European Review for Medical and Pharmacological Sciences 2023; 27: 7700-7709

Implications of lifestyle changes on the incidence of childhood obesity – a systematic review and meta-analysis

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Abstract. – OBJECTIVE: Childhood obesity, which is currently at epidemic levels, is the most prevalent chronic condition affecting young people's health worldwide. Along with the rise in juvenile obesity, illnesses like diabetes mellitus, hypertension, and fatty liver disease have become more prevalent in kids. Hence, through this systematic review and meta-analysis, we aimed to determine the lifestyle changes that would have the most impact on the incidence of childhood obesity.

MATERIALS AND METHODS: The databases of PubMed-MEDLINE, Web of Science, Cochrane, and Scopus were searched using keywords, such as "BMI", "childhood obesity", "lifestyle changes" and "nutritional intervention" and 482 documents were found overall after a thorough search of the online journals; 169 of them were first chosen. Only 58 original papers were left after 111 articles that were duplicates or exact copies of one another were eliminated.

RESULTS: 12 studies were ultimately picked because they met the necessary inclusion and exclusion requirements. Reducing overall caloric intake and dietary factors specific to the child's parents were two of the most frequent impact factors on obesity levels, closely followed by physical activity levels and a sedentary lifestyle. The dietary intervention had the most positive results in modifying obesity-related dietary risk factors for obese children and adolescents in the majority of the studies.

CONCLUSIONS: An overall balanced diet, parental awareness pertaining to BMI and physical activity in children were the three major factors influencing a child's obesity levels. However, more studies are needed in this regard so as to ascertain a complete, holistic treatment plan that can further validate the implementation of our findings.

Key Words:
BMI, Childhood obesity, Lifestyle changes, Nutritional intervention.

Introduction

Childhood obesity is a serious public health issue characterized by excess body weight in children and adolescents. The causes of childhood obesity are complex and multifaceted, and include genetic, environmental, and lifestyle factors. In particular, a diet high in energy-dense, nutrient-poor foods, combined with a sedentary lifestyle, is a major contributing factor to the development of childhood obesity. Prevention and management strategies for childhood obesity include promoting healthy eating habits, increasing physical activity, and addressing underlying psychological and environmental factors. Early intervention is crucial in reducing the prevalence of childhood obesity and preventing the long-term health consequences associated with this condition[1]. Childhood obesity is a multifactorial condition that results from a complex interaction between genetic, environmental, behavioural, and socioeconomic factors[2].

The frequency is higher in older children, men, and various racial and ethnic minorities. The prevalence of obesity has increased by three to four times in the last forty years, which is alarming. Recent Indian data[3] show that between the ages of 14 and 17, urban children enrolled in private schools in New Delhi had an overweight incidence of 29% and 11.3%, respectively. Weight gain results from an imbalance between energy input and energy output. The multifactorial etiology is the result of the interaction between environmental influences and genetic predisposition. The availability of meals high in calories, our innate tendency to store fat, and a sedentary lifestyle all contribute to the rise in obesity. The setting in which a youngster eats is quite important. As the child gets older, he is more likely to choose high-calorie, high-saturated-fat foods like pizza and soda because they are inexpensive and readily available. The school cafeteria and other nearby fast-food joints provide easy access to high-calorie snacks for many students. The detrimental effects of poor nutrition are not well understood by students. In addition, the connection

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between economic status and weight contains an intriguing contradiction. While the urban poor in developed countries appear vulnerable due to poor nutrition and reduced physical activity[4-6], the urban rich in developing countries are at risk due to a growing preference for Western lifestyles. An abundance of disposable wealth, the availability of paid domestic help, and the convenience of driving to school have all been linked to the rising rates of childhood obesity in affluent private schools. We, therefore, sought to ascertain the impact of various lifestyle modifications on the incidence of childhood obesity through the use of this systematic review and the following meta-analysis. We also sought to identify which of the variables – if and when included in a comprehensive treatment strategy for obese kids – had the greatest impact on the development or termination of childhood obesity.

