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Systematic Review

Interventions on childhood obesity: a systematic review

Bijayalaskhmi Dash[1]*, Sasmita Panigrahi[2]

[1]College of Nursing, MKCG, Berhampur, Odisha, India
[2]College of Nursing, AIIMS Bhubaneswar, Odisha, India

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***Correspondence:**
Dr. Bijayalaskhmi Dash,
E-mail: bldash20496@gmail.com

ABSTRACT

Childhood obesity is a significant medical issue that affects children and adolescents, representing a growing global health concern. Despite its well-documented contribution to cardiovascular disease, non-insulin dependent (type 2) diabetes, and other chronic noncommunicable diseases, it was previously overlooked by individuals. However, in recent years, researchers have conducted various interventional studies to address this pressing health issue. This systematic review evaluates interventional studies conducted between 2000 and 2024 that focus on reducing childhood obesity. Relevant studies were collected from multiple sources that focus on obesity reduction in children. After applying pre-determined selection criteria, only 44 out of 120 studies were chosen and analyzed in detail. The extracted data from eligible research studies included key general characteristics such as the author's name, year of research studied, year of publication, method of sampling and data collected, and study design. Additionally, the study population characteristics such as participant age, sex, sample size, and follow-up details were recorded. The type of intervention and its duration, the measures used to assess childhood weight, and the main findings were also extracted. The extracted data were summarized and presented in the form of table. Based on the findings, it was concluded that among various intervention strategies for managing childhood obesity, combining diet therapy with motivational counseling on diet and exercise produced the best results. It is recommended that a multidisciplinary school-based approach, involving family participation, may be the most feasible and effective strategy, ultimately leading to better outcomes in childhood obesity management.

Keywords: Childhood obesity, Overweight, Interventions for obesity, BMI, Randomized controlled trial physical activity diet therapy, Behaviour therapy

INTRODUCTION

Childhood obesity which is the key factor for obesity may become a long-term, chronic and multifaceted ailment and contributes to various negative physical and mental diseases in later age.[1] Obesity is also identified as a major public health concern which needs urgent intervention. The World Health Organization (WHO) has highlighted childhood obesity as greatest urgent public-health issues of the 21st century.[2] In recent decades, the incidence and prevalence of childhood obesity have risen sharply throughout the world. According to WHO data from 2024, in year 2022 approximately 37 million under-five children were grading I or grade II obese.[3] Prevalence of childhood obesity has touched at alarming points in India. National family health survey (NFHS-5), which has been conducted between 2019 and 2021 revealed that 3.4% of under 5 children were overweight. Additionally, UNICEF's 2022 World Obesity Atlas projected that India may have more than 27 million obese children by year 2030, which would signify 1 in every 10 children throughout glove.[4-6] A research study was conducted by Pati et al in a suburban area of Cuttack, Odisha, found that 12.1% of students were either overweight or obese.[7] Globally, obesity and overweight conditions have been depicted as 5th important risk factor for mortality. Data indicates that approximately 2.8 million adults die annually due to complications arising from excessive weight.[8] Obesity significantly

increases burden of several diseases, contributing to 44% of diabetic diseases, 23% of ischemic heart disease cases, and between 7-41% of specific cancer types. Additionally, more deaths worldwide are now attributed to obesity than underweight. Childhood obesity is not only linked to long-term health complications but also leads to significant psychological consequences.[9,10]

Many overweight children suffer from negative stereotyping, low self-esteem, and poor self-image, which may persist into adulthood. Furthermore, childhood obesity is strongly associated with future adult health risks, including type 2 diabetes mellitus, primary hypertension, asthma, heart disease, cancer, loud snoring with sleep apnea, non-alcoholic fatty liver disease, orthopedic complications, and mental health disorders such as depression.[11,12] Obesity can also lead to early menarche among adolescent girls, develop unhealthy eating habits and nutritional disorders such as anorexia nervosa and bulimia nervosa. Overweight broods are significantly more expected to become an overweight or obese adults.[13,42,47] Many of the strategies proven effective for weight loss and maintenance can also be instrumental in preventing childhood obesity. Various studies suggest that implementing specific dietary, physical activity, and behavioral changes through structured counseling can lead to a reduction in BMI. Researchers have explored different approaches to managing childhood obesity, including interventions through family involvement, community-based programs, school-based initiatives, and after-school activities. With this perspective, an extensive review was conducted to analyze the interventions provided, aimed at preventing and controlling childhood obesity and to identify the most effective strategies.

