56 high and can only be analyzed with a random effects model.



57
 58 **Figure 5** Outcome index weight (0-6 years old, 7-14 years old) forest map of two subgro
 59 ups

60 The seven studies on the influence of body weight show $\text{SMD-RE} = -0.77$,
 61 $95\% \text{ CI} (-1.53 \sim -0.01)$, $Z = 2.00$, $P = 0.05$, which has statistical significance. The
 62 intervention group and the control group have significant differences before and after
 63 the intervention. After excluding each article one by one to check the sensitivity, we
 64 observe no change in the result of the effect size, indicating that there is no literature
 65 to be excluded.

66 Additional evaluation shows that the results of the literature data merger are
 67 more robust. Among them, there are three sub-groups for 0–6-year-old children and
 68 four sub-groups of 7–14-year-old children. There were 499 experimental groups and
 69 463 control groups.

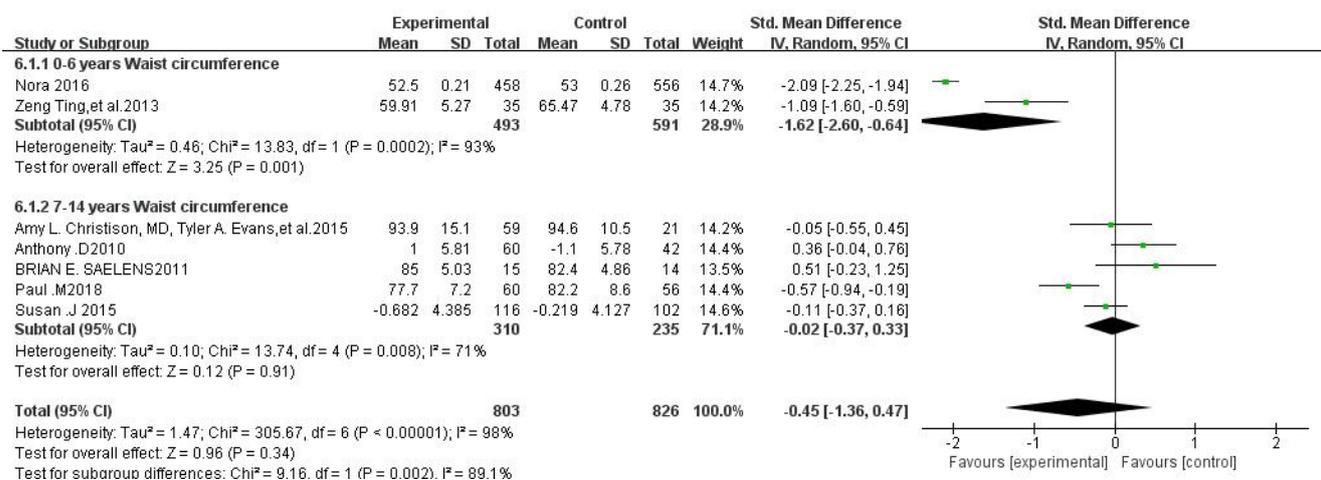
70 Results of the meta-analysis show that for 0–6-year-old children indicates that
 71 the heterogeneity is almost zero ($p=0.56$, $I^2=0\%$), whereas 7–14-year-old children
 72 group possesses greater heterogeneity ($p=0.83$, $I^2=0\%$). The difference between the
 73 two subgroups and the total subgroup indicates the heterogeneity of the systematic
 74 analysis of the subgroup literature ($P < 0.00001$, $I^2=99.4\%$). The diamond shape falls in
 75 the experimental group, which shows the effect analysis of the two sub-combinations.
 76 The difference between the experimental group and control group clearly shows that
 77 participation in family sports has a significant effect on weight loss in obese children.

78 4.3 The effect of family sports intervention on the waist circumference of children

79 As can be seen from the forest map in Figure 6, participation in family sports
 80 has a significant impact on the waist circumference of obese children. A total of 7
 81 articles were included in this analysis. The outcome index weight system analysis

82 shows that the heterogeneity of the included literature is relatively high and can only
 83 be analyzed with a random effects model ($\chi^2 = 1.47$, $df = 6$, $P < 0.00001$, $I^2 > 50\%$).
 84 Seven articles on the impact of waist circumference show that a significant effect is
 85 not obvious (SMD-RE= -0.45, 95% CI (-1.36 ~ 0.47), $Z = 0.96$, $P = 0.34$). The
 86 diamond on the forest map leans to the left in the associated forest chart (Figure 7),
 87 which shows that there is a significant difference between the experimental group and
 88 the control group after the experiment. This difference is significant before and after
 89 the experiment.