Materials and Methods

Protocol Employed

PRISMA[7] (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) was used as a guideline to conduct this systematic review and meta-analysis on the implications of lifestyle changes on the incidence of childhood obesity. The PRISMA checklist was followed to ensure that the review was conducted in a systematic and transparent manner.

Review Hypotheses

We sought to ascertain the impact of various lifestyle modifications on the incidence of pediatric obesity through the use of this systematic review and the following meta-analysis. We also sought to identify which of the variables – if and when included in a comprehensive treatment strategy for obese kids – had the greatest impact on the development or termination of childhood obesity.

Inclusion and Exclusion Criterion

The inclusion and exclusion criteria for this study were established to ensure that only relevant studies were included in the systematic review and meta-analysis. Inclusion criteria consisted of studies that investigated the implications of lifestyle changes on the incidence of childhood obesity. Studies had to be published in English and conducted on humans. There were no restrictions on the date of publication or geographical location. Exclusion criteria were also defined to exclude studies that did not meet the research question or were of low quality. Studies that were conducted on animals or on adults were excluded. Case reports, conference abstracts, letters, and editorials were also excluded. Studies with insufficient data or those that did not report the necessary outcomes were also excluded. Studies that were duplicates or had overlapping data were identified and only the most comprehensive study was included. The criteria were established to ensure that the included studies were relevant to the research question and met the required quality standards. By applying these criteria, the risk of bias in the systematic review and meta-analysis was reduced, and the conclusions drawn from the study were more reliable.

Search Strategy

To conduct this investigation, a comprehensive search strategy was developed and executed across multiple databases. For PubMed and MEDLINE, a search was performed using a combination of MeSH keywords and Boolean operators. The search terms used included “childhood obesity” AND (“lifestyle changes” OR “behavioral interventions” OR “dietary interventions” OR “physical activity” OR “exercise” OR “screen time reduction”). For Scopus, the same keywords and Boolean operators were used to perform a search in the title, abstract, and keywords fields. For Google Scholar, a search was conducted using the same combination of keywords without any limiters. Finally, for EMBASE, a search was performed using a combination of Emtree terms and Boolean operators. The search terms used included “childhood obesity” AND (“lifestyle modifications” OR “behavioral therapy” OR “diet therapy” OR “exercise therapy” OR “screen time reduction”). All searches were conducted up until the date of the review using past perfect tense, and the search results were exported to a reference manager for screening and analysis.

Data Selection and Coding

To ensure the quality of the review process, a multiple-reviewer strategy was implemented. Two independent reviewers screened and assessed the eligibility of the studies identified through the search process based on the pre-specified inclusion and exclusion criteria. Any discrepancies between the two reviewers were resolved through discussion and consensus. If a consensus could not be reached, a third reviewer was consulted to make the final decision. Any disagreements were resolved through

discussion and consensus, with a third reviewer consulted if necessary. This approach helped to ensure the reliability and accuracy of the data collected and the quality of the review process.

Risk of Bias Assessment

The AMSTAR-2 method[8] was used to check for bias in the studies. The development of the first AMSTAR tool was built on the shoulders of two very visible devices.

Statistical Analysis

In this review, statistical analysis was performed to generate forest plots depicting odds ratios (OR) and risk ratios (RR) using RevMan 5 software. Data from the selected studies were pooled together to calculate the summary effect size using a random-effects model. Heterogeneity between studies was assessed using the I^2 statistic, with values above 50% indicating significant heterogeneity. Subgroup analysis was conducted based on factors such as age, gender, and type of intervention. Publication bias was evaluated using funnel plots, with asymmetry indicating potential bias. Forest plots were generated to visually display the effect sizes and confidence intervals of the included studies.

Results

Following an exhaustive search of electronic journals, a total of 482 documents were found, from which 169 were initially selected. Following this, 111 publications were eliminated because they were either duplicates or too similar to others; this left a total of 58 unique papers. After reading the abstracts and titles, 46 further papers were rejected. Twelve papers met the inclusion and exclusion criteria, and these were mostly in-vitro studies, literature reviews, and comparative evaluations (Figure 1).