Objectives

The primary objectives of this review is to find out the most effective interventions for controlling childhood obesity and to provide recommendations for future prevention and management strategies.

METHODS

A systematic review reported in line with the Preferred reporting items for systematic reviews and meta-analyses (PRISMA). The steps that were followed were to identify the research question, to retrieve relevant studies, to chart the extracted data and synthesize and the results

Literature review

To identify relevant literature on interventions for managing childhood obesity, an electronic search was conducted across PubMed, MEDLINE, Scopus and ISI Web of Science. The search, spanning publications from 2000 to 2024, employed keywords such as 'Childhood Obesity,' 'Overweight,',' 'Interventions for Obesity,' BMI, ‘Randomized Controlled Trial’, 'Physical Activity’ 'Nutrition,' 'Behavior Therapy,' and 'Diet Therapy.' A total of 293 studies were identified."

Study selection and eligibility criteria

For the removal of duplicates and the selection of relevant papers was carried out in three phases. In the initial two phases, the titles and abstracts were screened, and any irrelevant papers were excluded. In the final phase, the full texts of the shortlisted papers were thoroughly reviewed to ensure only the most relevant studies were included. Papers were selected based on predefined inclusion criteria; those failing to meet the criteria were excluded and also studies with incomplete information, systematic reviews, meta-analysis, editorials and studies conducted other than the English languages were excluded from the study. Total 293 abstracts were selected and through screening process only 44 interventional studies have been selected (Figure 1).

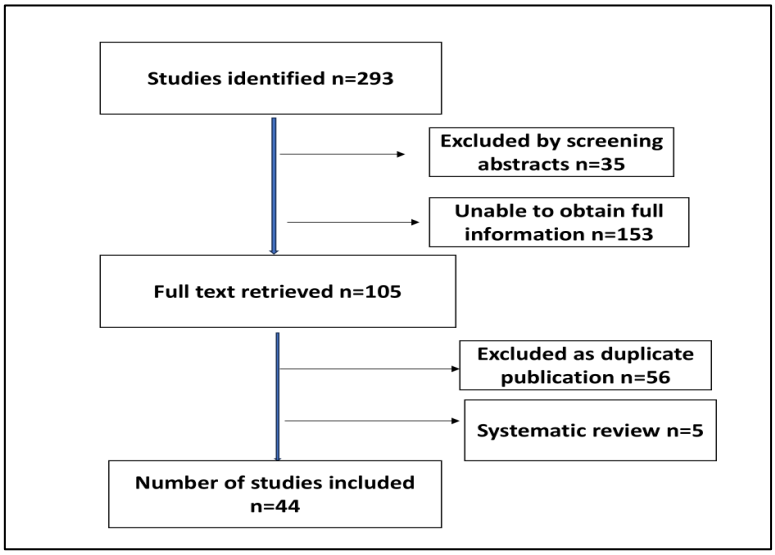

Figure 1: Study selection process by using PRISMA guideline.

Inclusion criteria

The inclusion criteria required for the studies were be conducted between 2000 and 2024, focus on children aged 2-18 who underwent interventions for obesity reduction, be conducted on obese or overweight children and adolescents, be published in the English language.

Exclusion criteria

The systematic reviews, meta-analysis and editorials were excluded from the study, the studies with incomplete information's and were conducted other than the English languages were excluded and the studies on children with specific disease conditions were excluded.

