

## Systematic Review

### THE EFFECT OF CHILDHOOD OBESITY ON PSYCHOMOTOR BEHAVIOR

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#### ABSTRACT

Childhood obesity is a complex problem, and its prevalence among school-age children has been found to have a greater impact on their physical well-being compared to their learning difficulties. In some cases, teachers or schools may not pay enough attention to issues that have the potential to affect or delay the psychomotor development of children. Therefore, this study aimed to provide enhanced comprehension regarding the effect of childhood obesity on psychomotor behavior. This study used a systematic review methodology to synthesize information regarding the effect of obesity on children's health and development. The information and data presented in this study were obtained from several scientific sources accessed through online libraries such as PubMed, ScienceDirect, and the Cochrane Library. A comprehensive search was conducted to identify scholarly publications, resulting in a total of 815 papers published between 2013 and 2022. The selected papers exclusively consisted of original research articles that primarily focused on investigating the relationship between obesity in children aged 5–14 years, their psychomotor abilities, and development outcomes. Following the screening process, five studies were found to meet the specified criteria. The findings of the selected studies revealed a substantial resemblance, specifically the correlation between childhood obesity and poor motor skills. Furthermore, the selected studies discovered that an increase in body fat was commonly associated with a rise in total body weight, or the relative body mass index (BMI), in both adults and children. Some studies demonstrated significant differences in the performance of diverse psychomotor variables according to children's BMI. According to the results of the studies, children with a higher BMI showed inferior performance in motor activities as a result of compromised body control and balance that inhibited the children's movement. This systematic review concludes that obesity affects the psychomotor behavior of children.

**Keywords:** Obesity; psychomotor; movements; children

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#### Highlights:

1. This study demonstrated an association between childhood obesity and poor psychomotor function, a concern that necessitates a greater effort from multiple stakeholders to improve child health.
2. Given the rising frequency of childhood obesity, this study provides an enhanced understanding of the impact of overweight and obesity on psychomotor abilities.

## INTRODUCTION

The classification of overweight and obesity in children and adolescents is determined by employing age- and sex-specific nomograms to calculate the body mass index (BMI). Children with a gender-specific BMI above the 95th percentile are considered obese. Meanwhile, children with a BMI

of the 85th percentile or above but below the 95th percentile are classified as overweight. This categorization is contingent on the risks of comorbidities that are commonly associated with obesity (Ghosh 2014). The prevalence of obesity is rising globally, resulting in detrimental effects on children's health, motor growth, and participation in physical activities. Childhood obesity is a global

phenomenon that affects all socioeconomic groups, regardless of age, gender, or ethnicity. The etiology of obesity in children is multifactorial and includes genetic, neuroendocrine, metabolic, psychological, environmental, and sociocultural factors (Berleze & Valentini 2022). The growth of children may subsequently result in a growing waistline. However, a lack of movement or activity leaves them more susceptible to the development of obesity and related health issues. Obesity is considered an independent risk factor for various diseases and mortality (Chahar 2014). It poses a serious public health concern and threatens the feasibility of essential medical care in many countries. Childhood obesity has been found to cause comorbidities, such as diabetes and cardiovascular disorders (Sahoo et al. 2015). According to a study by García et al. (2013), there has been a global rise in the prevalence of overweight and obesity among children. The prevalence rate increased from 4.2% in 1990 to 6.7% in 2010. The numbers of overweight and obese children aged 5 to 12 years in Indonesia were found to be even higher. The findings of the 2018 Basic Health Research revealed that the percentages of childhood overweight and obesity in Indonesia were 10.4% and 10.7%, respectively (Badan Penelitian dan Pengembangan Kesehatan 2020).

