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Enhancing young children's executive function through physical activities: A systematic review and meta-analysis

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ADMINISTRATIVE INFORMATION

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Review Stage at time of this submission - Completed but not published.

Conflicts of interest - None declared.

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 18 December 2023 and was last updated on 18 December 2023.

INTRODUCTION

Review question / Objective The primary objective of this investigation is to employ a meta-analytical approach to assess the impact of physical activity on the enhancement of executive functions among young children. Additionally, we will undertake an in-depth examination to discern the potential moderating roles played by four pivotal factors: children's age, pedagogical methodologies, intervention duration, and the influence of the exercise paradigm. This comprehensive analysis aims to yield findings that are not only scientifically robust but also grounded in reason.

Condition being studied Physical activity is defined as any body movement that requires energy expenditure. Its main purpose is to promote children's physical and mental development and enhance their physical fitness. The development of

executive function in early childhood establishes the basis for advanced cognition in adulthood. Executive function is divided into low and high-order processes. This refers to the higher cognitive ability to coordinate and control a series of cognitive processes to achieve specific goals. It mainly includes working memory, cognitive flexibility, and inhibitory control. It also includes reasoning, problem-solving, planning, and other higher-order executive functions. This study employed a meta-analysis to determine the effect of physical activity on executive function in young children.

METHODS

Participant or population Children aged between 3 and 6 years.

Intervention Physical activity intervention.

Comparator Non-physical activity intervention.

Study designs to be included Randomized controlled trial Empirical research.

Eligibility criteria 1. The study conducted was designed as an experimental investigation, encompassing both an experimental group and a control group. 2. Comprehensive metrics, such as the mean and standard deviation of both the experimental and control groups, were meticulously documented. These data sets were sufficiently comprehensive to facilitate the computation of the effect size. 3. The study cohort consisted of young children within the age range of 3 to 6 years. 4. The research theme revolves around investigating the influence of physical activity on executive functions in the context of young children. 5. In cases where data duplication is identified in two separate publications authored by the same individual, it is pertinent to select data from only one of the publications. 6. The research is disseminated in either the Chinese or English language. 7. Included studies must be randomized controlled trials.

Information sources Chinese literature was searched using the China National Knowledge Infrastructure (CNKI), while English literature was searched using the Web of Science, Science Direct, ProQuest, and Springer electronic databases.

Main outcome(s) Physical activity can significantly enhance the executive function of young children ($g=0.568$, $P < 0.001$), with an effect size above the medium threshold. In terms of intervention duration, it is noteworthy that interventions spanning a period exceeding 12 weeks yield the most substantial effect size. The implementation of gamification as a teaching method in sports activities has the potential to significantly enhance the development of children's executive function. A significant moderating effect was observed among the subjects' age groups. The effect was significantly higher in the 4-5 and 5-6-year-old age groups compared to the 3-4-year-old age group. The study found that acute physical activity intervention did not have an effect on infant executive function. However, chronic physical activity had a positive and significant effect on infant executive function.

Data management Endnote, zetero.

Quality assessment / Risk of bias analysis The quality of the literature included in the meta-analysis was evaluated using the Cochrane risk

bias assessment tool in Revman software. The tool assessed six areas, namely selection bias, measurement bias, follow-up bias, reporting bias, implementation bias, and other bias. Each index was classified as having high bias risk, low bias risk, or bias uncertainty.

Strategy of data synthesis A meta-analysis was conducted using Stata 17.0 software, with Hedges' g serving as the chosen effect size metric.

Subgroup analysis Child's age, instructional methodology, intervention duration, and exercise paradigm.

Sensitivity analysis To examine publication bias, funnel plots, and the Egger method were utilized. In the detection of publication bias through the funnel plot, the presence of symmetry in the distribution of scatter points around the true value, tending to cluster within a narrow interval, indicated the absence of publication bias. A random-effects model was employed for the meta-analysis in cases where the Q value was significant, and I^2 was equal to or greater than 75%.

Country(ies) involved China.

Keywords Physical activity; Executive function; Young children; Meta-analysis.

Contributions of each author

Author 1 - Yonggang Wei designed this study.

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