Data extraction and construct

The extracted data from all the selected studies included: General characteristics (Author's name, year of publication, study conducted period, design adopted, and the sampling method used). Study population characteristics (age, gender, sample size, and details about follow-up). Intervention type and its duration and the measures used to measure child weight, chief findings.

RESULTS

The analysis was conducted through a systematic synthesis of the selected studies, which were categorized according to the setting and type of intervention.

Studies were categorized based on their intervention setting and type. Among the total studies, seventeen focused on interventions at the school, fifteen on family-based treatments, as well as twelve on the clinic-based treatment.

Across all categories, the findings consistently demonstrate that multi-component interventions-those combining dietary modification, physical activity, and behavioral strategies-are more effective than single-component approaches.

However, the degree of effectiveness varies depending on the setting in which the intervention is implemented.

A summary of school-based interventions, clinical-based interventions, and family-based treatment for the prevention and control of obesity is presented in tabular format.

Table 1: School-based interventions on childhood obesity.

Name of the author and published year	Design	Study participants	Duration of intervention	Type of intervention	Outcomes
Liu et al, 2022[23]	A cluster randomized clinical trial	8 to 10 years school children	September 11, 2018, to June 30, 2019	Promotion of healthy dietary habit and engaging students in physical exercises and especially involving their parents to support behavioural changes practices of their children.	the overall BMI and it's mean decreased in the group where intervention was given, however it rather observed more in control group. The value difference in BMI mean was -0.46 with 95% CI, ($p<0.001$),
Ckovics et al, 2019[24]	Cluster randomized trial using 2×2 factorial design.	Fifth to eighth standard	3 years	Implementation of nutrition policies physical activity policies	BMI percentile increased 3%-4% especially result of implementation of school-based nutrition policies
Donnelly et al, 2009[15]	Randomized controlled trial (Cluster)	All children in grades two and three	3 years	Physical exercise across the curriculum was promoted and students were practiced	Significantly reduced BMI
Greening et al, 2011[38]	Randomized controlled trial	Children between 6-10 years old	Duration of 9 months	Education about balance diet and good nutrition and physical exercise	Statistically significant improvement in BMI, reduction of body fat, improvement in physical activity, showing good result in performance on fitness tests, and changes in dietary habits when compared with the control group.
Priyali et al, 2010[39]	Randomized controlled trial	8-18 years school children	29-months duration	Nutrition education and education about physical exercise, healthy cooking practice	Changes in knowledge and behaviour was observed particularly in old children between 8-11 years of age group.

Continued.

