

Effects of Family Intervention on Physical Activity and Sedentary Behavior in Children Aged 2.5-12 Years: A Meta-Analysis

Ting Huang

School of Physical Education, Nanchang University <https://orcid.org/0000-0003-0160-5661>

Guanggao Zhao

School of Physical Education, Nanchang University

Zhiqiang Guo

School of Physical Education, Nanchang University

Hua Wu

Rehabilitation Medicine Center, The Second Affiliated Hospital of Jiaxing University

Jinmei Fu

Jiangxi Research Institute of Sports Science, Nanchang Jiangxi

Shunli Sun

Jiangxi Research Institute of Sports Science, Nanchang

Wendi Lv

School of Physical Education, Nanchang University

Zihao He

School of Physical Education, Nanchang University

Qiming Hu

School of Physical Education, Nanchang University

Minghui Quan (✉ quanminghui@163.com)

Shanghai University of Sport

Research article

Keywords: physical activity, family intervention, meta-analytic review, parents

Posted Date: December 8th, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-122533/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License. [Read Full License](#)

Abstract

Background: To use a quantitative approach to examine the effects of family interventions on physical activity (PA) and sedentary behavior (SB) in children aged 2.5-12 years.

Methods: PubMed, OVID, Web of Science, and others were searched from their inception to May 2020. Intervention studies that examined the effects of family interventions on PA among children aged 2.5-12 years were included in this meta-analysis. Lastly, subgroup analyses were conducted to examine the potential modifying effects of family intervention's characteristics and study quality.

Results: Eleven articles met the inclusion criteria for this review. Studies investigated a range of PA outcomes, including moderate-to-vigorous PA (MVPA), total PA (TPA), daily steps, and SB levels. Meta-analysis showed that family intervention had a significant effect on PA [standardized mean difference (SMD)=0.10; 95%CI=0.01, 0.19], especially for daily steps [weight means difference (WMD)=1,006; 95%CI=209, 1,803], but not for SB (WMD=-0.38; 95%CI=-7.21, 6.46). Subgroup analyses indicated the improvements in PA occurred when children were 6-12 years old, intervention focused on PA only, intervention duration \leq 10 weeks, and "low risk of bias" study performed.

Conclusions: Family intervention may be a promising way to promote children's PA levels, especially for daily steps.

Trial registration: Meta-analysis protocol was registered on PROSPERO: CRD42020193667.

Background

Physical activity (PA) is a key factor in children's physical and mental health development [1–3], playing a crucial role in bone development [4, 5], motor ability development [6], and self-esteem cultivation [7, 8]. Previous studies have shown that a low PA level and high sedentary behavior (SB) level lead to poor health [9], increase the risk of obesity [10] and coronary heart disease [11] from childhood to adolescence, and raise the risk of PA deficiency in adulthood [12, 13]. However, with advances in technology, automated household appliances and convenient ways of traffic have led to a decline in PA and an increase in SB [14]. Eighty percent of the world's children do not meet the PA recommendation from the World Health Organization [15]. Therefore, identifying the effective ways to promote children's PA levels has great public health significance.

The family-centered intervention model is designed to interact, purposefully and systematically, with participants and their family members in family settings, to help prevent and respond to a variety of physical and mental health problems [16]. Potential mechanisms of intervention effectiveness include the construct of familial or parental social support, the theoretical and practical guidance of PA and SB to families, the technical and logistical support for parents and children activities, and the role modeling and supervision of parents. Family System Theory also believes that the PA and SB behaviors of family members influence each other [17], and parental involvement is crucial in supporting and managing children's related behaviors (PA, SB, diet, screen time, sleep) [18–22]. Based on the Family System Theory, some scholars tried to apply family intervention in the field of PA promotion in children [23–25]. Of them, some studies found that family interventions can have a significant effect on increasing children's PA and decreasing SB levels [26–28], but in other studies the positive effect was not observed [29–32]. In recent years, although previous qualitative reviews examined the effects of the family intervention on PA and SB levels in children [22, 33] no quantitative review based on experimental studies has been conducted. Therefore, this study aims to identify the effects of family interventions on PA and SB levels in children aged 2–12 years, by using meta-analytic approach. Findings of this study will provide a reference for children's health care work.

Methods

Protocol and Registration

This research program has been registered on the PROSPERO System Evaluation Registration Platform, registration number: CRD42020193667. This study has been reported according to the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines [34].

Data Sources and Search Strategy

Studies were identified by structured database searching from inception until May 2020. Studies were gathered using the following databases: PubMed, OVID, Web of Science, Scopus, and China National Knowledge Internet (CNKI). The following search strings were employed:

- 1) Participants: "child*", "preschool", "kindergar*", "pediatric", "young child*", "schoolage*", "nursery school*", "primary school*", "grade school*", "elementary school", "school*", "elementary student*", etc.
- 2) Interventions: "intervention", "health promotion", "family", "family-based", "parent*", "parent-based", "home-based", "mother*", "father*", "primary care giver*", "preventi*", "behavio*", "behavior Change*", "treatment", "methods", etc.
- 3) Outcome: "physical activity", "exercise*", "sport*", "healthy lifestyle*", "activit*", "inactivit*", "step", etc.
- 4) Study design: search words include "random*", "control*", "trial", "comparison", "RCT (randomized controlled trials)", etc.

The same terms were searched by "OR", different terms were searched by "AND". Then I browsed the references in the retrieved documents and conducted a manual retrieval, and supplemented the missing documents in the retrieval process.

Inclusion and Exclusion Criteria

Inclusion criteria: 1) Participants: children aged 2.5–12 years, basing on PubMed MeSH term definition of preschoolers (2–5 years) and children (6–12 years); 2) Interventions: family Interventions (e.g., intervene in the family, intervene with parents); 3) Outcomes: indicators include PA (including any intensities PA or steps) and SB levels; 4) Study design: randomized controlled trials (RCT) or clinical controlled trials (CCT); 5) published in peer-review journals; 6) written in English or Chinese.

Exclusion criteria: 1) studies were review article; 2) studies were missing data of PA level as an outcome; 3) participants had physical diseases or dyskinesia; 4) publications from the same project with relatively small sample size.

Data Extraction and Management

Two authors (TH and ZH) and trained research assistant separately categorized all articles and extracted data. Disagreements were resolved through discussion until there was 100% agreement. We extracted the following information: 1) studies characteristics (e.g., title, authors, publication year); 2) participants characteristics [e.g., age, body mass index(BMI), sample size]; 3) measuring methods and outcomes; 4) types of interventions; 5) intervention focus; 6) intervention duration; and 7) the mean and standard deviation values of pre- to post-intervention differences between treatment and control groups. If there were multiple results of the same study (e.g., report both any intensities PA and steps), their data were considered as independent study for data analysis. In the case of missing data, this information was requested from the authors a minimum of three times over 4 weeks.

Risk of Bias and Quality Assessment

Risk assessment was carried out using the Cochrane Risk of Bias tool [35]. The evaluation included 1) Random sequence generation, 2) Allocation concealment, 3) Blinding of personnel, 4) Blinding of outcome assessment, 5) Incomplete outcome data, 6) Selective reporting, and 7) Other bias. The evaluation criteria are as follows: the “√” judgment is a low risk of bias, the “x” judgment is a high risk of bias, and the “?” judgment is an unclear risk of bias. Each study was based on an overall assessment of seven items, with a rating of high, moderate, and low risk. Two authors (TH and ZH) and trained research assistant separately estimate and cross-audit all articles using unified standards. Disagreements were resolved through discussion until there was 100% agreement. Statistical charts of risk bias were generated by RevMan 5.3 software.

Statistical Analysis

In this review, a random-effect model was used for meta-analysis of the included studies, and STATA was used for analysis. The main analysis processes included forest map analysis, heterogeneity test, and subgroup analysis. Statistical analysis of data from different units was performed using a 95% confidence interval (95%CI) standardized mean difference (SMD). The values of the effect size were quantified as large (≥ 0.8 SMD), medium (0.5 SMD - <0.8 SMD), small (0.2 SMD - <0.5 SMD), or non-significant (< 0.2 SMD) [36]. The weight means difference (WMD) of 95%CI was used for statistical analysis of data of the same unit. $P < 0.05$ was regarded as a significant difference. Depending on the characteristics of included studies, the subgroup analysis was conducted by outcomes, age, BMI, types of intervention, contents of intervention, intervention duration, measuring methods, and study quality to test whether there were differences in the effects among different subgroups.

I^2 statistics were used to test the between-study heterogeneity. When $I^2 < 25\%$, $25\% - < 50\%$, $50\% - < 75\%$ and $\geq 75\%$ [37], it was defined as very low, low, moderate, and high heterogeneity, respectively. Publication bias was examined by the Egger's test. Sensitivity analysis was conducted to test the robustness of the results, by replacing the fixed-effects model with the random-effects model and removing one study at a time to test whether a single study significantly modified the pooled effect.