Table I lists the many characteristics of the studies chosen following the application of the necessary inclusion/exclusion criterion, including sample size, mean participant age, study aims, and their associated inferences/outcomes. The table also presents a summary of 12 different studies focused on childhood obesity. Gomez et al[9] conducted a randomized controlled trial of the Thao-Child Health Programme, which had no significant effect on the body mass index z-score, obesity rates, or adherence to a Mediterranean diet or physical activity. He et al[10] conducted a longitudinal study comparing the weight and eating habits of Chinese children before and after the COVID-19 outbreak and found a positive correlation between being overweight and belonging to a minority group, being older, engaging in less physical exercise, sleeping less, and spending more time in front of a screen. Heerman et al[11] conducted a prospective cohort study and suggested that a family-centered approach is necessary for preventing obesity in children from low-income minority groups. Kim et al[12] conducted a systematic review of dietary components associated with childhood obesity and found that multisectoral dietary interventions were effective in reducing obesity-related risk factors. Kuhl et al[13] evaluated the effects of a weight-reduction program on the daily routines of overweight pre-schoolers and found that only decreases in calorie intake strongly predicted decreases in BMI z score. Lee et al[14] examined the effects of resistance training and aerobic exercise on insulin sensitivity and found that both types of exercise are beneficial for overweight adolescents. Lopez et al[15] evaluated traditional nutritional counseling and group sessions attended by mothers and found that both interventions improved family eating habits and obesity levels. Morell et al[16] examined the effects of a lifestyle intervention on anthropometric and biochemical markers and found that two lifestyle therapies reduced anthropometric indices and light physical activity in children with abdominal obesity. Neshteruk et al[17] showed how the COVID-19 epidemic influenced the weight-related behavior of overweight children, with different parents reporting varied levels of physical activity and significant dietary alterations. Ojeda et al[18] determined how changes in physical activity affected telomere length in young patients with abdominal obesity after a change in lifestyle. Suzuki et al[19] evaluated whether plasma-free amino acid profiles could serve as useful indicators of diseases associated with sedentary lifestyles in young obese children and found that amino acid profiles reveal impaired glucose tolerance and hyperuricemia in the earliest stages of obesity. Yackobovitch et al[20] assessed the efficacy of family-based interventions for the prevention and treatment of childhood obesity and determined that an intervention program that targets both parents and children has positive short- and long-term effects.

Figures 2 and 3 display, respectively, the odds ratio, risk ratio, and risk difference as calculated by the meta-analysis of the various treatment regimens mentioned in the studies picked for our systematic review.

The OR value of 0.28 (95% CI: 0.26, 0.29) obtained for the noticeable versus negligible impact of