Name of the author and published year	Design	Study participants	Duration of intervention	Type of intervention	Outcomes
Fung et al, 2012[40]	Randomized Controlled trial (cluster)	Grade V students	From 2008 to 2010 (3 years)	Implementation of Alberta project promoting healthy eating and active living	Students become more physically active and BMI significantly decreased
Foster et al, 2008 [41]	Randomized Controlled trial (cluster)	School children (4-6th grade)	Duration 2 years	Nutrition education was promoted, healthy diet supply, implementation of nutrition policy and parent outreach	50% decline in overweight
Mauriello et al, 2010, USA[42]	RCT	Adolescents from eight high schools (4 states)	2006 to 2007 (1 year)	physical exercise, More vegetable and fruit consumption, and restricting the amount of time to spend using electronic devices	BMI reduced significantly Less overweight children in treatment group were found.
Bacardí-Gascon et al, 2012[10]	Randomized cluster-controlled trial	2nd class and 3rd class (n=532) lower primary school children	Six months duration	Decreasing of sedentary behaviour and promotion of nutrition education	After six months changes were observed in BMI and after completion of 2 year. The BMI z-score and waist circumference increased and abdominal fat reduced.
Plachta-Danielzik et al, 2007, Germany[43]	RCT	Children (only 6 years)	1 year	Providing nutrition education, practicing physical exercise regularly and decrease in TV consumption	Subsequently eight years later, there were favourable and constant outcomes on BMI-standard deviation score
Özgür et al, 2011[44]	Parallel group design	All primary school children Selected from 6 schools in Denizli	One year	The groups were randomly classified into 2 groups and the control group physical exercises and nutrition programs for group 1 and only nutrition program was arranged for group 2	BMI increase in both of the intervention groups but more in group 1
Bürgi et al, 2012, Switzerland[45]	Cluster-RCT	652 preschoolers (72% of migrant, 38% of low educational level (EL) parents)	1 year duration	A multidimensional lifestyle intervention performed	Children of migrant parents benefitted where as children of low educational level parents benefitted less.
Bloom et al, 2013[46]	A pilot evaluation (RCT)	Overweight children (ages 6-12 years old)	6 weeks	Children's Appetite Awareness Training	significant, short-term effect on the BMI.
Malakellis et al, 2017[47]	School-based systems change for obesity prevention in adolescents	Three intervention schools and three comparison schools age 12-16 years)	3 years duration	The intervention consisted of multiple initiatives at individual, community, and school policy level to support healthier nutrition and physical activity.	Within schools, two of three the intervention schools showed a significant decrease in the prevalence of overweight and obesity
Duncan et al, 2009[48]	Pre, post control group design	10-11 years old Children	6 weeks	6-week circuit training treatment on BMI in British primary school children	BMI decreased significantly in treatment group when associated to the control group.
Contento et al, 2010[13]	RCT Cluster trial	64 numbers 11-13 years old children	8-10 weeks	Behavioural education and follow-up	Behaviours change students use to take less sweetened beverages and packaged foods; increased walking followed by less BMI after 6 months

Continued.

Name of the author and published year	Design	Study participants	Duration of intervention	Type of intervention	Outcomes
Caballero et al, 2003[12]	Randomized controlled, school based trial	1704 children in 41 schools (3-5th grade Children)	over 3 consecutive years	The intervention had 4 components: 1) alteration in dietary intake, 2) Upsurge in physical exercise, 3) a classroom teaching giving importance on healthy nutrition and lifestyle, and 4) involvement of family members.	No significant reduction in percentage body fat Significant changes in fat intake and changes in food- and health-related behaviors. More intense or longer interventions may be needed to significantly reduce of BMI in this population.

Table 2: Family-based interventions on childhood obesity.

Name of author and published year	Design	Study participants	Duration of intervention	Type of intervention	Outcomes
Gunnarsdottr et al, 2012, Iceland[16]	Epstein's family-based behavioural treatment	7.5-13.6 years old children	18 weeks	Family lifestyle changes education	BMI mean and Standard deviation declined
Teran-Garcia et al, 2023[25]	Randomized control trial	One parent and one child 6-18 years of age from every family	6 months	Abriendo Caminos intervention (a type of family-based intervention program that aims to prevent childhood obesity)	These interventions effectively prevented unhealthy weight gain but observed no alterations in BMI-z scores between two clusters
Rimke et al, 2011[49]	RCT	11-15 years old children	3 months	multidisciplinary treatment	Significant fall in BMI standard deviation score after the study and after 1 year
Bean et al, 2012[58]	RCT pilot trial	6-11 years School going children	12 month	Parenting skill was changed and healthy habits were adopted	No changes on children's BMI percentile. An increment in children's fibre intake and protein consumption
Danielsen et al, 2013[14]	RCT	Children within 7-13 years	12 weeks	family-based perceptive behavioural treatment, treatment on BMI, self-esteem and depression syndromes	Mean BMI Standard deviation Score was reduced to0.18 units and continued after one year's follow-up
Kalavainen et al, 2007[50]	Randomized clinical trial	Seventy obese children (weight for height 115-182%) aged 7-9 years	6 months	Nutrition counselling physical activity education and behavioral therapy	Children present in the group treatment i. e., (physical exercise education and behavioural therapy lost more weight for height (6.8%) than children receiving routine counselling (1.8%) (p=0.001).
Teder et al, 2012.[5)]	One-group pre-test and post-test design	Children within 8 to 12 years age group	2 years duration	Type of intervention include health education about diet, physical activity increase and problem solving	The result depicted that there is no change in waist-hip ratio but overall, BMI decreased
Avery et al, 2012[52]	Family-based National program	11-15 years adolescents	8 months	The intervention was the cheer off of family members for implementing healthier lifestyle and behaviors	Height, weight, BMI and z-values were assessed. The mean, Standard deviation and BMI z-score was changed for 0.22 units
Raynor et al, 2012[37]	A family-based approach for weight management through RCT	Children (5-9 years Old)	6 months	3 treatments were provided. 1. Growth recording with response. 2- Reduction in first foods and sweetened tea/coffees, and 3. intake of more fruits and vegetables	It was observed that change in vegetable and fruits consumption was not significantly related to change in energy intake. However, reduction in snacks food intake was significantly related to reduction in energy intake