Children who are classified as obese may encounter difficulties to engage in sports and other recreational activities alongside their non-obese peers. This is because of their comparatively lower levels of real and perceived motor skill competence. The development of children's motor skills is contingent upon the complexity of the activities as well as the opportunities and resources that are accessible within the surrounding environment (Kakebeeke et al. 2017, Awad & Aneis 2022). Obesity is a physical problem that has the potential to decline or slowdown social, emotional, linguistic, and cognitive developments. The processes of intellectual and emotional development are simultaneously interrelated. The presence of an inhibitor in a specific development can potentially have a detrimental effect on other developments. The incidence of obesity in children is influenced by various factors, including lifestyle changes, dietary habits, and parental behaviors, which have been identified as contributors to the increasing prevalence of obesity (Kanazawa 2013, Agudo & Marcenaro-Gutierrez 2021).

One plausible hypothesis argues that obesity may have an impact on the physical development of children, potentially influencing their psychomotor skills and cognitive capacities. Obesity has been found to disrupt coordinated movements in children, particularly in regards to motor development and musculoskeletal issues (Srinag et al. 2020, Zacks et al. 2021). Children who are classified as obese or

overweight have inadequate gross and fine motor control, as well as delayed motor growth. Furthermore, obese children commonly experience neuromusculoskeletal deficits, which might impact their walking movements and hinder their interest or ability to engage in physical activities and exercise. Obesity has been linked to a higher risk of musculoskeletal disorders, which leads to a higher risk of musculoskeletal problems. This condition could potentially be attributed to the increased strain on joints and bones caused by excessive body weight (Wang et al. 2016, O'Malley et al. 2021). In light of the aforementioned risks associated with obesity, this study aimed to offer an enriched and thorough comprehension of the effect of childhood obesity on psychomotor behavior.

## MATERIALS AND METHODS

This study used a literature search strategy to identify and acquire scholarly publications that were deemed crucial to the subject under study. A thorough investigation was conducted on scientific databases using relevant keywords in the search engine queries. The approach used in the literature search for this systematic review was the PICO framework, which incorporated the components of population (P), intervention (I), comparator (C), and outcome (O). The use of the PICO framework in this systematic review assisted the authors in developing clear study questions, conducting direct literature searches, and improving comprehension. This study employed the PICO framework to examine the impact of childhood obesity on psychomotor behavior through a comparative analysis of groups of obese children and control groups of healthy children (Methley et al. 2014).

This systematic review adhered to the standards outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to further expand our knowledge regarding the effect of obesity on the health and developmental outcomes of children. The use of PRISMA guidelines ensured that research methods were carried out in a systematic and transparent manner, improving the quality and consistency of systematic review reporting. The information and data used in this study were systematically obtained from reputable databases, including PubMed, ScienceDirect, and the Cochrane Library. The keywords explored in the literature search were ("effect") AND ("obesity") OR ("obesity in children") OR ("children with obesity") AND ("children") OR (adolescent) AND ("psychomotor") AND ("behavior"). We excluded studies that investigated either adults or people of higher ages, as well as those that did not provide findings related to psychomotor behavior. This systematic review

implemented solid inclusion criteria, specifying that all selected papers must be written in the English language, to ensure the consistency and convenience of data extraction and analysis. The age range of children included in this systematic review was limited to individuals between the ages of 5 and 14 years old. This specific age range was set to focus on a particular developmental stage and gain a comprehensive understanding of the effect of obesity on this age group. This systematic review exclusively contained original research articles to assure the inclusion of comprehensive and reliable research. The researchers made the decision to incorporate primary research and comprehensive evidence synthesis methodologies in the conduct of this study (Page et al. 2021).

The appropriate data from the selected studies were carefully and methodically collected. The dataset contained details pertaining to the population, design, and methodology of the studies. Additional information and data were obtained from several scholarly sources, such as scientific reports and books, by conducting searches on Google Scholar, targeted websites, and e-book platforms. The data were then classified and analyzed to draw conclusions regarding the relationship between obesity and psychomotor disorders in children. Moreover, the significant information from each study was gathered and organized using the software Zotero for Windows, version 6.0. The utilization of Zotero in this systematic review assisted the authors in efficiently managing, organizing, and citing references (Ivey & Crum 2018).