Results

Study Selection

A total of 1596 articles were searched from each database, 1585 articles were excluded according to the inclusion and exclusion criteria. Finally, 11 articles were included in this study [31, 38–47]. (Fig. 1)

Study Characteristics

All of included studies were published in 2012 or later, among which 7 were published in 2015 or later. Of them, 4 studies from Australia [38, 40, 45, 46], 3 from the United States [31, 42, 44]. The United Kingdom [47], Germany [43], Finland [41], Norway and Sweden [39] each have one study. The included studies consisted of 10 RCTs [31, 38–41, 43–47] and 1 CCT [42], with a total of 955 participants in the treatment group and 931 participants in the control group. Five of the included studies [31, 38, 39, 42, 44] only used theory interventions, including PA knowledge education, health behavior lectures, PA counseling services, interviews, and telephone return visits. One of the included studies [41] only used behavior interventions in the form of specific activity tasks or activity classes that parents and children participated in together. In addition, 5 of the included studies [40, 43, 45–47] used both theory and behavior interventions. Most interventions included in this review targeted more than one health behavior, and intervention focus were categorized as “PA only” and “included other behavior”. Intervention focus, “PA only”, focuses only on PA improvement during the intervention, not other health behaviors. “Included other behavior” focuses not only on PA but also on the improvement of other health behaviors (e.g. diet, sleep, screen time). (Table 1)

Table 1
Characteristics results of a meta-analysis on the family intervention on PA and SB in children aged 2.5–12 years.

Author	Year of Publication	Study Location	Age Mean ± SD	BMI	Sample		Scheme c	Scheme ^T		Focus ^{T3}		Intervention Duration	Outco
					T	c		Theory 1	Behavior 2	PA	Infl O		
Jared [44]	2019	USA	3.6 ± 1.0	Overweight/Obesity	47	58	Daily PA	✓			✓	6 mo	MVPA
Yoong [38]	2019	AUT	4.3 ± 0.5 ^T 4.5 ± 0.6 ^C	Normal	37	37	Daily PA	✓			✓	3 mo	MVPA TPA
Philip [45]	2019	AUT	4–12	Normal	74	79	Daily PA	✓	✓	✓		2 mo	Daily steps
Laukkanen [39]	2017	NOR & SWE	6.09 ± 1.17 ^T 6.5 ± 1.11 ^C	Normal	44	47	Daily PA	✓			✓	6 mo	MVPA SB
Skouteris [40]	2015	AUT	2.7 ± 0.56 ^T 2.8 ± 0.60 ^C	Normal	71	79	Daily PA	✓	✓		✓	10 we	MVPA SB
Pipsa [41]	2015	FIN	6.5 ± 0.5 ^T 6.5 ± 0.5 ^C	Normal	86	89	Daily PA		✓	✓		7 we	MVPA SB
Adam [46]	2015	AUT	7.7 ± 2.5	Normal	23	22	Daily PA	✓	✓		✓	7 we	Daily steps
Robert [42]	2014	USA	8.7 ± 1.4	Overweight/Obesity	13	14	MIG ⁵	✓			✓	12 we	Daily steps, SB
Freia [43]	2013	GER	5.0 ± 0.2	Normal	433	376	Daily PA	✓	✓	✓		12 mo	MVPA SB
Russell [47]	2013	UK	6–8	Normal	25	23	Daily PA	✓	✓		✓	8 we	MVPA
Truls [31]	2012	USA	3.06 ± 1.0	Normal	102	107	Daily PA	✓			✓	8 mo	MVPA SB

MVPA: Moderate-to-Vigorous physical activity; TPA: total physical activity; SB: sedentary behavior. T treatment group, C control group; “mo” month, “we” week interventions, including lectures on health behavior education, face to face counsel and various forms PA knowledge education; 2 Behavior intervention, including activity courses or tasks, and intervention measures to complete behavioral tasks; 3 Intervention focus were divided into intervention PA only and included of screen time, a healthy diet (increasing the intake of vegetables, fruits, and water, avoiding the intake of junk food, etc.), promoting high-quality sleep, and supportive parenting. 4 The measuring method of accelerometer and pedometer is an objective measurement, while the questionnaire is a subjective measurement. 5 “N” intervention group to hand out manuals only. Accelerometers include Actigraph, Kersh Health, Triaxial, and Hookie

Risk of Bias

Of the 11 articles, 6 articles [38, 40, 41, 43, 45, 46] were classified as low risk, 2 articles [31, 47] were classified as moderate risk, and 3 articles [39, 42, 44] were classified as high risk. All included studies were non-selective and the integrity of the data results was described in detail. More than half of all articles described randomization, allocation concealment, and blind implementation. (Figs. 2 and 3).

Green: low risk of bias; yellow: unclear risk of bias; red: high risk of bias.

Results of Meta-analysis

The Results of PA

Meta-analysis of 11 included studies was revealed that family intervention had a significant effect on the improvement of PA in children aged 2.5–12 years (SMD = 0.10; 95%CI = 0.01, 0.19). Also, no significant heterogeneity was observed across included studies ($I^2 = 0\%$, $P = 0.52$) (Fig. 4). Publication bias was also not observed with Egger's test ($P = 0.11$, 95%CI = -0.24, 2.08).

Subgroup analysis results showed that subgroups of “daily steps” (WMD = 1,006; 95%CI = 209, 1,803), the “≥6 years” (SMD = 0.24; 95%CI = 0.04, 0.45), intervention focus “PA only” (SMD = 0.16; 95%CI = 0.01–0.30), intervention duration “≤ 10 weeks” (SMD = 0.25; 95%CI = 0.09, 0.41), and “low risk of bias” (SMD = 0.13; 95%CI = 0.02, 0.23) have significant effect in PA promotion. (Table 2).

Yoong-MVPA; Yoong2-TPA.

Table 2
Subgroup analysis of the effect of the family intervention on PA.

Subgroup	Potential modifiers	No. of studies	Effect size (95%CI)	Heterogeneity
All studies		11	0.10 (0.01, 0.19)	$I^2=0\%$, $P=0.52$
Outcomes ¹	MVPA	8	0.43 (-1.19, 2.04)	$I^2=19.6\%$, $P=0.27$
	TPA	1	-----	---
	Daily steps	3	1006 (209, 1803)	$I^2=0\%$, $P=0.86$
Age ²	< 6 years	5	0.05 (-0.06, 0.15)	$I^2=0\%$, $P=0.56$
	≥ 6 years	5	0.24 (0.04, 0.46)	$I^2=0\%$, $P=0.71$
BMI	Normal	9	0.09 (-0.003, 0.19)	$I^2=0\%$, $P=0.53$
	Overweight/Obesity	2	0.28 (-0.11, 0.67)	$I^2=11.6\%$, $P=0.29$
Types of intervention	Theory	5	0.02 (-0.13, 0.27)	$I^2=16.4\%$, $P=0.31$
	Behavior	1	-----	---
	Theory plus behavior	5	0.10 (-0.02, 0.21)	$I^2=0\%$, $P=0.74$
Intervention focus	PA only	5	0.16 (0.01, 0.30)	$I^2=20.6\%$, $P=0.28$
	PA plus others	6	0.06 (-0.10, 0.22)	$I^2=0\%$, $P=0.59$
Intervention duration	> 10 we	7	0.08 (-0.04, 0.19)	$I^2=7.5\%$, $P=0.37$
	≤ 10 we	4	0.22 (0.02, 0.41)	$I^2=0\%$, $P=0.84$
Measuring methods	Subjective	2	0.15 (-0.10, 0.39)	$I^2=0\%$, $P=0.86$
	Objective	9	0.11 (-0.004, 0.22)	$I^2=9.5\%$, $P=0.36$
Risk of bias	Low risk	6	0.13 (0.02, 0.23)	$I^2=0\%$, $P=0.62$
	Moderate risk	2	-0.11 (-0.35, 0.14)	$I^2=0\%$, $P=0.43$
	High risk	3	0.19 (-0.08, 0.45)	$I^2=0\%$, $P=0.44$

¹ The subgroup of outcomes units were the same, and WMD statistics were used, SMD was used for all the other subgroup except the outcomes subgroup. Yoong [38] contained two outcomes [MVPA and light PA(LPA)], so the total number of outcomes subgroups was 12; ² philip [40] is not divided into age subgroup because of participants were 4–12 years old.

The Results of SB

Meta-analysis of 6 included studies was revealed that family intervention had no significant effect on the improvement of SB outcome in children aged 2.5–12 years (WMD=-0.38; 95%CI=-7.21, 6.46) (Fig. 5). There was no significant difference in all subgroups. Also noteworthy was the fact that no significant heterogeneity was observed ($I^2 = 0\%$, $P=0.82$) (Table 3). Publication bias was also not observed with Egger’s test ($P=0.72$, 95%CI=-1.36, 1.80).

Table 3
Subgroup analysis of the effect of the family intervention on SB.