90



91

92 **Figure 6.** Two subgroup forest charts of outcomes indicators waist circumference (0-6
 93 years old, 7–14 years old)

94

95 By excluding each article one by one to check the sensitivity, we observe that
 96 the result of the effect size has no change. The consolidation result of the data from
 97 each article is robust. Among them, there are two subgroups of 0–6 years old and five
 98 subgroups of 7-14 years old. There were 803 experimental groups and 826 control
 99 groups. Results of the meta-analysis sub-grouping indicate that the heterogeneity risk
 100 of systematic analysis of the subgroup literature is still high ($P = 0.002$, $I^2 = 89.1\%$).

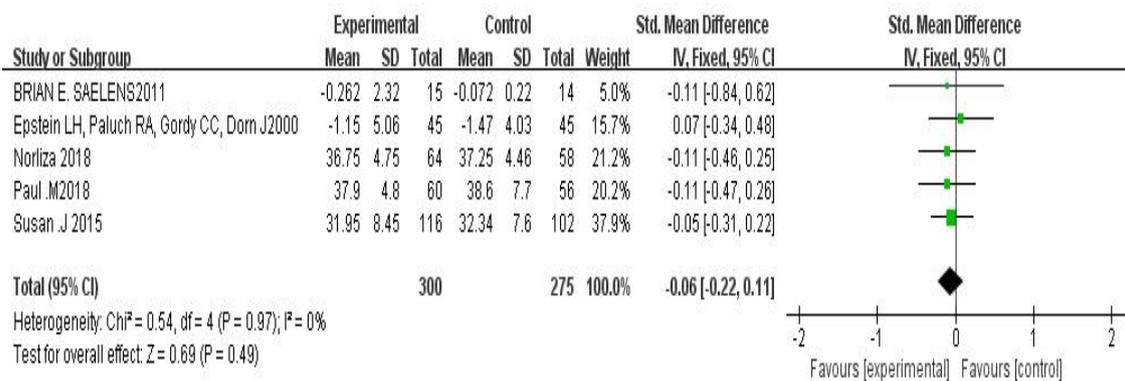
101 The effect of the two sub-combinations is then analyzed. According to the
 102 total results, the difference between the experimental group and the control group is
 103 high, and the diamond on the forest map falls on the left side. The results show that
 104 participation in family sports has a significant effect on the waist circumference of
 105 obese children.

106

107 **4.4 The effect of family sports intervention on the body fat rate of children**

108 As can be seen from the forest map in Figure 7, family sports participation has

109 a significant impact on the weight of obese teenager. A total of five articles were
 110 included. The age of the population belongs only to the 7–14-year-old children group;
 111 hence, no subgroup analysis of age was required. The experimental group included
 112 300 children, and 275 participants were in the control group. Outcome indicators
 113 systemic analysis of body fat rate shows: $\chi^2 = 0.54$, $df = 4$, $P = 0.97$, $I^2 < 50\%$.



114

115 **Figure 7.** Forest map of outcome index body fat percentage

116

117 The homogeneity of the included literature is high, using a fixed effect model
 118 analysis. Five articles on the impact on body weight show: $SMD-FE = -0.06$, 95% CI
 119 $(-0.22 \sim 0.11)$, the total effect value $Z = 0.69$, $P = 0.49$. The statistical analysis shows
 120 no significance.

121 After excluding each article to check sensitivity, we find no change in the
 122 results of the effect size, indicating that there is no literature to be excluded, and the
 123 evaluation shows that the results of the literature data merger are relatively robust.
 124 The total effect of diamonds falls in the experimental group, indicating that the data
 125 results are significantly different between the experimental group and the control
 126 group before and after the experiment. The participation in family sports has a
 127 significant effect on the reduction of body fat rate in obese children.

