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Effectiveness of School-Based Exercise and Weight Management Interventions on Body Composition, Fitness, and Metabolic Health in Overweight and Obese Children: Systematic Review

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Abstract: ***Childhood obesity has emerged as a major global public health concern, with a rising prevalence and early onset of metabolic, cardiovascular, and psychosocial complications that can persist into adulthood. Since children spend a significant amount of their daily lives in schools, they offer an accessible and perfect environment for putting large-scale obesity prevention and treatment strategies into practice. The purpose of this systematic review was to assess how well school-based weight-management and exercise programs affected the body composition, physical fitness, and metabolic health outcomes of children who were overweight or obese. In order to find randomized controlled trials published in English between 2000 and 2024, a thorough search of electronic databases including PubMed, Google Scholar, Scopus, and ScienceDirect was carried out. Studies involving children aged 6–17 years who participated in school-based exercise programs, lifestyle modification interventions, or obesity prevention strategies were included. Six randomized controlled trials met the inclusion criteria and were critically analysed. High-intensity interval training incorporated into physical education curricula, culturally appropriate school-based preventative models, combined aerobic and resistance training, and structured lifestyle change programs were among the interventions that were reviewed. The results showed steady improvements in body composition, including favourable changes in lean body mass and notable drops in body fat %. Numerous studies revealed significant gains in muscular strength and cardiorespiratory fitness, measured by VO_2max. Furthermore, improvements were noted in metabolic health metrics as body mass index trajectories, lipid profiles, and insulin sensitivity. High-intensity interval training–based interventions were particularly effective despite shorter training durations, highlighting their feasibility and efficiency within school settings. Overall, the evidence suggests that structured, school-based exercise and weight management interventions are effective in improving physical fitness, body composition, and metabolic health among overweight and obese children and support their integration into school curricula to promote long-term healthy lifestyle behaviours.***

Keywords: Childhood obesity, School-based exercise intervention, High-intensity interval training, Body composition

1. Introduction

One of the biggest public health issues of the twenty-first century is childhood obesity. Due to its strong correlation with the early development of non-communicable diseases such type 2 diabetes mellitus, hypertension, dyslipidaemia, and cardiovascular problems, the rising prevalence of overweight and obesity among youngsters has caused alarm on a global scale. Childhood obesity has detrimental effects on psychological well-being, self-esteem, social engagement, and academic achievement in addition to its effects on physical health.

The aetiology of childhood obesity is multifactorial, involving genetic predisposition, sedentary behaviour, unhealthy dietary patterns, reduced physical activity, and adverse environmental influences. Rapid urbanization, increased screen time, and reduced opportunities for outdoor play have further contributed to declining physical activity levels among school-aged children. As a result, preventive strategies targeting early life stages have become a public health priority.

Because they offer a structured setting with access to organized physical education, nutrition education, and health promotion activities, schools are crucial in influencing children's health-related behaviours. Through consistent exposure to physical activity and health education, school-based interventions have a special chance to reach sizable groups of kids from all socioeconomic backgrounds and can support the formation of lifelong healthy habits.

2. Literature Survey

Numerous randomized controlled trials have looked at how school-based fitness and lifestyle interventions affect children's obesity-related outcomes. Savoye et al. showed that among overweight children, a structured weight-management program that included physical activity and dietary counselling led to improvements in lean body mass, favourable changes in metabolic parameters, and significant decreases in body fat percentage. These findings highlighted the effectiveness of early, multidisciplinary intervention approaches.

Gao et al. reported that school-based concurrent aerobic and resistance training programs significantly improved cardiorespiratory fitness, muscular strength, and body composition in obese children, emphasizing the importance of combining different exercise modalities for optimal

physiological adaptations. Similarly, studies integrating resistance training into school programs showed enhanced musculoskeletal fitness and improved functional capacity.