Subgroup	Potential modifiers	No. of studies	WMD (min/day) (95%CI)	Heterogeneity
All studies		6	-0.38 (-7.21, 6.46)	I ² =0%, P= 0.82
Age	< 6 years	3	-0.46 (-7.76, 6.84)	I ² =6%, P= 0.35
	≥ 6 years	3	0.23 (-19.15, 19.61)	I ² =0%, P= 0.97
BMI	Normal	5	-0.37 (-7.22, 6.49)	I ² =0%, P= 0.70
	Overweight/Obesity	1	-----	---
Types of intervention	Theory	3	-0.004 (-17.73, 17.74)	I ² =0%, P= 0.97
	Behavior	1	-----	---
	Theory plus behavior	2	-0.32 (-7.99, 7.34)	I ² =52.7%, P= 0.15
Intervention focus	PA only	4	-3.30 (-11.62, 5.01)	I ² =0%, P= 0.98
	PA plus others	2	5.71 (-6.28, 17.70)	I ² =0%, P= 0.48
Intervention duration	> 10 weeks	4	-3.23 (-11.40, 4.94)	I ² =0%, P= 0.97
	≤ 10 weeks	2	6.27 (-6.20, 18.73)	I ² =0%, P= 0.52
Measuring methods	Subjective	2	7.94 (-5.71, 21.58)	I ² =0%, P= 0.80
	Objective	4	-3.16 (-11.05, 4.73)	I ² =0%, P= 0.97
Risk of bias	Low risk	3	-0.44 (-7.85, 6.96)	I ² =6.1%, P= 0.35
	Moderate risk	1	-----	---
	High risk	2	2.25 (-24.08, 28.58)	I ² =0%, P= 0.91

Sensitivity Analysis

Two sensitivity analyses were performed to test the robustness of our results: (1) the findings were consistent when the fixed-effects model was replaced by the random-effects model; and (2) the results indicated no single study to be significantly modified by the overall trend by removing one study from the meta-analysis each time.

Discussion

Overall Effect of Family Intervention

This study aimed to quantitatively examine the effect of family interventions on the PA and SB in children aged 2.5–12 years by synthesizing the available literature in this field of inquiry. Through the combined 11 studies included, we found that family intervention could effectively improve the PA of children aged 2.5–12 years, especially for daily steps, but there was no obvious effect on SB.

Comparison with the Findings from Previous Reviews

Findings of this study indicated that family interventions have a positive effect on PA in children aged 2.5–12 years and our study is therefore a valuable extension of two published systematic reviews and meta-analysis [48, 49]. A meta-analysis provides evidence that school-based interventions can be effective in increasing PA enjoyment in children [48]. Jane's [49] meta-analysis, based on school and family interventions, found that family interventions (involving children and parents) had better PA improvement than school interventions (only children). On this basis, when our study concentrate on family interventions, it still found that a significant intervention effect on PA in children. This study may provide additional information and be valuable contribution to this area of inquiry from family intervention and PA.

Indeed, a growing body of evidence has shown the benefits of intervention on children's PA [47, 48], however, which index of PA is more sensitive to family intervention remains unclear. Among children previous reviews suggested that neither active play interventions [50] nor school-based interventions [51] have an effect on moderate-to-vigorous PA (MVPA). In accord with previous studies, findings from our study align with the previous points indicating that family interventions have no effects on MVPA. However, we found that family interventions significantly improved the children's daily step of 1,006 steps per day. Among previous reviews suggested that positive relationships between daily steps and physical fitness were observed [52]. Daily steps is an excellent indicator of health-related outcomes [53, 54]. Some studies suggested converting MVPA to steps because daily steps were easier to recognize generally[55]. The reason why our findings have no significant improvement on MVPA but improve daily steps may be the increased activity comes from LPA, not MVPA. Although PA guideline recommended to engage in sufficient MVPA to obtain health benefits from PA [56], previous reviews revealed that engaging in more LPA is also good for children's health [57, 58]. Therefore, we cannot ignore the potential health effects from family interventions to enhance LPA.

Nevertheless, the results of our review showed that family intervention had no significant effect on SB in children aged 2.5–12 years. It is a disappointing outcome for public health practitioners and researchers who consider the family a promising setting for interventions [17]. Previous school-based [51] or

classroom-based [59] interventions have also been ineffective for SB. In general, family interventions design may focus more on PA logically not SB. Future research should consider the differences and concerns between PA and SB in study design.

Analysis of Influencing Factors

The result of subgroup analysis expressed that family interventions were more effective in increasing PA levels in certain subgroups, for example, intervention focus “PA only”, “low risk of bias”. In addition, our review showed that age may be one of the factors influencing the effectiveness of family interventions. How do these findings compare to those of other published studies? A number of studies focused on preschool children found no changes in PA and SB following PA interventions [60, 61]. However in this study, family intervention had a significant effect on PA in children aged 6–12 years. With the growth and cognitive development, the cognitive ability of school-age children (6–12 years old) was better than that of preschool children [62], and they also had a better understanding of family intervention and PA. At this time, parents could set a good example, or they live in a PA positive family, which can have a profound effect on a child's PA. Therefore, well-designed and targeted RCTs were needed for children of other ages in the future.

The study also demonstrated that intervention duration affect the effectiveness of family interventions. Intervention duration were categorized as “> 10 weeks” and “≤ 10 weeks” based on characteristics of included studies. It was found that interventions less than 10 weeks may have a more significant impact on PA improvement. The short-term (≤ 10 weeks) intervention effects may be attributed to the curiosity of the participants in the early stages of the intervention, and they are willing to participate in the implementation [63]. Over time, the decline in the interest and compliance of the participants led to the intervention effect not being maintained.

Strength and Limitations

This study has demonstrated several strengths. First, to the best of our knowledge, this is the first meta-analysis to quantitatively examine the effect of family interventions on PA in children aged 2.5–12 years, which provides additional insight in the field of family interventions and PA. Second, the meta-analysis is based on data from controlled trials studies regarded as a study design that substantially reduces selection bias and has a good comparability.

There were also some limitations in this study. First, most of the included studies was distributed in developed countries, so the research results were not widely representative. However, this study has included as much as possible the latest and most comprehensive research related to this proposition. Second, the family intervention programs (focus, means, duration) varied across included studies, which may lead to estimation bias of the overall effect. However, sensitivity analysis showed that the reduction of any one of the included studies did not significantly affect the combined results of this study.

Conclusions

In summary, findings from this meta-analysis that family intervention can effectively improve PA of children aged 2.5–12 years, especially daily steps, but has no obvious effect on SB. Considering that family members engage in physical activity together is safe, meaningful, and effective for not only promoting the relationship between parents and children but also development of good habits, we should encourage family members to take up physical exercise together. Future studies should focus on considering the different characteristics of preschoolers and school-age children, exploring the optimal combination of interventions focus, means, and duration.

Abbreviations

PA: Physical activity; SB: sedentary behavior; CNKI: China National Knowledge Internet; RCT: randomized controlled trials; CCT: clinical controlled trials; BMI: body mass index; SMD: standardized mean difference; WMD: weight means difference; MVPA: moderate-to-vigorous Physical activity; TPA: total Physical activity; LPA: light Physical activity

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and materials

All data generated or analysed during this study are included in this published article [and its supplementary information files].

Competing interests

The authors declare that they have no competing interests.

Funding

MQ is supported by the National Natural Science Foundation of China grant 81703252, and supported by the Shanghai Commission of Science and Technology grant 19080503000.

GZ is founded by Social Sciences project, supported by Ministry of Education of China grant 18YJC890060.

TH is funded by the Graduate Student Innovation project, supported by the Nanchang University grant CX2019046.

The funders had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Author's contributions

TH, HW, MQ, GZ and ZH designed conception and search strategy; TH, GZ, MQ and ZH designed inclusion and exclusion criteria; TH and ZH conducted quality assessment with arbitration by GZ; Summary statistics were produced by TH and data analysis was performed by MQ and ZG; TH, WL and SS wrote the first draft. All authors made substantive contributions and approved the final manuscript.

Acknowledgements

Not applicable.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Authors' details

¹School of Physical Education, Nanchang University, China ²Rehabilitation Medicine Center, The Second Affiliated Hospital of Jiaying University, Zhejiang, China; ³Jiangxi Research Institute of Sports Science, Nanchang Jiangxi, China; ⁴School of Kinesiology, Shanghai University of Sport, Shanghai, China

*Correspondence: quanminghui@163.com (M.Q.), +86-21-65507367; zhaogg2002@163.com (G.Z.) , +86-0791-83969706