## RESULTS

The literature search resulted in a total of 815 publications, as shown in Figure 1. The 815 publications were subjected to a rigorous screening process aimed at eliminating duplicates as well as papers with titles and abstracts that were deemed irrelevant. Afterwards, a total of 50 articles were screened for the purpose of determining their eligibility with regard to the main topic of this study. After a thorough evaluation of the titles and abstracts, 41 studies were deemed ineligible for inclusion in the systematic review. Among the 41 publications that were omitted, 39 had irrelevant topics, while one study was written in a non-English language. The remaining nine studies underwent further scrutiny, resulting in the exclusion of four publications on account of their undesirable results. As a result, a total of five studies were eligible for inclusion in this systematic review.

This systematic review included five studies that were conducted in Italy, Spain, Croatia, and Britain. The studies that were included in the analysis exhibited a wide range of sample sizes. The age

range of the subjects examined in these studies was around 5 to 14 years old, as shown in Table 1. In this study, an assessment of the risk of bias was conducted to ensure an accurate review. This facilitated the researchers in proving the transparency of the findings derived from the selected studies during evidence synthesis. According to the findings presented in Table 2, the selected studies indicated a statistically significant relationship between childhood obesity and motor activity, with  $p < 0.05$ .

Obesity has been known as a significant factor that causes a variety of diseases and disorders in both adults and children. In recent times, researchers have expressed a growing interest in investigating the potential relationship between obesity and the cognitive and psychomotor abilities of children. The study conducted by Gonzalez et al. (2020) revealed that obesity was linked with both agility and cardiorespiratory fitness. Children who were classified as obese or overweight also showed poor social interactions and relationships. This might be due to several factors related to the children's weight, such as low self-esteem. Obese children might have an increased risk of emotional problems that persist into adulthood. The empirical evidence indicated that obese girls experienced poorer outcomes in their social relationships. Consequently, they might be inclined to engage in solitary activities, including sedentary behavior, which could hinder their psychomotor development and efforts to reduce obesity (Black et al. 2015).

The study conducted by Madrona et al. (2019) examined the relationship between childhood obesity and psychomotor skills. The study involved a sample of 694 children aged 5 years who were enrolled in their third year of early childhood education in Spain in the year 2016. The sample was comprised of 46.7% girls and 53.3% boys. The findings of the study indicated that girls who were obese or overweight had poorer performance in motor activities, social relationships, and perceptual skills in comparison to girls who had a normal weight. In the study conducted by Marmeleira et al. (2017), a sample of 156 participants aged 6–10 years was examined to investigate the relationship between motor skills and body fat percentage in children. The findings revealed a negative correlation between motor skills and body fat percentage, indicating that higher levels of body fat were associated with poorer motor skills. Moreover, the study demonstrated that children who were within the normal weight range exhibited superior motor skills compared to their overweight or obese counterparts. It was observed that the negative impact of excessive body weight was more pronounced on gross motor skills, while fine motor skills appeared to be less influenced by the

constraints imposed by excessive body weight. According to the findings of Favieri et al. (2021), a significant correlation was observed between diminished motor skills and a higher BMI. The correlation was found to be influenced by food intake and eating behavior. Chagas & Batista (2016) revealed that overweight or obese adolescents had poorer motor coordination in comparison to their normal-weight counterparts. This observation was made regardless of the research subjects' levels of physical activity. Furthermore, Cheng et al. (2016) reported that a higher body weight was associated with decreased performance in motor skills, particularly in total and gross motor skills. These skills generally improve as individuals grow older.