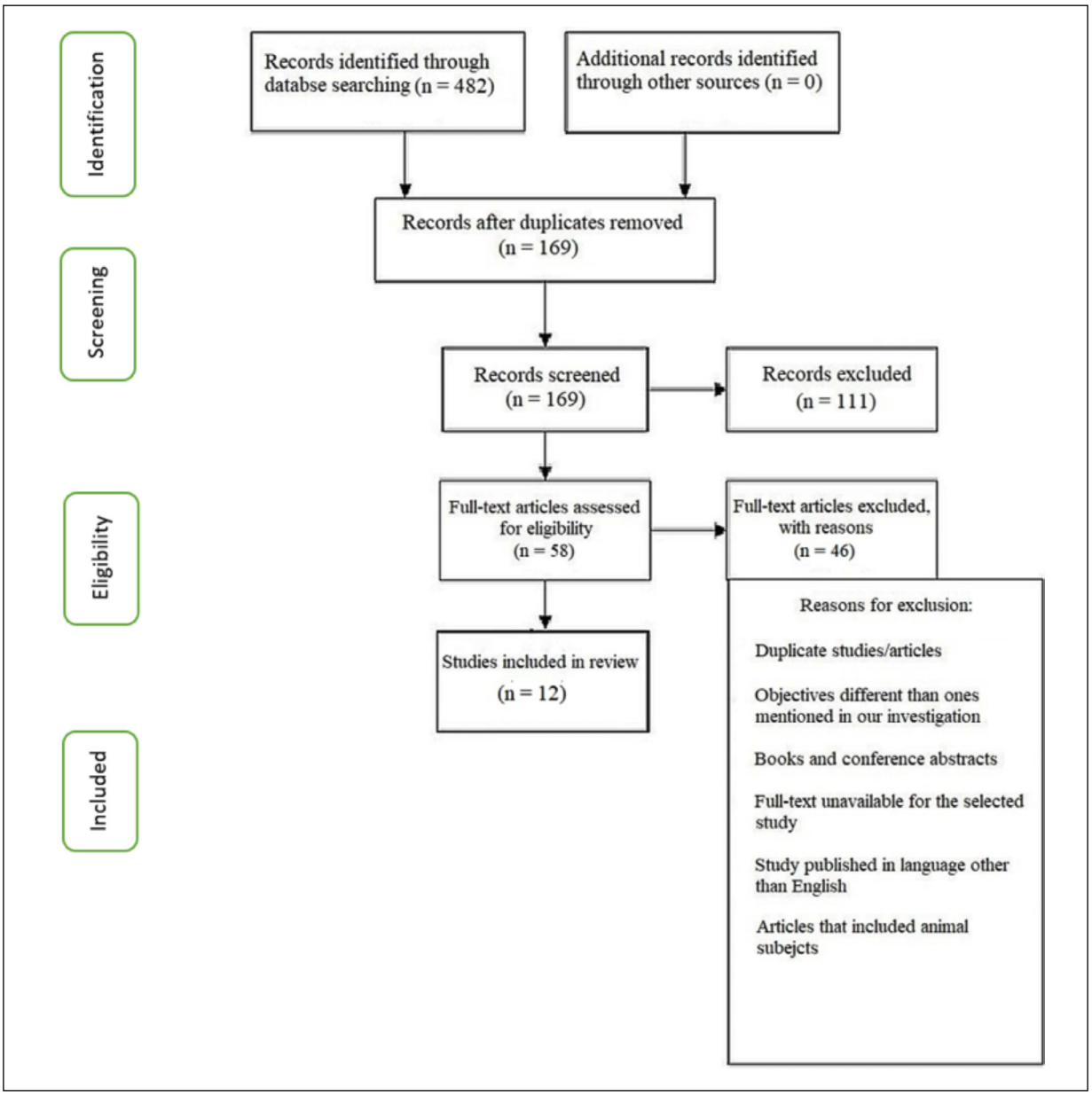

Figure 1. Representation of selection of articles through PRISMA framework.

lifestyle changes on the incidence of childhood obesity, as shown in Figure 3, indicates a statistically significant association between lifestyle changes and a reduced risk of childhood obesity. This implies that children who adopt healthy lifestyle habits, such as regular physical activity and a balanced diet, are less likely to become obese compared to those who do not adopt these habits. The heterogeneity test showed significant heterogeneity (I^2 = 93%), which means that the included articles were diverse in terms of their populations, interventions, and outcomes. However, the overall effect test showed a strong statistically significant association between lifestyle changes and the reduced incidence of childhood obesity, with a Z-value of 44.17 (p-value < 0.00001). Therefore, the results of this meta-analysis support the notion that lifestyle changes have a noticeable impact on reducing the risk of childhood obesity.

Discussion

The findings of the study revealed a noticeable impact of lifestyle changes on the incidence of

Table I. Description and outcomes as observed in the studies selected for the systematic review.