Received: date 2020; Accepted: date 2020; Published: date 2020

References

1. Lv Y, Cai L, Gui Z. Effects of physical activity and sedentary behaviour on cardiometabolic risk factors and cognitive function in children: protocol for a cohort study. *BMJ Open*. 2019;9(10):31. . (:e030322.
2. Robinson LE, Stodden DF, Barnett LM. Motor Competence and its Effect on Positive Developmental Trajectories of Health. *Sports Med*. 2015 **Sep**;45(9):1273–84.
3. Zeng N, Ayyub M, Sun H. Effects of Physical Activity on Motor Skills and Cognitive Development in Early Childhood: A Systematic Review. *Biomed Res Int*. 2017;2017:2760716.
4. Nikander R, Sievänen H, Heinonen A. Targeted exercise against osteoporosis: A systematic review and meta-analysis for optimising bone strength throughout life. *BMC Med*. 2010 **Jul**;21:8:47.
5. Janz KF, Burns TL, Levy SM. Iowa Bone Development Study. Tracking of activity and sedentary behaviors in childhood: the Iowa Bone Development Study. *Am J Prev Med*. 2005 **Oct**;29(3):171-8.
6. Kambas A, Michalopoulou M, Fatouros IG. The relationship between motor proficiency and pedometer-determined physical activity in young children. *Pediatr Exerc Sci*. 2012 **Feb**;24(1):34–44.
7. Duman F, Kocaçaya MH, Doğru E. **The Role of Active Video-Accompanied Exercises in Improvement of the Obese State in Children: A Prospective Study from Turkey**. *J Clin Res Pediatr Endocrinol*. 2016 **Sep** 1;8(3):334 – 40.
8. Reed K, Wood C, Barton J. A repeated measures experiment of green exercise to improve self-esteem in UK school children. *PLoS One*. 2013 **Jul**;24(7):e69176. .;8.
9. Kristensen PL, Møller NC, Korsholm L. **Tracking of objectively measured physical activity from childhood to adolescence: the European youth heart study**. *Scand J Med Sci Sports*. 2008 **Apr**;18(2):171-8.
10. Timmons BW, Leblanc AG, Carson V. Systematic review of physical activity and health in the early years (aged 0–4 years). *Appl Physiol Nutr Metab*. 2012 **Aug**;37(4):773 – 92.
11. Sääkslahti A, Numminen P, Varstala V. Physical activity as a preventive measure for coronary heart disease risk factors in early childhood. *Scand J Med Sci Sports*. 2004 **Jun**;14(3):143-9.
12. Matton L, Thomis M, Wijndaele K. Tracking of physical fitness and physical activity from youth to adulthood in females. *Med Sci Sports Exerc*. 2006 **Jun**;38(6):1114-20.
13. Telama R, Yang X, Viikari J. Physical activity from childhood to adulthood: a 21-year tracking study. *Am J Prev Med*. 2005 **Apr**;28(3):267 – 73.
14. Fan X, Cao ZB. Physical activity among Chinese school-aged children: National prevalence estimates from the 2016 Physical Activity and Fitness in China-The Youth Study. *J Sport Health Sci*. 2017 **Dec**;6(4):388–94.
15. Hallal PC, Andersen LB, Bull FC, Guthold R, Haskell W, Ekelund U. **Lancet Physical Activity Series Working Group. Global physical activity levels: surveillance progress, pitfalls, and prospects**. *Lancet*. 2012 **Jul** 21;380(9838):247 – 57.
16. Miller G. Application of theory to family-centered care: a role for social workers. *Soc Work Health Care*. 2012;51(2):89–106.

17. Kitzman-Ulrich H, Wilson DK, St George SM. The integration of a family systems approach for understanding youth obesity, physical activity, and dietary programs. *Clin Child Fam Psychol Rev*. 2010 **Sep**;13(3):231 – 53.
18. Bruss MB, Morris J, Dannison L. Prevention of childhood obesity: sociocultural and familial factors. *J Am Diet Assoc*. 2003 **Aug**;103(8):1042-5.
19. Hesketh KR, Lakshman R. Barriers and facilitators to young children's physical activity and sedentary behaviour: a systematic review and synthesis of qualitative literature. *Obes Rev*. 2017 **Sep**;18(9):987–1017., van Sluijs EMF.
20. Ek A, Sorjonen K, Eli K, Lindberg L. Associations between Parental Concerns about Preschoolers' Weight and Eating and Parental Feeding Practices: Results from Analyses of the Child Eating Behavior Questionnaire, the Child Feeding Questionnaire, and the Lifestyle Behavior Checklist. *PLoS One*. 2016 **Jan**;22(1):e0147257..;11.
21. Dong F, Howard AG, Herring AH. Parent-child associations for changes in diet, screen time, and physical activity across two decades in modernizing China: China Health and Nutrition Survey 1991–2009. *Int J Behav Nutr Phys Act*. 2016 **Nov**;11(1):118..;13.
22. Vollmer RL, Mobley AR. Parenting styles, feeding styles, and their influence on child obesogenic behaviors and body weight. A review. *Appetite*. 2013 **Dec**;71:232 – 41.
23. Birch LL, Davison KK. Family environmental factors influencing the developing behavioral controls of food intake and childhood overweight. *Pediatr Clin North Am*. 2001 **Aug**;48(4):893–907.
24. Jago R, Edwards MJ, Urbanski CR, Sebire SJ. General and specific approaches to media parenting: a systematic review of current measures, associations with screen-viewing, and measurement implications. *Child Obes*. 2013 **Aug**;9(Suppl(Suppl 1):51–72.
25. Loprinzi PD, Trost SG. Parental influences on physical activity behavior in preschool children. *Prev Med*. 2010 **Mar**;50(3):129 – 33.
26. Catenacci VA, Barrett C, Odgen L, Browning R, Schaefer CA, Hill J, Wyatt H. Changes in physical activity and sedentary behavior in a randomized trial of an internet-based versus workbook-based family intervention study. *J Phys Act Health*. 2014 **Feb**;11(2):348 – 58.
27. Guagliano JM, Brown HE, Coombes E, Hughes C, Jones AP, Morton KL, Wilson ECF. van Sluijs EMF. **The development and feasibility of a randomised family-based physical activity promotion intervention: the Families Reporting Every Step to Health (FRESH) study. Pilot Feasibility Stud**. 2019 **Feb** 9;5:21.
28. Ling J, Robbins LB, Wen F, Peng W. Interventions to Increase Physical Activity in Children Aged 2–5 Years: A Systematic Review. *Pediatr Exerc Sci*. 2015 **Aug**;27(3):314 – 33.
29. Nyberg G, Sundblom E, Norman Å, Bohman B, Hagberg J, Elinder LS. **Effectiveness of a universal parental support programme to promote healthy dietary habits and physical activity and to prevent overweight and obesity in 6-year-old children: the Healthy School Start Study, a cluster-randomised controlled trial. PLoS One**. 2015 **Feb** 13;10(2):e0116876.
30. Peirson L, Fitzpatrick-Lewis D, Morrison K, Warren R, Usman Ali M, Raina P. **Treatment of overweight and obesity in children and youth: a systematic review and meta-analysis. CMAJ Open**. 2015 Jan 13;3(1):E35-46.
31. Østbye T, Krause KM, Stroo M, Lovelady CA, Evenson KR, Peterson BL, Bastian LA, Swamy GK, West DG, Brouwer RJ, Zucker NL. Parent-focused change to prevent obesity in preschoolers: results from the KAN-DO study. *Prev Med*. 2012 **Sep**;55(3):188 – 95.
32. Harvey-Berino J, Rourke J. Obesity prevention in preschool native-american children: a pilot study using home visiting. *Obes Res*. 2003 **May**;11(5):606 – 11.
33. van Sluijs EM, Kriemler S, McMinn AM. The effect of community and family interventions on young people's physical activity levels: a review of reviews and updated systematic review. *Br J Sports Med*. 2011 **Sep**;45(11):914 – 22.
34. Moher D, Liberati A, Tetzlaff J, Altman DG, Group P. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Ann Intern Med*. 2009;151:264-W64.
35. Higgins JP, Altman DG, Gøtzsche PC, **Cochrane Bias Methods Group; Cochrane Statistical Methods Group**. The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. *BMJ*. 2011 **Oct**;18:343:d5928.
36. Cohen J. *Statistical power analysis for the behavioral sciences. 2nd ed. Hillsdale: Lawrence Erlbaum; 1988.*
37. Higgins JP, Thompson SG. Quantifying heterogeneity in a meta-analysis. *Stat Med*. 2002 **Jun**;15(11):1539-58..;21.
38. Yoong SL, Grady A, Stacey F. A pilot randomized controlled trial examining the impact of a sleep intervention targeting home routines on young children's (3–6 years) physical activity. *Pediatr Obes*. 2019 **Apr**;14(4):e12481.
39. Laukkanen A, Pesola AJ, Finni T, Sääkslahti A. Parental Support and Objectively Measured Physical Activity in Children: A Yearlong Cluster-Randomized Controlled Efficacy Trial. *Res Q Exerc Sport*. 2017 **Sep**;88(3):293–306.
40. Skouteris H, Hill B, McCabe M, Swinburn B, Busija L. A parent-based intervention to promote healthy eating and active behaviours in pre-school children: evaluation of the MEND 2–4 randomized controlled trial. *Pediatr Obes*. 2016 **Feb**;11(1):4–10.
41. Tuominen PPA, Husu P, Raitanen J, Kujala UM, Luoto RM. **The effect of a movement-to-music video program on the objectively measured sedentary time and physical activity of preschool-aged children and their mothers: A randomized controlled trial. PLoS One**. 2017 **Aug** 31;12(8):e0183317.
42. Newton RL Jr, Marker AM, Allen HR, Machtmes R, Han H, Johnson WD, Schuna JM Jr, Broyles ST, Tudor-Locke C, Church TS. Parent-targeted mobile phone intervention to increase physical activity in sedentary children: randomized pilot trial. *JMIR Mhealth Uhealth*. 2014 **Nov** 10;2(4):e48.
43. De Bock F, Genser B, Raat H, Fischer JE, Renz-Polster H. A participatory physical activity intervention in preschools: a cluster randomized controlled trial. *Am J Prev Med*. 2013 **Jul**;45(1):64–74.
44. Tucker JM, DeFrang R, Orth J, Wakefield S, Howard K. **Evaluation of a Primary Care Weight Management Program in Children Aged 2–5 years: Changes in Feeding Practices, Health Behaviors, and Body Mass Index. Nutrients**. 2019 **Feb** 27;11(3):498.