128

129 5. Discussion

130 This project reflects the first comprehensive meta-analysis of the impact of
 131 family sport intervention on childhood obesity using a quantitative synthetic statistical
 132 method. We reviewed 16 RCT studies where the focal intervention method (family
 133 sports participation) and other intervention measures (diet adjustment and behavioral
 134 habit intervention) were used to treat and prevent obesity of children. The
 135 experimental intervention periods lasted at least three months.

136 We specifically select four common measurement indicators for meta-analysis
 137 across both age groups. Our analysis shows that the combined results of interventions

138 on body weight are statistically significant, but the combined results of interventions
139 on BMI, waist circumference and body fat rate are not statistically significant. The
140 combined effect falls on the left side of the experimental group, indicating that the
141 intervention of the experimental group can effectively reduce measures of obesity
142 such as BMI, weight, waist circumference, and body fat rate.

143 Our meta-analysis of increasing children's physical activities shows a similar
144 intervention effect as that of Brown, which studied the family-based intervention
145 measures and found that children's physical activity level is increased through family
146 participation.¹⁵ Additionally, Pamungkas studied family-based treatment and
147 prevention interventions on children's obesity: Systematic review and meta-analysis
148 disclose that family management can increase the frequency of physical activity and
149 reduce sedentary time.⁹

150 The main purpose of family exercise therapy is to reduce the total fat content
151 and visceral fat content of children and parents, increase the lean body weight,
152 accelerate the consumption of excess energy in the body, maintain the balance of
153 energy in the body, improve the level of resting metabolism, improve the level of lipid
154 metabolism, and reduce metabolic and cardiovascular complications.

155 When designing family exercise interventions, exercise training should reflect
156 children's growth and development rules, as well as age and gender differences, in
157 order to appropriately enhance their physical health. For example, aerobic training,
158 anti-group training, or combined exercise training are mainly used in home sports
159 studies, and both types of exercise can effectively reduce total fat. However,
160 resistance exercise is more effective in increasing lean body weight and reducing the
161 proportion of body fat.

162 Additional designs and suggestions for family exercise prescription for
163 treating childhood obesity are summarized in the following paragraphs.

164 Neral suggests principles to govern the use of family exercise therapy:

- 165 1. The principle of safe exercise should try to avoid sports injuries.
- 166 2. The principle of training plan arrangement varies from person to person.
- 167 3. The principle of gradual and orderly training load arrangement.
- 168 4. Develop the principle of good behavior habits, reduce sedentary behavior
169 and increase physical activity.
- 170 5. Promoting overall health is the first principle.

171 Likewise, the Korean pediatric obesity group offers four strategies for exercise
172 therapy:

- 173 1. Physical activity time should not exceed one hour. Young children
174 participate in unstructured sports activities and older children participate in

- 175 recreational sport activities.
- 176 2. Exercise for one hour every day in an organized and planned way under
177 parental supervision.
- 178 3. Clarify the goal of physical activity in multidisciplinary obesity treatment,
179 and make exercise plans for negative energy balance.
- 180 4. Appropriate exercise therapy strategies can be selected according to
181 children of different ages and obesity degree.

182 Table 5 shows that the five factors considered in the design of family exercise
183 prescription for obese children are exercise mode, exercise frequency, progressive
184 load, exercise intensity, and duration.¹⁷ Family sports is characterized by varied and
185 convenient daily physical activities wherein family members are encouraged to
186 participate with children to increase physical activities, and children are the targets for
187 intervention.

188 Generally, obese children's primary exercise is arranged to walk for 10
189 minutes every 3–5 days, gradually increasing to exercise frequency every day.
190 Exercise duration should be 60–80 minutes, with medium and high intensity
191 (55%–90% maximum heart rate) as the main factor. The monitoring and evaluation of
192 exercise tasks provide records of goal tables and create an exercise log (space,
193 duration and prescribed training means of behavioral goals).

194 We also offer a number of suggestions for how to prescribe specific exercise
195 regimens for children based on our research. These include:

- 196 1. Develop appropriate exercise load according to children's obesity and
197 children's physical fitness (especially patients with back, knee and heel
198 pain) to avoid joint injury.
- 199 2. Pay attention to the foundation of children's early sports in order to
200 cultivate healthy habits, interest in sports, and the concept of lifelong
201 sports.
- 202 3. Pay attention to the growth and development of different ages and changes
203 in human body composition.