A series of tests were conducted on girls and boys aged five years to assess the performance of their psychomotor skills. The tests consisted of a range of psychomotor variables, including physical, sensory,

and social-emotional movements. The children were classified into different BMI groups, i.e., malnutrition, moderate malnutrition, average weight, overweight, and obesity. According to the results of more than half of the physical and motor skill tests, overweight girls had lower scores in comparison to their normal-weight counterparts. These results were apparent in regards to their dynamic adjustment, athletic performance, and balance. Simultaneously, their assessment of tonic attitude control yielded poor scores (Madrona et al. 2019).

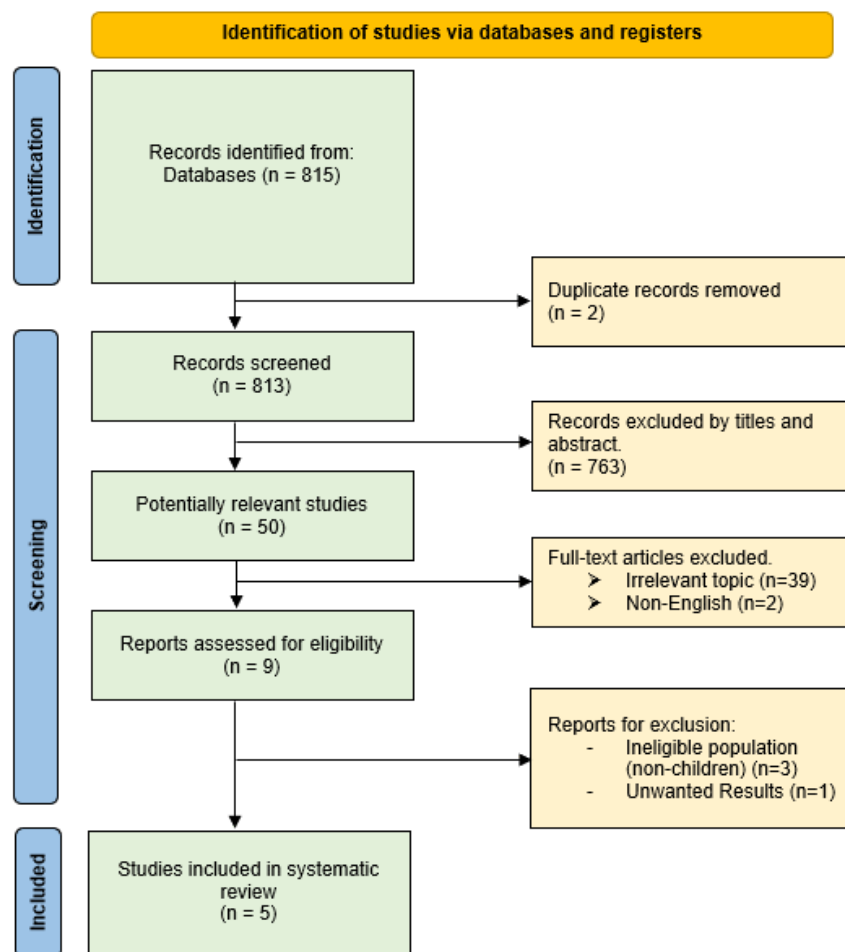


Figure 1. PRISMA flow diagram for this systematic review.

Table 1. Characteristics of the selected studies in this systematic review.

Authors, year	n	Age	Measurement instruments	Outcomes	Results
<a href="#">Madrona et al. (2019)</a>	694	5	CPA	BMI, CPA	Obesity and overweight contributed to poorer performances in motor activities, social relationships, and perceptual skills.
<a href="#">Marmeleira et al. (2017)</a>	156	6-10	Anthropometry measurement, BOTMP-SF	BF%, BMI	There was a negative correlation between children's motor skills and their body fat percentage. Normal-weight children had superior motor skills to those who are overweight or obese.
<a href="#">Favieri et al. (2021)</a>	166 (96 childrens, 70 adolescents)	7-11, 15-18	Assessment of executive functions, Pearson's r correlation	BMI	There was a correlation between poorer motor inhibition and a higher BMI.
<a href="#">Chagas &amp; Batista (2016)</a>	56	13-14	PAQ-C, KTK	Levels of physical activity and motor skills, BMI	Overweight or obese adolescents had lower motor coordination compared to their normal-weight peers, regardless of their physical activity levels.
<a href="#">Cheng et al. (2016)</a>	668	5, 10	BOTMP-SF, CDC standard measurements	BMI, motor skills	Higher weight was associated with decreased activity and motor skills.