Continued.

Name of author and published year	Design	Study participants	Duration of intervention	Type of intervention	Outcomes
Stark et al, 2014[26]	Pilot RCT	Children within 2-5 years	6 months duration	Behavioural family-based intervention	Significant more deterioration of BMI z-score percentile
Garipağaoğl et al, 2009[53]	RCT	Children between 6-14 years old	3 months	Provide low-caloric food through individual treatment or group treatment and persuade healthy eating behaviour and practice to reduce sedentary habits	A substantial declining of BMI and standard deviation score were observed in two groups, and this reduction was sustained for one year. In the treatment group, there was an increase in fruit and vegetable intake and a decline in the consumption of sugar added beverages in both groups
Skelton et al, 2008[54]	Experimental	Children 2-18 years old	12 months	Intellectual and behavioural modification, proper diet and physical exercise teaching	There was a significant decrease on the primary outcome of change in BMI z-score
Berkowitz et al, 2011, USA[27]	RCT	Adolescents within 13-17 years	One year	Dietary replacements and provision of healthy diet in treatment of adolescents with obesity	Significant weight loss and BMI decrease in meal replacement or treatment group,
Savoye et al, 2011[28]	Parallel design with randomised trial	Children between 8-16 years	One year	Interventions on lifestyle modifications	BMI and body fat (BF%) percentage, tends to decrease but because of majority of them are moderate to severe of obese and coming from culturally diverse backgrounds of children, the benefits of an intensive lifestyle program can be continued 12 months after finishing vigorous intervention phase
Berkowitz et al[59]	A randomized controlled trial	13-17 years adolescents	12 month	Meal replacement, lifestyle modifications	Significant increase in weight loss and decrease in BMI in meal replacement group

Table 3: Interventions at clinic on childhood obesity.

Name of author and published year	Design	Study participants	Duration of intervention	Type of intervention	Outcomes
Kirk et al, 2012[55]	RCT	Children between 7-12 years of age	3 months	Participants were allocated to any one of the three dietary groups. Intervention: dietary counselling. Biweekly group exercise sessions	Less BMI z-score in entire dietary clusters which were continued at 6 months with identical results for Body fat percentage (BF%) and waist circumference.
Kelishadi et al, 2012[18]	Clinical non-randomized trial	Children and adolescents (2-18 years of age)	24 weeks	This trial included three components i.e. exercise, dietary education and behaviour modification education	The mean of anthropometric measurements and cardio-metabolic risk factors reduced significantly
Murer et al, 2011[56]	Multidisciplinary weight-loss program	Adolescents aged 12-16 years	2 months	Multidisciplinary weight-loss program (Moderate calorie control, everyday physical exercises, and application of behaviour modification strategies)	Weight, BMI, body fat assessed 14.8% and 22.8% loss of body weight and sum of fat mass (FM) respectively

Continued.