45. Morgan PJ, Young MD, Barnes AT, Eather N, Pollock ER, Lubans DR. Engaging Fathers to Increase Physical Activity in Girls: The "Dads And Daughters Exercising and Empowered" (DADEE) Randomized Controlled Trial. *Ann Behav Med*. 2019 **Jan**;53(1)(1):39–52.
46. Lloyd AB, Lubans DR, Plotnikoff RC, Morgan PJ. Paternal Lifestyle-Related Parenting Practices Mediate Changes in Children's Dietary and Physical Activity Behaviors: Findings From the Healthy Dads, Healthy Kids Community Randomized Controlled Trial. *J Phys Act Health*. 2015 **Sep**;12(9):1327-35.
47. Jago R, Sebire SJ, Turner KM, Bentley GF, Goodred JK, Fox KR, Stewart-Brown S, Lucas PJ. Feasibility trial evaluation of a physical activity and screen-viewing course for parents of 6 to 8 year-old children: Teamplay. *Int J Behav Nutr Phys Act*. 2013 **Mar**;4:10:31.
48. Burns RD, Fu Y, Podlog LW. School-based physical activity interventions and physical activity enjoyment: A meta-analysis. *Prev Med*. 2017 **Oct**;103:84–90.
49. Dellert JC, Johnson P. Interventions with children and parents to improve physical activity and body mass index: a meta-analysis. *Am J Health Promot*. 2014 **Mar-Apr**;28(4):259 – 67.
50. Johnstone A, Hughes AR, Martin A, Reilly JJ. **Utilising active play interventions to promote physical activity and improve fundamental movement skills in children: a systematic review and meta-analysis**. *BMC Public Health*. 2018 Jun 26;18(1):789.
51. Jones M, Defever E, Letsinger A, Steele J, Mackintosh KA. A mixed-studies systematic review and meta-analysis of school-based interventions to promote physical activity and/or reduce sedentary time in children. *J Sport Health Sci*. 2020 **Jan**;9(1):3–17.
52. Carson V, Lee EY, Hewitt L, Jennings C, Hunter S, Kuzik N, Stearns JA, Unrau SP, Poitras VJ, Gray C, Adamo KB, Janssen I, Okely AD, Spence JC, Timmons BW, Sampson M, Tremblay MS. **Systematic review of the relationships between physical activity and health indicators in the early years (0–4 years)**. *BMC Public Health*. 2017 Nov 20;17(Suppl 5):854.
53. Poitras VJ, Gray CE, Borghese MM. Systematic review of the relationships between objectively measured physical activity and health indicators in school-aged children and youth. *Appl Physiol Nutr Metab*. 2016 **Jun**;41(6 Suppl 3):197–239.
54. Fang C, Zhang J, Zhou T, Li L, Lu Y, Gao Z, Quan M. **Associations between Daily Step Counts and Physical Fitness in Preschool Children**. *J Clin Med*. 2020 **Jan 7**;9(1):163.
55. Adams MA, Johnson WD, Tudor-Locke C. **Steps/day translation of the moderate-to-vigorous physical activity guideline for children and adolescents**. *Int J Behav Nutr Phys Act*. 2013 **Apr 21**;10:49.
56. Piercy KL, Troiano RP, Ballard RM, Carlson SA, Fulton JE, Galuska DA, George SM, Olson RD. **The Physical Activity Guidelines for Americans**. *JAMA*. 2018 Nov 20;320(19):2020–2028.
57. Dwyer T, Ponsonby AL, Ukoumunne OC. Association of change in daily step count over five years with insulin sensitivity and adiposity: population based cohort study. *BMJ*. 2011 **Jan**;13:342:c7249.
58. Bassett DR Jr, Toth LP, LaMunion SR, Crouter SE. Step Counting: A Review of Measurement Considerations and Health-Related Applications. *Sports Med*. 2017 **Jul**;47(7):1303–15.
59. McMichan L, Gibson AM, Rowe DA. **Classroom-Based Physical Activity and Sedentary Behavior Interventions in Adolescents: A Systematic Review and Meta-Analysis**. *J Phys Act Health*. 2018 **May 1**;15(5):383–393.
60. Larson N, Ward DS, Neelon SB, Story M. What role can child-care settings play in obesity prevention? A review of the evidence and call for research efforts. *J Am Diet Assoc*. 2011 **Sep**;111(9):1343-62.
61. van Sluijs EM, McMinn AM, Griffin SJ. Effectiveness of interventions to promote physical activity in children and adolescents: systematic review of controlled trials. *BMJ*. 2007 **Oct 6**;335(7622):703.
62. de Onis M, Onyango AW, Borghi E. Development of a WHO growth reference for school-aged children and adolescents. *Bull World Health Organ*. 2007 **Sep**;85(9):660-7.
63. Johnstone A, Hughes AR, Martin A. **Utilising active play interventions to promote physical activity and improve fundamental movement skills in children: a systematic review and meta-analysis**. *BMC Public Health*. 2018 Jun 26;18(1):789.

Figures

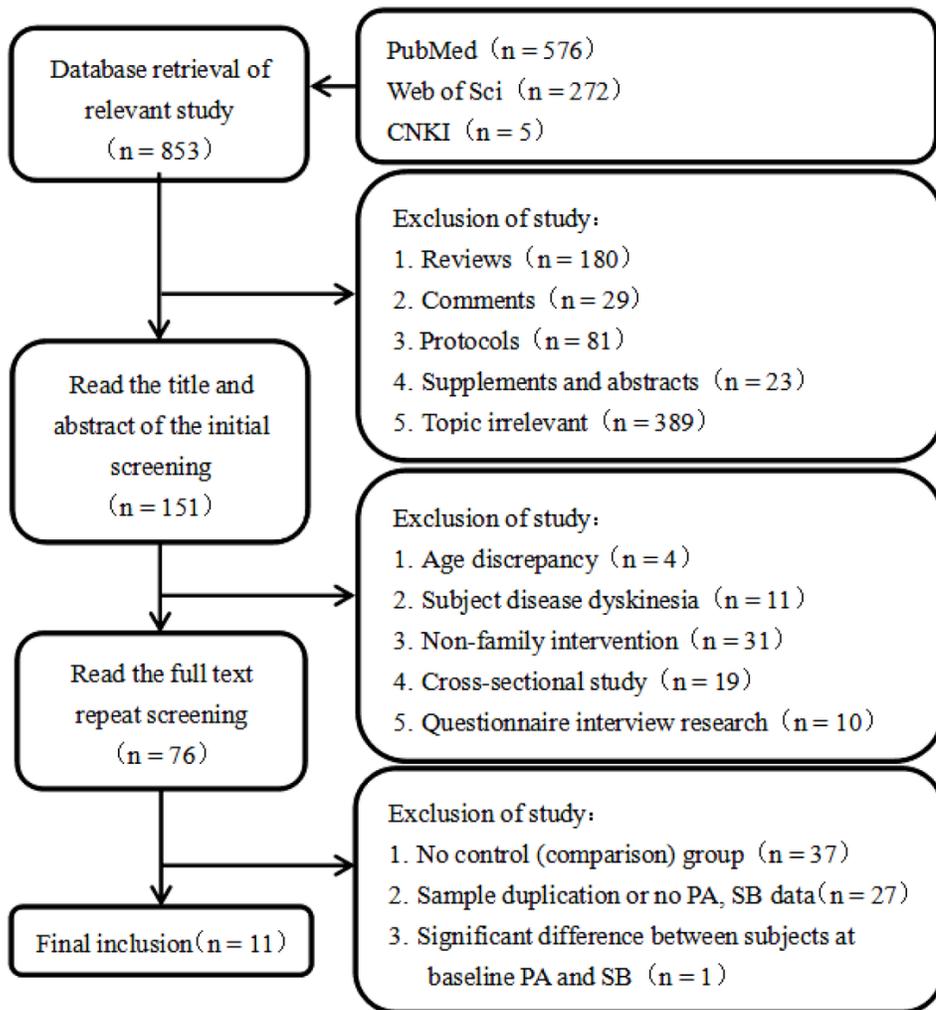


Figure 1

Article selection flow chart for the meta-analysis.