Notes: CPA= Checklist of Psychomotor Activities; BOTMP-SF=The Bruininks-Oseretsky Test of Motor Proficiency-Short Form; PAQ-C=The Physical Activity Questionnaire for Older Children; KTK=*Körperkoordinationstest für Kinder* (Body Coordination Test for Children); CDC=Centers for Disease Control and Prevention; BF%=Body fat percentage.

Table 2. Detailed information on the selected studies' objectives and results.

Author, year	Objectives	Results
<a href="#">Madrona et al. (2019)</a>	Assessment of children's psychomotor development using the CPA	There was a correlation between obesity and decreased performance in motor tasks (p=0.001).
<a href="#">Marmeleira et al. (2017)</a>	Assessment of body composition through BMI and skinfold thickness measurement by using the BOTMP-SF	Obese children performed substantially poorer in gross motor abilities and general motor proficiency than children of normal weight (p<0.01).
<a href="#">Favieri et al. (2021)</a>	Correlation analysis of executive functions and BMI	Greater BMI was associated with poorer set-shifting during adolescence and poorer motor inhibition during the initial stages of teenhood (p=0.001 in the BMI to age ratio based on performance).
<a href="#">Chagas &amp; Batista (2016)</a>	Assessment of physical activity and motor coordination levels using the PAQ-C and KTK	Adolescents who were classified as overweight or obese showed lower levels of motor coordination than their normal-weight peers (p<0.05). There was a significant correlation between physical activity and motor coordination observed in the normal weight group.
<a href="#">Cheng et al. (2016)</a>	Assessment of children's motor skills using BOTMP-SF	A greater BMI was associated with severe motor abilities among children aged 5 years (p<0.001).

Notes: CPA= Checklist of Psychomotor Activities; BOTMP-SF=The Bruininks-Oseretsky Test of Motor Proficiency-Short Form; PAQ-C=The Physical Activity Questionnaire for Older Children; KTK=*Körperkoordinationstest für Kinder* (Body Coordination Test for Children).

## DISCUSSION

In this study, we investigated the effect of childhood obesity, which can have significant adverse consequences because childhood is an important stage of human development. One of the consequences of obesity in children is psychomotor disorder. Moreover, physical exercise, basic movement abilities, and motor coordination are all related to childhood obesity ([Han et al. 2018](#), [Kliegman & III 2019](#)). The coordinated movements involved in walking and throwing, which primarily

involve larger muscle groups such as the upper body and legs, are commonly known as gross motor skills. Numerous studies have found a correlation between higher BMI and a subsequent delay in the development of children's fine and gross motor skills ([Zacks et al. 2021](#)).

Numerous studies have been conducted to investigate the correlation between obesity and psychomotor disorders in children. One of the studies revealed that there was a negative correlation between motor competency levels and BMI in

children and adolescents due to biomechanical problems. These problems might arise due to the increased mechanical effort required when performing motor activities that call for body weight support, particularly in individuals with higher body mass. The instruments used for the assessment of motor coordination in the study were the Physical Activity Questionnaire for Older Children (PAQ-C) and the Body Coordination Test for Children (Körperkoordinationstest für Kinder/KTK). The PAQ-C assesses the general levels of physical activity of participants, while the KTK is a comprehensive test that evaluates various aspects, including balance, rhythm, strength, laterality, speed, and agility (Chagas & Batista 2016).