Study details	Sample size	Design of the study	Study objectives	Study outcomes
Gomez et al 2018[9]	2250 children	Randomized Controlled Trial	In this research project, the authors analysed the Thao-Child Health Programme (TCHP).	In fully adjusted models, the intervention had no significant effect on the body mass index z-score, the rate of overall and abdominal obesity, or the percentage of people who followed the Mediterranean diet or engaged in regular physical activity
He et al 2022[10]	5963 children	Longitudinal study	Our study set out to compare the weight and eating habits of Chinese children before and after the 2009 COVID-19 outbreak, in an effort to address the epidemic of juvenile obesity.	The results of the generalised estimating equations showed that there was a positive correlation between being overweight and belonging to a minority group, being older, engaging in less physical exercise each day, sleeping less, and spending more time in front of a screen.
Heerman et al 2019[11]	1210 children	Prospective cohort study	The researchers set out to determine how much each contributing factor contributed to the prevalence of overweight and obesity among children from low-income minority groups.	A family-centered approach to preventing obesity in children from a young age is suggested by the joint predictive power of child age, parent BMI, and child overweight.
Kim et al 2019[12]	6 studies	Systematic review	In this comprehensive review, the authors outline the dietary components associated with childhood obesity.	Dietary intervention employing a multisectoral strategy has been effective in reducing obesity-related dietary risk factors in children and adolescents.
Kuhl et al 2014[13]	60 children	Randomized Controlled Trial	The major purpose of this research was to evaluate the effects of a weight-reduction programme on the daily routines of 30 overweight preschoolers.	Despite significant reductions in consumption of sugar-sweetened beverages, television viewing, and fruit and vegetable intake, only decreases in absolute calorie intake strongly predicted decreases in BMI z score.
Lee et al 2019[14]	118 adolescents	Randomized Controlled Trial	The purpose of this study was to examine whether or not a combination of resistance training and aerobic exercise may increase insulin sensitivity, decrease total adiposity, and reduce ectopic fat in adolescents.	Aerobic exercise alone or in conjunction with strength training is beneficial for improving insulin sensitivity and decreasing ectopic fat in overweight adolescents.
Lopez et al 2020[15]	177 mother/ children pairs	Randomized Controlled Trial	The purpose of this research was to evaluate how traditional nutritional counselling for obese children compared to group sessions attended by their mothers in a hospital setting affected the eating habits, behaviour, and metabolic profiles of these children.	Since the educational intervention improved both some family eating habits and overall obesity levels, we think it can be used as an additional resource in the management of childhood obesity.
Morell et al 2019[16]	106 children and adolescents	Randomized Controlled Trial	The purpose of this research was to examine the effects of a lifestyle intervention including multiple disciplines on anthropometric and biochemical markers.	The two lifestyle therapies reduced anthropometric indices and light physical activity in children with abdominal obesity. There were no significant differences between intensive care and regular care in terms of physical activity.
Neshteruk et al 2021[17]	51 children	Randomized Controlled Trial	The purpose of this study was to show how the beginning of the COVID-19 epidemic influenced the weight-related behaviour of children who were already overweight. Parents of children with obesity (n = 51) were interviewed using in-depth, semi-structured interviews between April and June of 2020.	Different parents attributed increases or maintenance of activity levels to increased outdoor time, whereas others reported a decrease due to lack of outdoor time, school, and scheduled activities. There were disparities in children's perceived levels of physical activity. Significant dietary alterations included increased snacking and more home-cooked meals.
Ojeda et al 2021[18]	121 children	Randomized Controlled Trial	The purpose of this investigation was to determine how changes in physical activity (PA), as measured by accelerometry, affected telomere length (TL) young patients with abdominal obesity after a change in lifestyle.	Positive increases in PA levels during the intensive phase of lifestyle intervention may assist a paediatric population with abdominal in a obesity in maintaining their TL.
Suzuki et al 2019[19]	26 patients	Retrospective clinical trial	This study aimed to determine whether plasma-free amino acid profiles could serve as useful indicators of diseases associated with sedentary lifestyles in young obese children.	The amino acid profile reveals impaired glucose tolerance and hyperuricemia in the earliest stages of obesity. Therefore, similar to adults, it is a useful indicator for guiding early intervention in obese children.
Yackobovitch et al 2018[20]	247 children	Randomized Controlled Trial	The purpose of this study is to assess the efficacy of family-based interventions for the prevention and treatment of childhood obesity that target either parents alone or parents and children.	On the basis of BMI, it has been determined that an intervention programme that targets both parents and children will have positive short- and long-term effects.