Name of author and published year	Design	Study participants	Duration of intervention	Type of intervention	Outcomes
Taveras et al, 2011[29]	Cluster RCT	475 numbers of children between 2-6 years of age group	1 year	Aiming television viewing on the effect of the fast food and sweetened food motivational talk by clinicians and provision of educational modules	BMI among intervention group changes when compared with the group getting usual care, treatment group had nonsignificant change in BMI
Rezvanian et al, 2010[30]	RCT (Triple masked, placebo controlled clinical trial)	180 number of subjects age between 10 to 16 years.	12 weeks	All groups were randomly assigned to four groups of equal numbers of subjects to receive different individual and combination of drugs along with placebo.	BMI decreased significantly in all treatment groups, WC significantly decreases in metformin receivers but this was not significant with the placebo group.
Shalitin et al, 2009, Israel[31]	Randomized clinical trial	162 numbers of 6-11 years obese children	12 weeks interventions a	Subjects divided into 3 groups moderate exercise 3 days/week for 90 minutes, balanced low caloric diet and for 3rd group diet+exercise was administered	BMI, BMI-SDS and FM decline was significantly. Diet combined with exercise are the utmost effective short-term treatments for weight loss and improved cardiometabolic profiles for obese children
Ounis et al, 2009[32]	Clinical trial	24 obese adolescent boys	2 months	3 groups: dietary restriction i.e. Hypocaloric diet, individualized training program, and diet combined with training	At end of these programmes, adolescents in dietary therapy when combined with group receiving health education showed greater reductions in BMI
Knöpfli et al, 2008[57]	Multidisciplinary in-patient program	Adolescents (12-15 Years old)	8 weeks	Physical exercise daily, low calorie diet, behaviour modification	At end of this treatment program all the adolescents had lost a significant amount of body weight
Dreimane et al, 2007[34]	A clinic-based, family-centred treatment plan	Overweight children and adolescents (7-17 years)	12 weeks	Treatment program comprising of up to 12 ninety-minute sessions at outpatient setting. (Interactive dietary and Physical activity sessions with behaviour alteration)	BMI, and BMI z-score were less throughout the program than observation period or before programme period
Ford et al, 2009, Sweden[35]	Randomized controlled trial	Young obese people aged 9-17 (n=106)	12 months	The Mandometer was used along with lifestyle modification therapy	Change in BMI and standard deviation score (SDS) over 1 year with continuation assessment at 1 and half year after the start of the treatment
Tan-Ting et al, 2011[20]	Clinic based multi-disciplinary weight loss programme	The participants include 5-17 years old children and adolescents	3 months	Alteration in diet consumption and changes in eating habits, increasing physical exercise, and motivation on eating habits	The patients shown a decreasing in BMI, BMI z-score, body fat percentages, decreasing blood pressure, and waist circumference.

School-based interventions emerged as the most impactful and sustainable strategy. One key reason is their broad reach: schools provide access to a large and diverse population of children across different socioeconomic backgrounds. This allows interventions to be implemented at scale, increasing their public health impact. Additionally, the structured nature of the school environment ensures regular exposure to intervention activities, such as scheduled physical education, nutrition education, and regulated meal programs.

Another important factor is peer influence. Children are highly responsive to social norms, and behaviours adopted within peer groups tend to be reinforced and normalized. For example, when a majority of students engage in physical activity or choose healthier food options, it creates a positive social environment that encourages others to follow. This "ripple effect" enhances adherence and long-term behaviour change.

Moreover, schools play a critical role in shaping daily routines. Since children spend a significant portion of their day in school, interventions integrated into this setting-such as active breaks, healthy cafeteria policies, and health education-become part of their habitual behaviour. Over time, these repeated exposures contribute to sustained lifestyle changes, making school-based programs particularly effective for long-term obesity prevention.