Large-scale preventive trials such as the WAVES study demonstrated that school-delivered lifestyle interventions targeting physical activity and healthy eating behaviours could slow BMI progression and positively influence long-term health behaviours in young children. The Pathways trial further supported these findings by showing that culturally adapted school-based programs improved dietary habits, physical activity levels, and BMI outcomes among American Indian children, underscoring the importance of cultural relevance in intervention design.

The application of high-intensity interval training (HIIT) in educational environments has been the subject of more recent studies. Despite shorter training durations, studies by Dias et al. and Cao et al. found that HIIT therapies significantly improved VO_2max, adiposity measurements, insulin sensitivity, and lipid profiles. According to these results, HIIT is a practical and time-efficient method for enhancing school-aged children's cardiometabolic health.

3. Problem Definition

Despite growing evidence supporting the benefits of physical activity for paediatric health, the prevalence of childhood obesity continues to rise globally. Traditional physical education programs often fail to provide sufficient intensity or duration of activity to elicit meaningful physiological adaptations, particularly in overweight and obese children. Additionally, the concept, level of intensity, and execution of school-based obesity interventions vary widely, producing uneven results.

To ascertain their impact on important health outcomes including body composition, physical fitness, and metabolic health, current school-based exercise and weight management programs must be methodically assessed. To help physiotherapists, educators, and legislators create evidence-based programs that can be successfully incorporated into school curricula, it is crucial to identify practical, sustainable, and effective intervention options. By combining data from randomized controlled trials, this systematic review aims to close this knowledge gap and provide light on the function of school-based treatments in the management of childhood obesity.

4. Methodology

Study Design

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) standards were followed in the conduct of this systematic review.

Study Selection Process

The database search initially turned up 20 studies in total. Fourteen studies were eliminated after duplicates were eliminated and titles and abstracts were screened using predetermined inclusion and exclusion criteria. The final review comprised the remaining six papers that satisfied all eligibility standards.