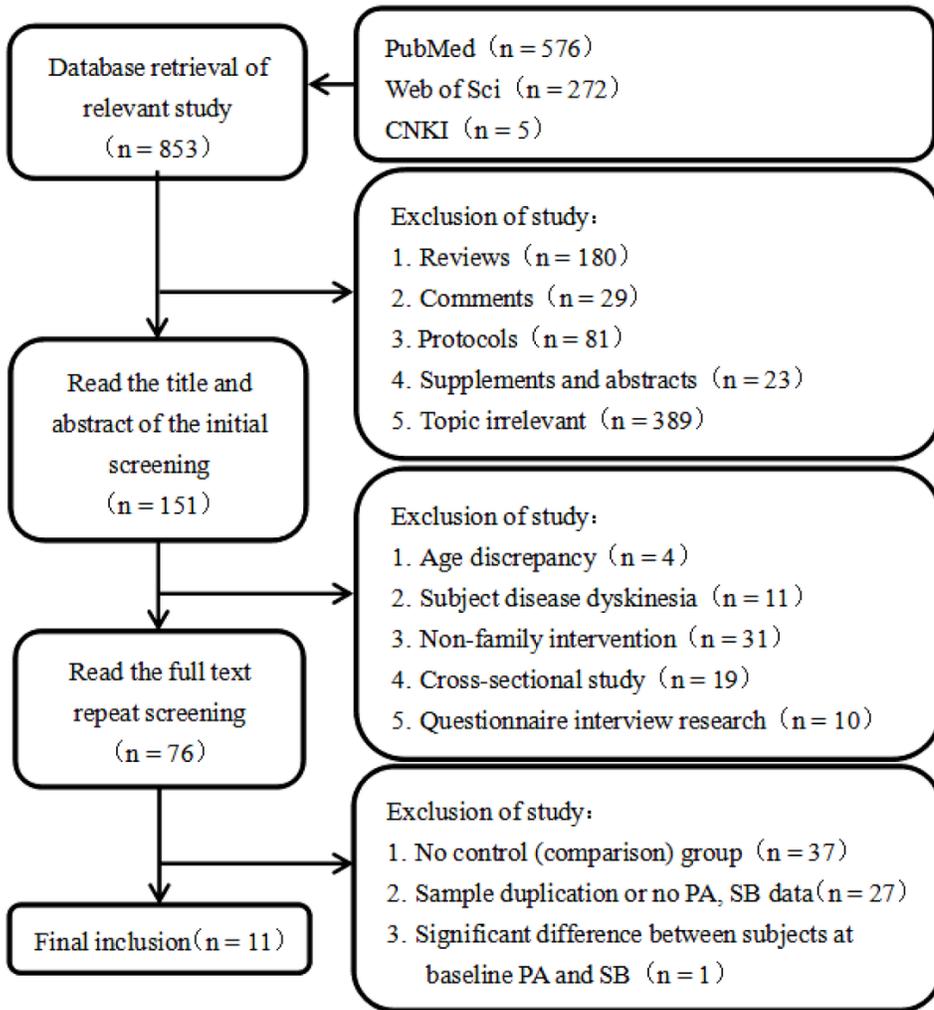


Figure 1

Article selection flow chart for the meta-analysis.

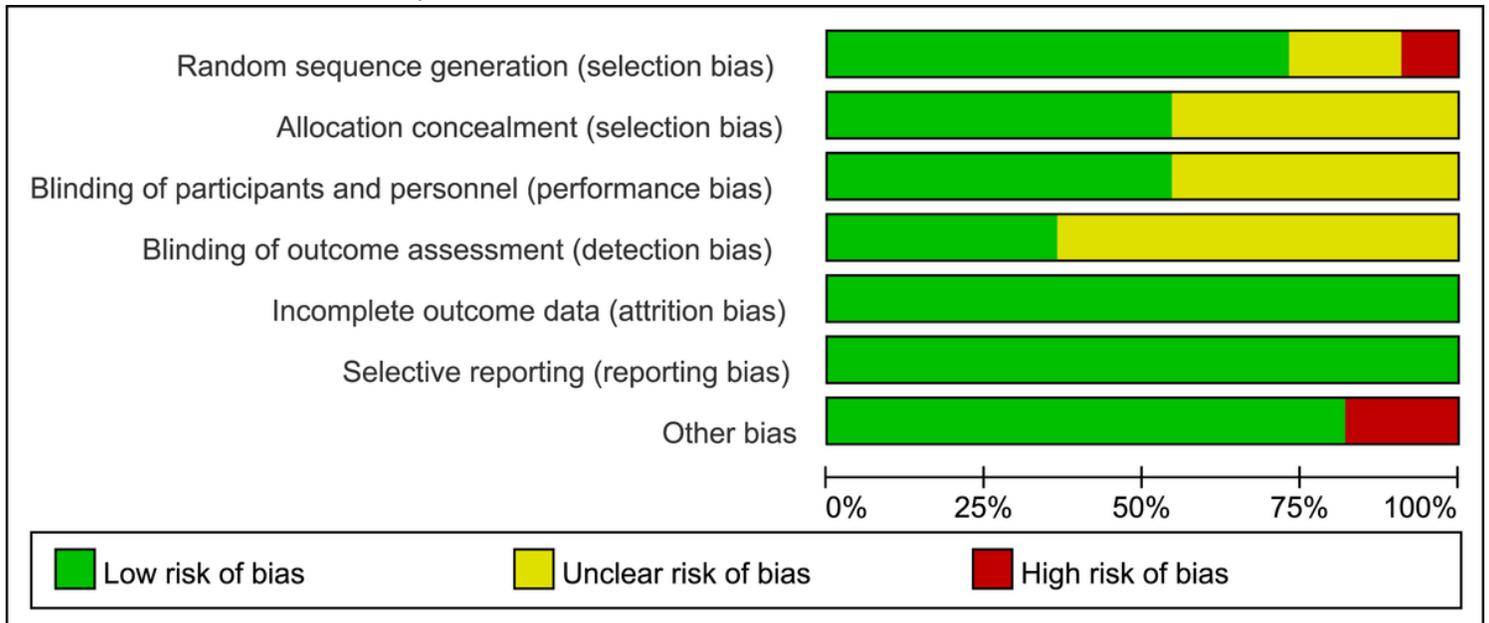


Figure 2

Risk of bias graph: each risk of bias item presented as percentages.

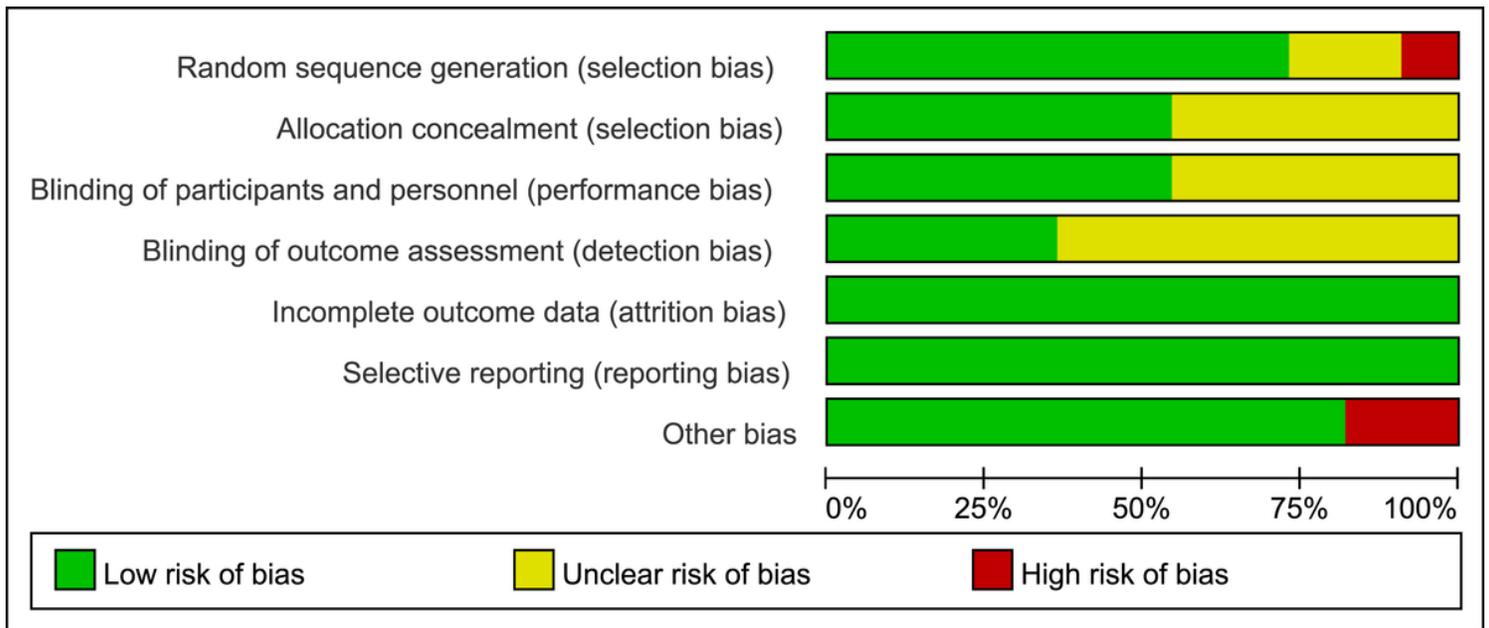


Figure 2

Risk of bias graph: each risk of bias item presented as percentages.