Family-based interventions, while also effective, show variability in outcomes, their success largely depends on parental involvement, consistency, and the home environment. Interventions that actively engage parents in nutrition education, meal planning, and physical activity tend to produce better results. However, differences in parental knowledge, time availability, and socioeconomic conditions can influence the effectiveness and sustainability of these programs.

Clinic-based interventions are typically more individualized and often involve professional guidance, such as dietary counselling, medical monitoring, and behavioural therapy. These interventions can be highly effective for children already identified as overweight or obese, particularly in managing clinical outcomes. However, their reach is more limited compared to school-based programs, and they may be less sustainable due to factors such as cost, accessibility, and reliance on regular follow-up visits.

Overall, the findings suggest that while all three approaches contribute to the prevention and management of childhood obesity, school-based interventions offer the greatest potential for large-scale, long-term impact. Their ability to integrate health-promoting behaviours into daily routines, leverage peer influence, and reach a wide population makes them a critical component of public health strategies aimed at reducing childhood obesity.

DISCUSSION

Based on the overall findings, it can be anticipated that school-based intervention programs have the potential to create long-term positive effects. Although all the three types of interventions (school-based, family-based, and clinic-based) have demonstrated effectiveness in managing childhood obesity, school-based programs stand out as the most sustainable and impactful. A key strategy for childhood obesity management is behavioural therapy, which includes various components like motivational counselling, setting of goal, target tracking, continuous monitoring, positive reinforcement, and cognitive restructuring. According to Teder et al family-based behavioural intervention programs (FBIPs) against childhood obesity have shown promising result in their study.[51]

Aychiluhm et al conducted a systematic review and meta-analysis on interventions for childhood central obesity depicted that RCTs, combining dietary changes with physical activity, as well as using behavioral strategies alone, were associated with reduced central obesity in children from high- and middle-income countries.[60]

Research findings indicate that behavioural therapies are highly effective in promoting weight reduction, BMI improvement, healthier dietary habits, and increased physical activity levels.[61] Among the different behavioural approaches, behaviour modification therapy has been identified as the most effective method for children, particularly those in early adolescence. Some of the studies (interventions) shows very nonsignificant change effects or no effects in on anthropometric index.[29,34]

Several studies have demonstrated that when dietary changes, physical exercise, and behaviour therapy are integrated into a single intervention plan, the results tend to be more impactful, especially among older children. This suggests that adopting a comprehensive and multifaceted approach is crucial in ensuring the long-term success of obesity management strategies. Findings further indicate that a multidisciplinary school-based approach that actively involves families can be the most feasible and effective intervention for addressing childhood obesity. A systematic review and meta-analysis were conducted by Johns et al on diet or exercise interventions vs combined behavioral weight management programs and depict that behavioral weight management programmes combining diet and physical activity are more effective for weight loss over 12 months than interventions based on diet or physical activity alone.[61]

Cure from obesity is difficult if it started in later stage but it can be easily prevented from childhood itself.[62] Family involvement plays a critical role in developing children's dietary habits and physical activity levels, making it a key component of any successful intervention strategy. If such interventions are designed in collaboration with nutritionists and health professionals, they can yield even better results in managing and preventing childhood obesity. In conclusion, to effectively combat the rising prevalence of childhood obesity, intervention programs should focus on school-based initiatives that incorporate diet, exercise, and behaviour therapy while engaging families in the process. A well-structured, evidence-based approach guided by expert recommendations from nutritionists and healthcare professionals can significantly enhance the long-term achievement of obesity prevention programs and contribute to better health results for children and adolescents.

CONCLUSION

To tackle childhood obesity, a diverse range of interventions are needed, encompassing individual-level strategies like healthy eating and physical activity, as well as broader societal changes like policy and environmental interventions. Policies could limit the marketing of unhealthy foods to children or promote clear food labeling to help families make healthier choices. Schools can adopt guidelines to provide healthier lunches, prohibit junk food sales, and integrate wellness program. Developing parks, playgrounds, and safe walking paths encourages children to be more physically active at urban areas to reduce childhood obesity.

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