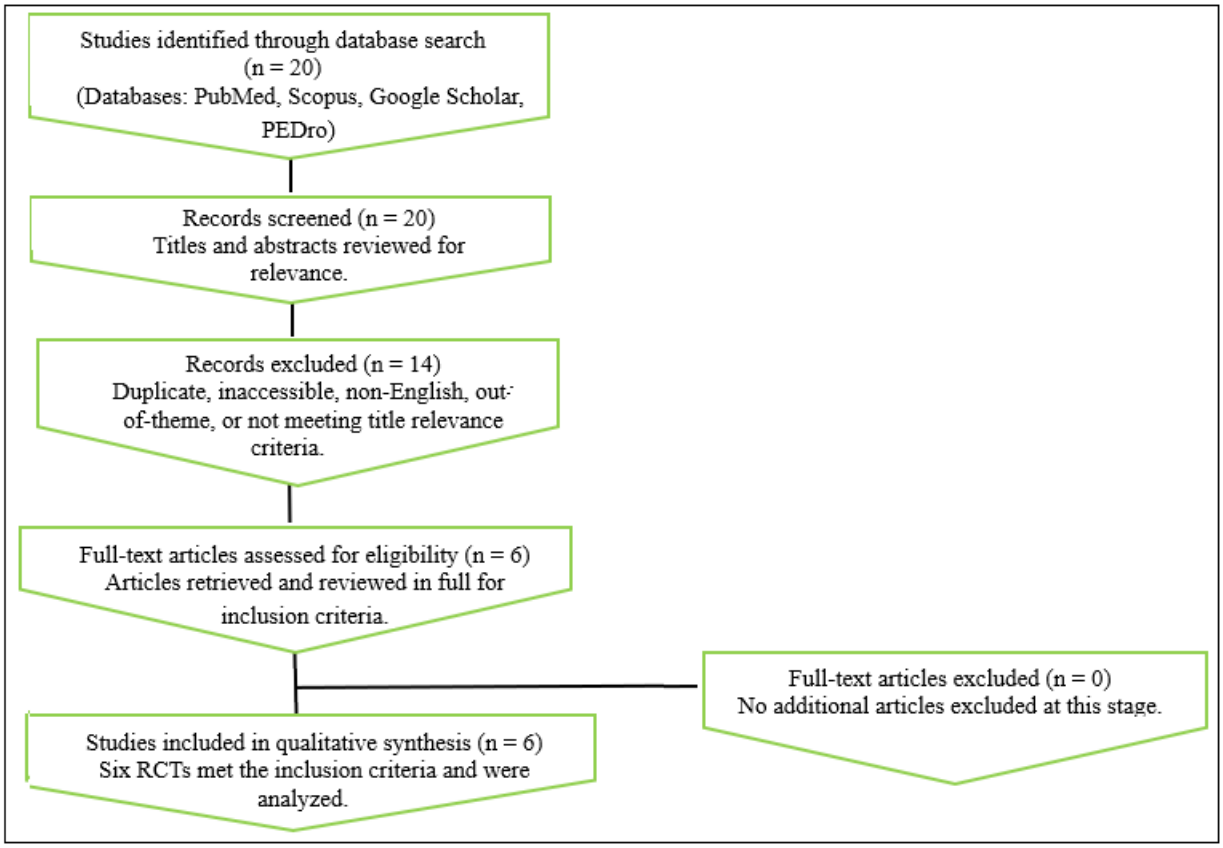

Figure 1: PRISMA flow diagram showing the selection process for studies included in the review

Table 1: Summary of studies included

Author	Study design	Participants	Objective of the study	Results obtained	Conclusion
Savoye M et al.	Randomized Controlled Trial (RCT)	46 overweight children aged 8–12 years	to assess how a systematic weight-management program that incorporates exercise and dietary advice affects adolescents who are overweight in terms of their body composition and metabolic health.	Significant reductions in body fat, improved lean mass, and favourable changes in lipid and insulin profiles were observed.	Combined physical activity and nutrition programs can effectively improve body composition and metabolic parameters in overweight children.
Gao Y et al.	Randomized Controlled Trial (RCT)	60 obese children aged 9–12 years	to ascertain how concurrent aerobic and resistance training in schools affects obese children's body composition and level of fitness.	Marked improvements were seen in cardiorespiratory fitness, muscular strength, and reductions in fat mass.	Concurrent training in schools is a successful method for helping obese kids improve their body composition and level of physical fitness.
Adab P et al.	Cluster Randomized Controlled Trial (WAVES Study)	1,467 children aged 6–7 years	to assess the clinical and financial viability of an obesity prevention program implemented in schools that emphasizes increased physical activity and a balanced diet.	Children in the intervention group showed improved health behaviours and a lower rate of BMI progression.	Early, school-delivered obesity prevention programs can positively influence children's long-term health behaviours and weight outcomes.
Caballero B et al.	Cluster Randomized Controlled Trial (Pathways Trial)	1,704 American Indian school children aged 7–11 years	To assess a culturally adapted, school-based obesity prevention intervention in American Indian communities.	Improved dietary habits, higher physical activity levels, and reduced BMI trends were noted post-intervention.	Culturally sensitive, community-based school programs effectively promote obesity prevention in indigenous children.
Dias KA et al.	Randomized Controlled Trial (RCT)	68 children with obesity aged 10–13 years	To look at how fat mass, cardiometabolic biomarkers, and physical fitness are affected by high-intensity interval training (HIIT).	HIIT significantly increased VO_2max, reduced fat mass, and improved insulin sensitivity and lipid profiles.	HIIT is a time-efficient and effective approach to enhance fitness and metabolic health in children with obesity.
Cao M et al.	Randomized Controlled Trial (RCT)	84 obese children aged 9–12 years	To examine the effects of implementing HIIT within the school PE curriculum on physical activity, body composition, and cardiorespiratory fitness.	The intervention led to improved energy expenditure, reduced body fat percentage, and enhanced aerobic fitness levels.	Incorporating HIIT into school programs provides a practical and effective strategy for improving health and physical activity in children with obesity.

5. Results

Six randomized controlled trials involving children aged 6–17 years were included. The interventions varied in duration, intensity, and type of exercise. All studies demonstrated positive outcomes following school-based interventions.