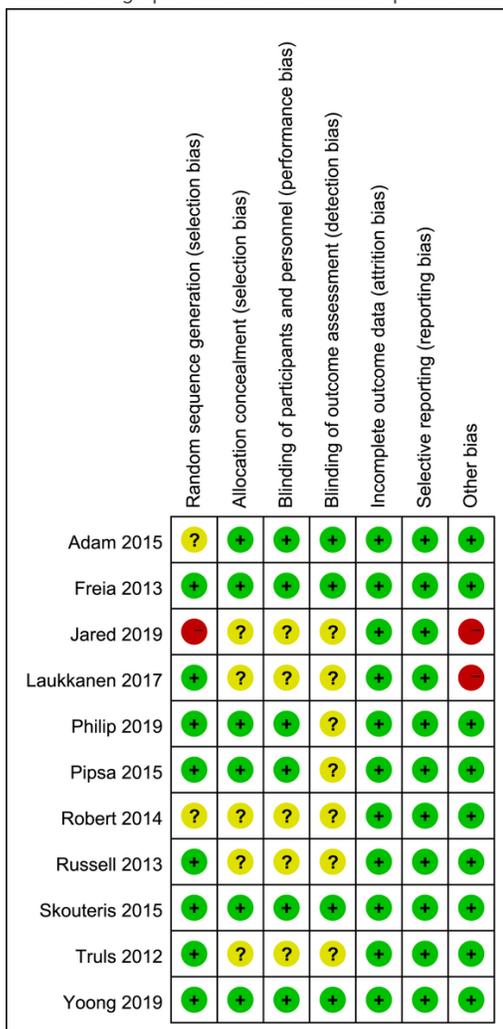


Figure 3

Risk of bias of included studies. Green: low risk of bias; yellow: unclear risk of bias; red: high risk of bias.

	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
Adam 2015	?	+	+	+	+	+	+
Freia 2013	+	+	+	+	+	+	+
Jared 2019	-	?	?	?	+	+	-
Laukkanen 2017	+	?	?	?	+	+	-
Philip 2019	+	+	+	?	+	+	+
Pipsa 2015	+	+	+	?	+	+	+
Robert 2014	?	?	?	?	+	+	+
Russell 2013	+	?	?	?	+	+	+
Skouteris 2015	+	+	+	+	+	+	+
Truls 2012	+	?	?	?	+	+	+
Yoong 2019	+	+	+	+	+	+	+

Figure 3

Risk of bias of included studies. Green: low risk of bias; yellow: unclear risk of bias; red: high risk of bias.

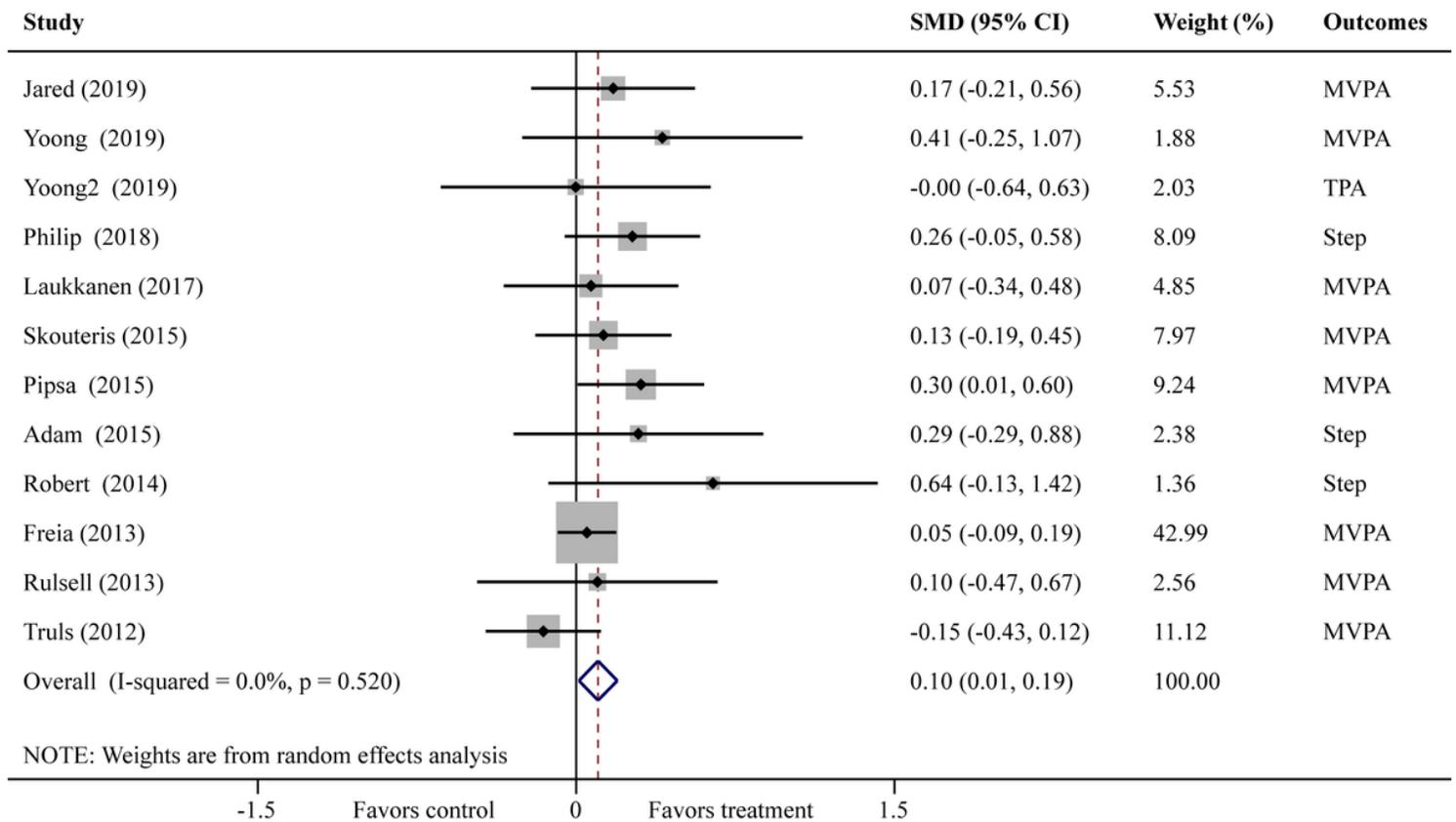


Figure 4

Forest plot of family intervention on PA in children aged 2.5-12 years. Yoong-MVPA; Yoong2-TPA.