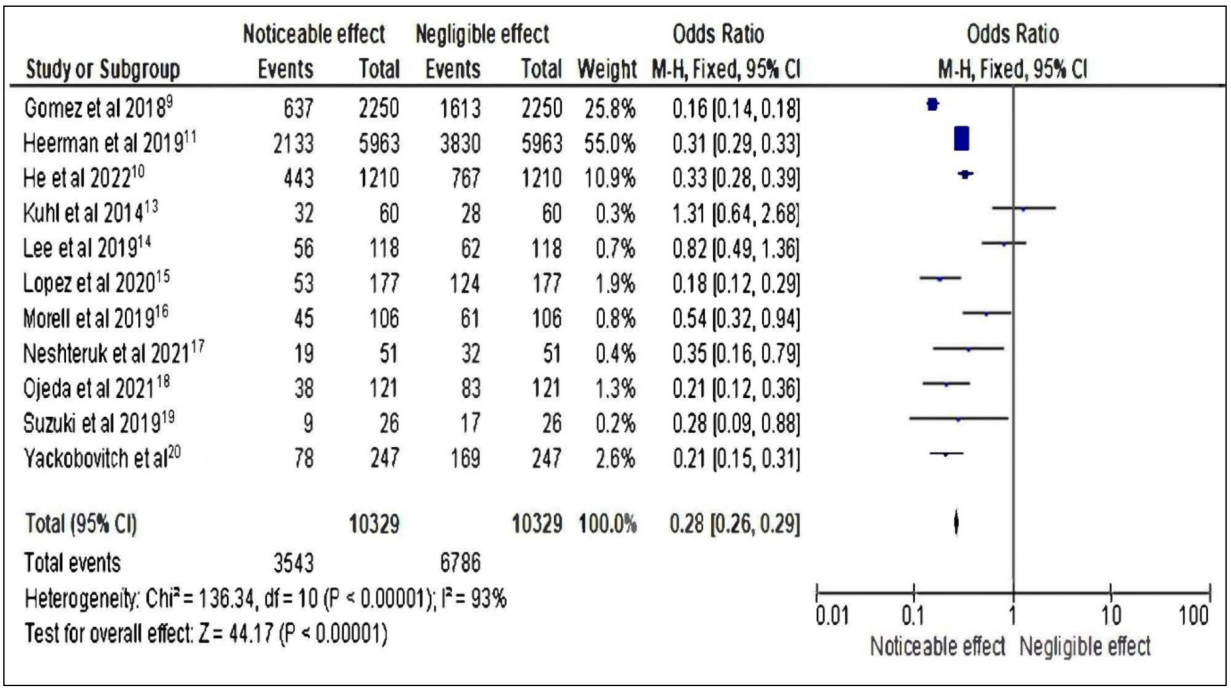

Figure 2. Forest plot of odds ratio displaying the level of impact of various lifestyle interventions on the incidence of childhood obesity in clinical trials selected for the review.