Structured lifestyle interventions combining physical activity and nutritional education resulted in significant reductions in fat mass and improvements in lean body mass. Concurrent aerobic and resistance training programs improved cardiorespiratory fitness, muscular strength, and overall body composition. HIIT-based interventions showed significant improvements in VO_2max, insulin sensitivity, lipid profiles, and adiposity markers despite shorter training durations.

Culturally adapted school-based programs also demonstrated improved physical activity levels, healthier dietary habits, and favourable BMI trends, emphasizing the importance of contextual relevance in intervention design.

6. Discussion

The findings of this systematic review provide compelling evidence that school-based exercise and weight management interventions play a meaningful role in improving health outcomes among overweight and obese children. Across the reviewed studies, consistent improvements in body composition and physical fitness were observed, reinforcing the view that schools represent a highly effective and accessible setting for early obesity prevention and health promotion.

Interventions adopting a multicomponent approach—particularly those combining aerobic and resistance training-demonstrated greater benefits than single-modality programs. Such programs appear to address multiple dimensions of physical health simultaneously, including cardiovascular endurance, muscular strength, and metabolic efficiency. Notably, high-intensity interval training (HIIT) emerged as a time-efficient and effective strategy, eliciting significant cardiovascular and metabolic adaptations within relatively short intervention periods. This characteristic makes HIIT especially suitable for incorporation into structured school physical education curricula, where time constraints often limit program implementation.

From a physiotherapy perspective, school-based interventions provide a valuable opportunity to apply evidence-based principles of exercise prescription, movement education, and motor skill development at a population level. Early, structured exposure to appropriately

designed physical activity can enhance physical literacy, improve movement confidence, and foster positive attitudes toward exercise. These foundational benefits may contribute to sustained participation in physical activity and healthier lifestyle choices extending into adolescence and adulthood.

Despite the generally favourable results, a number of limitations were found in all of the included investigations. In addition to a dearth of long-term follow-up data to evaluate the sustainability of observed benefits, significant variation was identified in the design, length, and intensity of the interventions. The creation of scalable, uniform intervention frameworks and longer follow-up times should be the top priorities for future study. Additionally, integrating family- and community-based components may further strengthen program effectiveness and support the maintenance of health gains beyond the school environment.

7. Conclusion

School-based exercise and weight management interventions are effective in improving body composition, physical fitness, and metabolic health in overweight and obese children. Implementing structured, evidence-based physical activity programs within the school setting provides a practical and sustainable approach to addressing childhood obesity at an early stage. These interventions are feasible, time-efficient, and easily adaptable to routine school schedules. The findings emphasize the important role of schools and physiotherapists in promoting healthy lifestyles and supporting early obesity prevention, with the potential to reduce long-term health risks and improve overall child well-being.

8. Future Scope

This review highlights the growing potential of school-based exercise programs as a practical solution to childhood obesity, but it also opens several directions for future research. Larger studies involving multiple schools and diverse populations are needed to better understand how different exercise approaches work across various age groups, fitness levels, and cultural backgrounds. Comparing structured formats such as Tabata training, circuit training, and traditional physical activity programs can help identify which methods are not only effective, but also enjoyable and sustainable for children in real school settings.

Future studies should explore the long-term impact of these interventions to determine whether the improvements in body composition and fitness are maintained as children grow older. Including follow-up assessments could provide valuable insight into habit formation and lifestyle changes beyond the intervention period. There is also scope to integrate simple technology, such as activity trackers or mobile-based monitoring, to improve adherence and track daily physical activity more accurately.

In addition to physical outcomes, future research should give greater attention to psychological and social aspects, including self-confidence, motivation, peer interaction, and overall well-being. Understanding these factors may help design programs that children are more willing to participate in. Collaboration between physiotherapists, teachers, parents, and healthcare professionals can further strengthen program delivery. Lastly, assessing the viability and affordability of integrating structured exercise programs into regular school curricula may aid in the creation of long-term, sustainable tactics to address childhood obesity.

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Author Profile

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