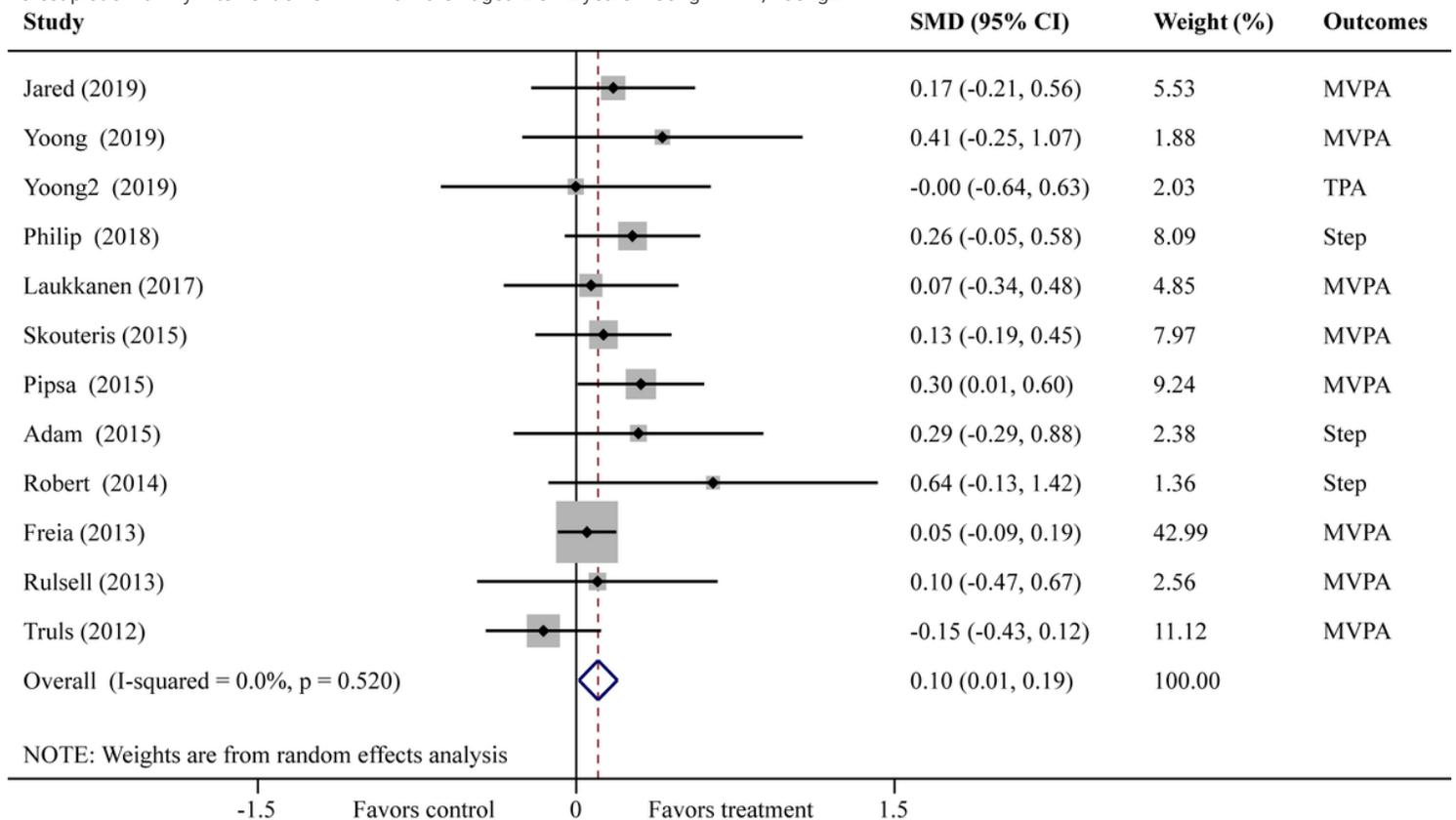


Figure 4

Forest plot of family intervention on PA in children aged 2.5-12 years. Yoong-MVPA; Yoong2-TPA.

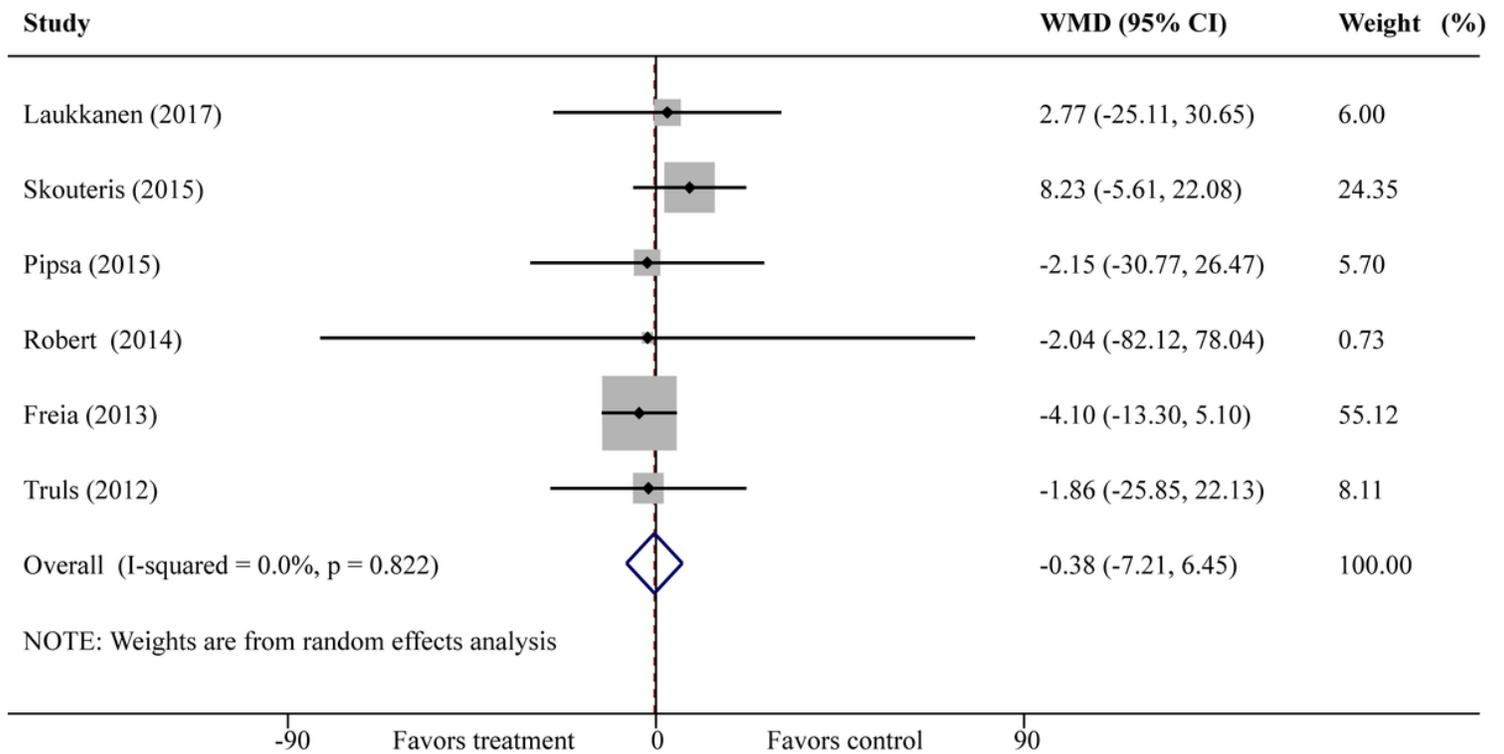


Figure 5

Forest plot of family intervention on SB in children aged 2.5-12 years.

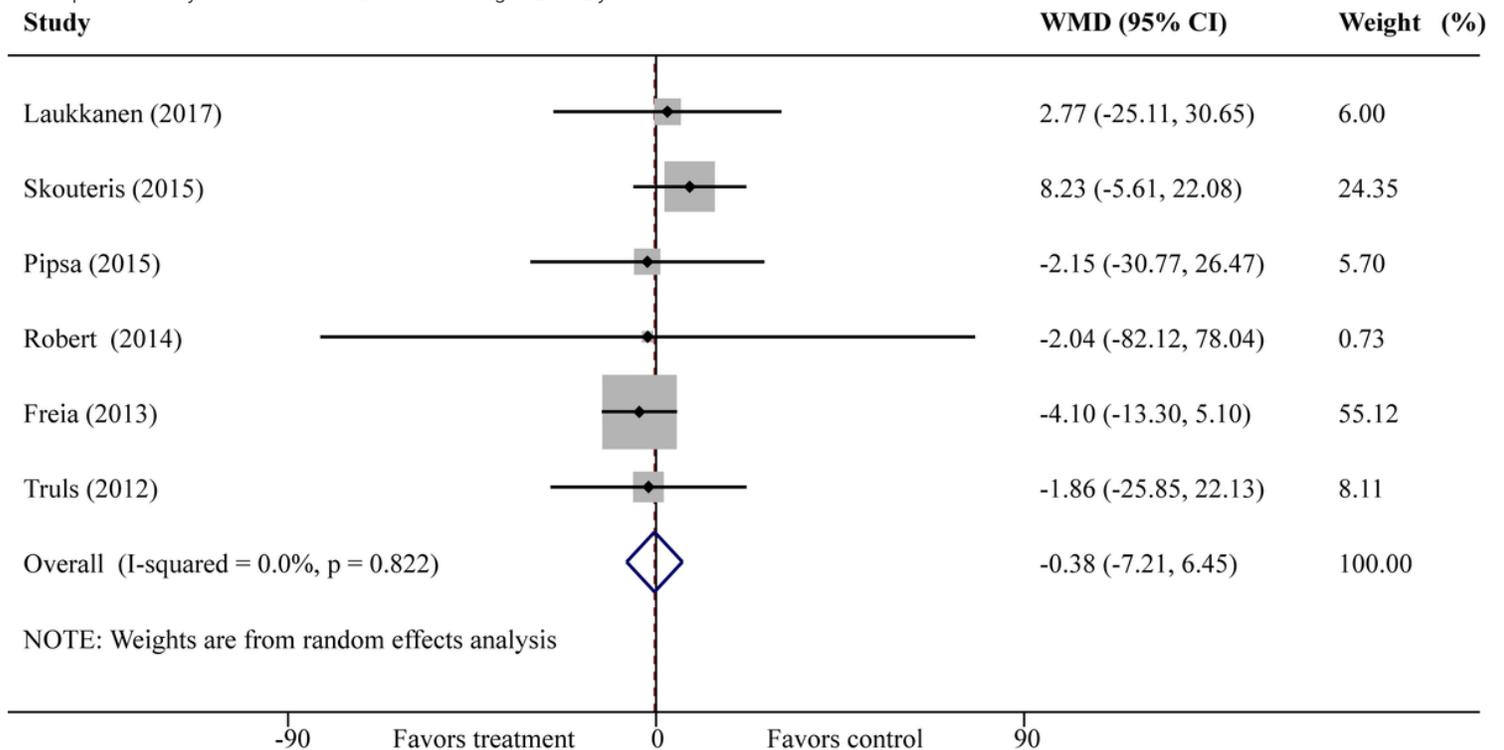


Figure 5

Forest plot of family intervention on SB in children aged 2.5-12 years.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [PASensitivityAnalysis.png](#)

- PASensitivityAnalysis.png
- PRISMA2009Checklist.doc
- PRISMA2009Checklist.doc
- SBSensitivityAnalysis.png
- SBSensitivityAnalysis.png