Evidence from multiple studies demonstrated that BMI strongly influenced the performance of physical-motor skills. Assessment using the Bruininks-Oseretsky Test of Motor Proficiency-Short Form (BOTMP-SF) was conducted to evaluate both the gross and fine motor abilities of 156 children. The BOTMP-SF assesses gross motor competence (i.e., running speed and agility, balance, bilateral coordination, and strength), gross and fine motor competence (i.e., upper limb coordination), and fine motor development (i.e., response speed, visual motor control, and upper limb speed and dexterity). The results showed that gross motor skills were more adversely affected by extra body weight than fine motor skills (Marmeleira et al. 2017, Martins et al. 2022).

According to the analyses of the selected studies, obese girls perform poorer than their peers in terms of dynamic coordination, motor function, and balance. The Checklist of Psychomotor Activities (CPA) was utilized to examine 694 obese children pertaining to various variables, such as postural alterations and decreased stability. The results showed that boys had higher motor performance than girls. The Checklist of Psychomotor Activities (CPA) is a tool for assessing the psychomotor development of children. It consists of three domains: physical-motor (i.e., laterality, dynamic coordination, balance, motor execution, and tonic postural control), perceptual (i.e., respiratory control, schema and body image, motor dissociation, visual-motor coordination, and spatial orientation), and social-emotional (i.e., control and social relations). In the study, girls had lower levels of physical activity and motor experiences compared to boys, indicating a substantial impact of BMI on their psychomotor capacity (Madrona et al. 2019). These results might be attributable to the boys' greater involvement in physical activity compared to girls. Poorer set-shifting in adolescence and poorer motor inhibition in young adulthood were found to be related to a higher BMI.

In addition, compared to babies and toddlers with lower fat deposits under the skin, those with more subcutaneous fat had a higher incidence of motor problems, including delayed developmental milestones of rolling over, sitting up, and crawling (Cataldo et al. 2016). According to Favieri et al. (2021), executive functioning difficulties were reported to be related to a higher BMI throughout adolescence and young adulthood. This observation took place among a healthy sample that represented the majority of the population in these age groups, with the subjects falling within the healthy weight to overweight range. In another recent study conducted by Martins et al. (2021), there was a correlation between obesity and several negative outcomes, including impaired motor skill development and a worsened quality of life. This was evidenced by the obese individuals' lower scores in the areas of emotional well-being and physical.

### Strength and limitations

The study used a systematic review approach by initially conducting a rigorous and comprehensive search of the current literature. This implies that a wide range of relevant studies were screened for inclusion, improving the validity and reliability of the results. This systematic review ensured the accuracy and validity of the information acquired in evaluating the psychomotor activity of children. Additionally, it featured control groups of healthy children, allowing for a direct comparison of the psychomotor activity of obese and non-obese children. Therefore, it became easier to pinpoint how obesity specifically affects psychomotor performance.

It is noteworthy to acknowledge the limitations of this systematic review study. First, different methodologies were employed for each of the selected studies. Second, the age range of the research subjects was rather broad, and the instruments were diverse across studies. Third, two out of five studies produced different results compared to the remaining studies. It was challenging to establish a gold standard for evaluating childhood obesity and associated psychomotor side effects due to the various outcomes of the selected studies. Several studies revealed that there was no negative correlation between obesity and motor activity.

### CONCLUSION

A high body mass index (BMI), either classified as overweight or obese, has an effect on the psychomotor behavior of children. Children who are classified as obese or overweight have a high probability of experiencing a decline in their

psychomotor behavior. The suboptimal psychomotor performance observed in overweight and obese children is attributable to their poor body control and balance, which commonly inhibit their ability to move effectively.

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### Conflict of interest

None.

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None.

### Author contribution

MAK contributed to the conception and design, drafting of the article, analysis and interpretation of the data, and collection and assembly of the data. PSR, S, and NEFMF contributed to the conception and design, drafting of the article, critical revision of the article for important intellectual content, and final approval of the article.

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