204 For the treatment of childhood obesity, the main means are to increase
205 physical activity and limit calories.¹⁷ Specifically, obese children should focus on
206 increasing lean body weight and reducing the proportion of body fat. These children
207 should strictly follow the sequence of sports training (preparation activities-intensive
208 training-relaxation and stretching) and use social resources (environment, venue,
209 facilities, media learning, etc.).¹⁹⁻⁴⁸ Diet therapy can help limit the total calorie intake
210 of patients. Behavioral therapy can help patients improve sedentary behavior and lack
211 of dyskinesia, and cultivate healthy eating and behavior habits.⁶ The foundational
212 elements of these behavior change skills include self-monitoring, goal setting,
213 self-efficacy, problem solving, recurrence prevention, and stimulation control.¹⁶

214 **Table 4.** Family sports treatment strategies according to age and the degree obesity
 215 in children

Age group	Degree of obesity	Basic training	Intensive training
Infant (<2 years old)	Weight for height \geq 95th pc	Preventive precautions	Preventive precautions
Early childhood (2-5 years)	BMI 5–84th pc BMI 85–94th pc risk \emptyset BMI 85–94th pc risk present BMI \geq95th pc	Preventive precautions Preventive precautions Step 1 Step 1	Preventive precautions Preventive precautions Step 2 Step 3
Childhood (6-14 years)	BMI 5–84th pc BMI 85–94th pc risk \emptyset BMI 85–94th pc risk present BMI 95–99th pc BMI \geq 99th pc	Preventive precautions Preventive precautions Step 1 Step 1 Step 1 Parents participate in the selection of the second or third steps	Preventive precautions Preventive precautions Step 2 Step 3 Step 3 Parents participate in the fourth step of choice
The Korean Pediatric Gastroenterology Hepatology and Nutrition Obesity Group classified obesity treatment and exercise strategies in four steps			

Table 4. Family sports plan for treating childhood obesity

Items and prescriptions	Aerobic exercise	Resistance movement	Physical activity	Stretching	Mixed motion
Exercise mode	Skateboard, racket, dance, basketball, football, volleyball, tennis, swimming, gymnastics, skipping, cycling, walking, hiking, skipping, climbing, running, kicking, and stair climbing	Rope climbing, tree climbing, rock climbing, push-ups, weightlifting, and boating	Children go to school on foot, play at rest, go hiking, walk with dogs, clean houses, park in farther places, walk dogs, use stairs instead of elevators or escalators)	Yoga, dance, gymnastics	Competitive games, recreational skills learning (judo), dual tasks and mini sports games
Progressive load	Medium to high strength	high strength (50-70% MVC)	Low to medium strength	Medium to low intensity	Moderate to severe intensity
Motion frequency	≥3 times a week	2-3 times a week	Everyday	≥5 times a week	2 times a week
Exercise intensity	Medium and high strength	Medium and high strength	Medium and low strength	Low-intensity	Moderate intensity to severe intensity, the intensity is 65- 75% of the maximum heart rate (HR)
Duration	20 -90min	2-3 minutes (8-20 times in each group, total times ≥30)	≥ 20 min	10 min	60min
Other	Wear a pedometer (measuring steps and stepping time)	Exercise major muscle groups	not feel excessive fatigue, so as to avoid excessive	No clear exercise prescription	Portable hr detector

MVC: Maximum voluntary contraction. **The content of the family training schedule comes from the literature that meets the standards and the literature that adopts family sports/exercise intervention to treat and prevent childhood obesity.**

6. Limitations

There were some difficulties in interpreting and producing high-quality data. In 16 studies, the subgroup analysis of each outcome index by age showed that BMI, body weight, and waist circumference were more heterogeneous, and the body fat rate was more homogeneous.

At the research level and outcome level, we discuss the evidence of the entire study from the perspective of high risk. Two articles (Döring et al. 2016 and Sacher et al. 2010) have high risk bias. Participants and staff guide the experiments, and the resulting evaluation is not blind. The results of the report are not comprehensive, and some reports are optional statements.