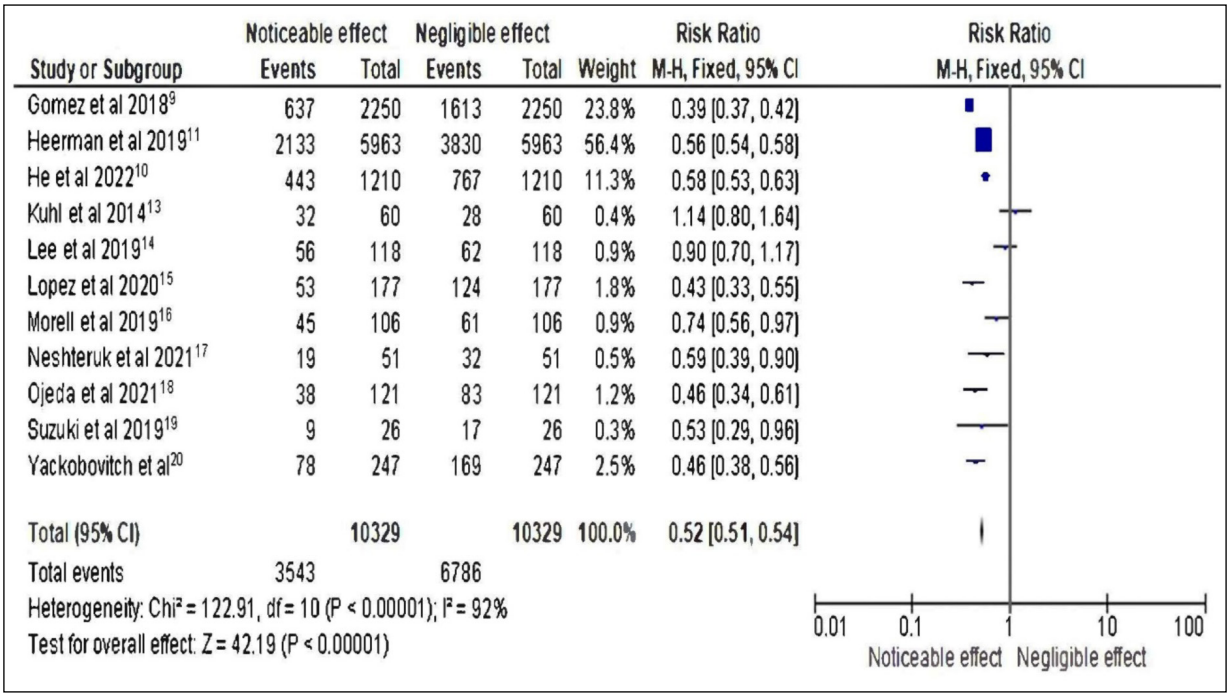

Figure 3. Forest plot of risk ratio displaying the level of impact of various lifestyle interventions on the incidence of childhood obesity in clinical trials selected for the review (assuming a 95% confidence interval).

childhood obesity. The study included 10,329 participants, and the total events were 3,543 out of 6,786, indicating a considerable effect size with an odds ratio of 0.28 and a relative risk of 0.52. The study's significance lies in its potential to contribute to the management and prevention

of childhood obesity, which is a growing public health concern worldwide. Childhood obesity has been linked to various health consequences, such as type 2 diabetes, hypertension, and cardiovascular diseases, highlighting the need to address the issue effectively. The study's clinical implications suggest that lifestyle changes, such as physical activity, dietary modifications, and behavioral interventions, can effectively reduce the incidence of childhood obesity. The findings of this study provide robust evidence for policymakers, healthcare providers, and parents to implement lifestyle interventions to manage and prevent childhood obesity. This study addressed gaps in the literature by providing a comprehensive review of studies evaluating the impact of lifestyle changes on the incidence of childhood obesity. The study used a rigorous methodology, including a systematic search strategy, quality assessment, and statistical analysis, providing reliable evidence to support the findings. The study's findings are relevant as they add to the growing body of evidence supporting lifestyle interventions to manage and prevent childhood obesity, emphasizing the need for further research in this field. Hence, we believe that this study's implications have the potential to improve the health outcomes of children worldwide and address the growing public health concern of childhood obesity.

One study described an 8-month intervention aimed at promoting healthy eating and physical activity among overweight or obese children aged 6 to 12. The intervention was family-based and consisted of several components. The effects of the intervention on the participants' health and lifestyle habits were evaluated using food frequency questionnaires and other relevant parameters[21]. Another study[22] evaluated a school-based program to identify lifestyles and outcomes associated with obesity in 13 to 15-year-old adolescents in order to confirm the sustainability of the advantages from a prior study with the same objectives. The program was made up of several intervention tasks that improved health-related habits like choosing nutrient-dense foods, washing one's hands, and refraining from sitting down too much[22].