Seven of the documents did not explain whether they were blind to the staff, and thus there might be a high risk of bias. Only four documents had a low risk of bias. At present, a long-term randomized controlled study on family sports as the main single factor intervention for juvenile obesity is currently being run. There are only experimental plan reports, and the results have not yet been obtained.¹² The differences in the degree of intervention of family sports combined with diet and behavior intervention and the length of intervention (3–39 months) lead to differences in the effect of outcome indicators.

There are also great differences in the level of evidence found in the research results, and the high risk of heterogeneity may be caused by the specific intervention populations and measures. These intervention populations have ethnic differences, the family economic level is inconsistent, the age span of children is large. Moreover, the physiological development speed of men and women is different, which may affect obesity levels across gender. Most studies do not limit the spread of growth, social factors, and family class to the outcome indicators.

Additionally, the intervention measures are composed of different exercise forms and different exercise doses, so it is impossible to judge whether the above key factors have potential influencing effects. The above evidence is insufficient and threatens the high quality of results. At the same time, the sensitivity of each included outcome index is checked one by one, and the heterogeneity changes are analyzed and observed. Some individual studies indicate potential instability, which may bias the overall results.

7. Conclusion

A meta-analysis of 16 studies showed that participation in family sports and other interventions significantly improved the body composition (BMI, weight, waist circumference, body fat index SMD and CI values) of children and adolescents.

Specifically, this intervention shows better results for obesity treatment and prevention of obesity in children. However, the evidence is limited with high heterogeneity and bias in the literature, and no adverse events have been documented.

The 16 papers included in this study use a variety of intervention methods. Six studies use family sports, behavioral habits, and dietary adjustment for joint intervention, and 10 studies use only family sports intervention and dietary adjustment for intervention. The meta-analysis shows that the intervention effects of family sports intervention, dietary intervention, and behavioral habits alone are not as efficient as those of the combinations.¹⁸

The research of the treatment and prevention of childhood obesity by British health improvement institutions mainly focuses on five topics:

1. Family sports activities and interventions encourage and promote health.
2. Family planning, taking parents' as the main change element.
3. Family behavior correction procedures.
4. Behavior correction subjects are children.
5. Exercise treatment scheme.²⁰

In summary, we find that family sports interventions are effective as prevention mechanisms and the continuous treatment of childhood obesity. However, this places family at the center of the intervention, as they are required to provide continuous exercise therapy, thereby cultivating an exemplary teaching environment for children in shaping their behavior habits. Family members are encouraged to supervise and manage the implementation of children's sports plans.

Moreover, long-term regular interaction generates a healthy and close relationship between parents and children. In other words, family activities have a positive impact on children's growth, and intervention measures based on family sports can prevent children's obesity and act as an integral part of weight loss.

In the future, long-term sports training plans for children with obesity should be implemented. Relevant government departments and education departments should provide sports professional knowledge, behavioral intervention guidance, and continuous education support to instill knowledge of nutrition and empirically backed exercise regimens for children in different obesity treatment periods.

Additionally, it is necessary to further study the efficiency of different forms of family sports intervention measures and avoid possible adverse events. In order to find more efficient treatment and prevention of childhood obesity, it is necessary to constantly practice and innovate the methods and means of family sports. Follow-up research should examine large-scale clinical trials with family sports as a single factor intervention, which are needed to provide stronger evidence of the intervention effect.

Declarations

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

Availability of data and material

Please contact author for data requests

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

T.L. and X.M. conceived and designed the project. Y.L, Y.N., X.Q., collected the data. Y.L. and Y.N. performed analyses. Y.L. drafted the manuscript. All authors have read and approved the manuscript.

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List of abbreviations

Abbreviations	Expanded
RCTs	Randomized controlled trials
CNKI	China National Knowledge Infrastructure
SCI-E	science citation index-expanded
SSCI	social sciences citation index
A&HCI	arts and humanities citation index
CPCI-S	conference proceedings citation index-science
CPCI-SSH	conference proceedings citation index-social sciences and humanities
ESCI	emerging sources citation index
CCR-E	current chemical reactions-expanded
IC	index chemicus
WHO	World Health Organization
BMI	Body Mass Index

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