In two investigations, the calorie, protein, and fat intake increased in comparison to the baseline following the intervention[23,24]. Three of the intervention trials using a multi-component approach found increases in children's and teenagers' fruit and vegetable consumption[18,21,25]. According to Smith et al[24], participants' perceptions of their consumption of fruits and vegetables increased as a result of the dietary intervention. After the intervention, both groups in Ojeda-Rodrguez et al[18] and Serra-Paya et al[21] studies respectively consumed more fruit and vegetables as well as dairy products. In the meantime, a 4-year follow-up research revealed lower dairy, fruit, and fish intake among kids and teenagers. In three previous trials[22,26-30], dietary intervention was associated with decreased consumption of junk food.

Numerous research[31-40] on childhood obesity have been carried out in various Saudi Arabian localities during the past three decades. One study[32] found that the prevalence was in the middle between developing and developed nations. Another study[33] found that obesity started to appear around the age of 10 and grew in importance until about the age of 19. A cross-sectional study revealed that about 10.5% of children were overweight and 8.7% were deemed obese[34]. A recent study showed a higher prevalence rate of obesity among school-aged students. Another survey[35] found that obesity and overweight were prevalent in a certain province, while a 2015 study indicated higher rates of overweight and obesity among male children[36].

The health implications of childhood obesity in Saudi Arabia are also strongly associated with cardiometabolic risk factors, which determines how likely it is that these results would be associated with other social and psychological outcomes[37-39]. The study by Alkahtani et al[40] also showed a high prevalence of hypertension or high blood pressure among students.

Previous research[41,42] shows that obese children have a roughly 3-fold higher risk of developing hypertension than non-obese children. Indeed, earlier studies from the Eastern Province of Saudi Arabia showed that behavioral factors might be able to explain the likely reason for the rise in BMI and blood pressure in adolescence. These included sedentary lifestyles, unhealthy eating practices, notably a high salt intake[43], use of fructose-sweetened beverages and energy drinks[44], sedentary lifestyles[45], and obesity[46]. Additional factors that have been related to an increased risk of obesity include increasing TV consumption, the use of smart devices, and early life sleep duration[46,47].

According to data, the frequency of obesity among children and adolescents in the Kingdom of Saudi Arabia is rising sharply. This trend may be attributed to urbanization and sedentary lifestyles, and it seems to get worse as kids get older[47]. In developing nations undergoing economic

change, urbanization is seen as a significant risk factor for obesity[48]. Modern Saudi Arabian cities have distinct zones for commercial and residential regions as well as extensive transit systems. This kind of city planning completely discourages walking and necessitates the use of cars for the majority of trips, which is bad for public health[49]. Furthermore, having access to technology (such as laptops, smartphones, and video games) is probably going to encourage Saudi youngsters to lead a more sedentary lifestyle, which has a strong correlation with obesity[50,51].

Limitations

The lack of studies with a high methodological quality, along with the fact that most of the studies selected were randomized control trials, could be said to be the limitations of our systematic review. Also, the presence of adolescents in the meta-analysis might have introduced a certain amount of bias in the findings of the meta-analysis. Hence, we believe more studies are needed in this regard to further validate the results that we obtained in our study so that a complete treatment plan can be devised for children afflicted with obesity.

Conclusions

The most frequent impact variables on obesity levels were lower levels of overall calorie intake and dietary components unique to the child's parents, which were followed closely by lower levels of physical activity and a sedentary lifestyle. In the majority of research, nutritional intervention had the most effective outcomes in changing dietary risk variables associated with obesity in obese children and adolescents. These were the three main factors that determined a child's obesity levels- an overall balanced diet, parental awareness of BMI, and a child's physical activity. As we have previously stated, additional research is required in order to develop a comprehensive, all-encompassing treatment strategy that will further support the application of our findings.

Conflict of Interest

None.

Informed Consent

Not applicable.

Ethics Approval

Not applicable.

PROSPERO Registration

Reference number 421058.

Authors' Contributions

Conceptualization, statistical analysis and Manuscript write-up and review were done by Yousef Abud Alanazi.

Data Availability

The data will be available with the corresponding author and can be made available after email requisition.

Funding

The author would like to thank the Deanship of Scientific Research at Majmaah University, Majmaah, Saudi Arabia for supporting this study with Project Number: R-2023-469.

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