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BEYOND THE SCALE: COMPREHENSIVE TREATMENT OPTIONS FOR YOUTH OBESITY

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ABSTRACT

Introduction: This review aims to examine the multifactorial nature of childhood obesity by exploring its prevalence, diagnostic standards, and associated metabolic and psychological complications, as well as evaluating current strategies for management.
Materials and Methods: A comprehensive review of the literature was conducted using the PubMed and Google Scholar databases using the following keywords: “childhood obesity”, “obesity treatment”, “Mediterranean diet”, “DASH diet”. physical activity”, “liraglutide”, “semaglutide”, “phentermine-topiramate”, “setmelanotide” and “bariatric surgery”.
Summary: Childhood obesity is a growing global issue with serious health consequences that often persist into adulthood. It stems from multiple factors like diet, activity levels, and environment. Healthy diets (e.g., Mediterranean, DASH) and at least 60 minutes of daily physical activity are key for prevention and treatment. Medications like GLP-1 receptor agonists (e.g., liraglutide, semaglutide) may help in severe cases, while bariatric surgery is an option for extreme, treatment-resistant obesity. Effective management requires a combination of lifestyle changes and medications.
Conclusions: Combating childhood obesity requires a personalized approach combining lifestyle changes, nutrition education, physical activity, and, when needed, medication or surgery. Early intervention is vital to reduce long-term health risks and psychological effects. Treatment should involve multidisciplinary teams, including pediatricians, dietitians, psychologists, and specialists. Future efforts must improve public health policies, promote healthy environments, and conduct long-term studies on treatments. Continued innovation in diagnosis and prevention is essential to tackle this growing epidemic and improve children's quality of life.

KEYWORDS

Childhood Obesity, Obesity Treatment, Physical Activity, Liraglutide, Semaglutide, Bariatric Surgery

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Introduction

Childhood obesity has evolved into a widespread epidemic in developed countries, triggering a variety of serious health issues. These conditions not only contribute to higher rates of illness but also increase the likelihood of premature death, placing a significant burden on individuals and healthcare systems alike. Children and adolescents who fall within the obese weight range are significantly more likely to struggle with obesity in adulthood, with the risk being five times greater than that of their peers who maintain a healthy weight throughout their youth [1].

An increase in the number of obese children has been observed globally, including developing countries, where the prevalence of overweight and obesity rose from 8.1% to 12.9% among boys and from 8.4% to 13.4% among girls between 1980 and 2013. Similarly, in developed countries, the rates have also risen, with 23.8% of boys and 22.6% of girls affected by overweight or obesity in 2013 [2].

In children under 2 years old or those whose height is more than 2 standard deviations below the population average, obesity is defined based on weight for height, using international reference tables from the National Center for Health Statistics (NCHS) and the World Health Organization (WHO). The classifications are as follows. Overweight is when weight is between 110% and 119% of the ideal weight, or weight for height is more than 2 standard deviations above the established average according to WHO growth standards. Obesity is when weight is between 120% and 129% of the ideal weight, or weight for height is more than 3 standard deviations above the established average according to WHO growth standards. Severe obesity is when weight is greater than 130% of the ideal weight [3]. The BMI guidelines used to categorize overweight and obesity in children and adolescents aged 2 to 20 years are as follows. A child or adolescent is considered overweight if their BMI is at or above the 85th percentile, but below the 95th percentile for their age and sex. Obesity is identified when the BMI is at or above the 95th percentile for their age and sex. Severe obesity is defined as a BMI at or above 120% of the 95th percentile, or a BMI of 35 kg/m² or greater, whichever is lower [4].

Childhood obesity is associated with increased levels of low-density lipoprotein (LDL), triglycerides (TG), blood glucose, and insulin, as well as decreased levels of high-density lipoprotein (HDL) [5]. Childhood obesity is a major contributing factor to the development of several long-term health issues linked to poor diet, including conditions that may arise later in life, such as heart disease, high blood pressure, stroke, type II diabetes and various forms of cancer. Beyond its physical impact, obesity in children also has profound psychological effects, such as increased levels of anxiety, depression, sleep disturbances, and low self-esteem. These emotional struggles can significantly hinder a child's ability to engage in social interactions and excel in academic settings, ultimately affecting their overall well-being and future opportunities [6].

The aim of this paper is to review the current scientific literature on the treatment of childhood obesity, with particular focus on dietary interventions, physical activity, pharmacotherapy, and bariatric surgery, highlighting their efficacy, safety, and long-term impact on youth.

Methodology

The literature review was conducted using publications retrieved from databases such as PubMed, Google Scholar, and other peer-reviewed scientific journals. The review included articles published between 1997 and 2025, focusing on the treatment of obesity in young individuals. The search strategy employed the following keywords: “childhood obesity”, “obesity treatment”, “Mediterranean diet”, “DASH diet”. physical activity”, “liraglutide”, “semaglutide”, “phentermine-topiramate”, “setmelanotide” and “bariatric surgery”. Ultimately, a total of 36 articles were selected for detailed analysis, with particular emphasis placed on the most recent publications to ensure the inclusion of up-to-date evidence and current treatment approaches.

Diet

There is still a lack of consensus regarding the most effective structured dietary strategies for promoting weight loss in children. However, research has shown that diets which modify carbohydrate intake can be equally effective as traditional portion-controlled diets. There are several key principles of healthy eating. It is recommended to increase the intake of at least five servings of fruits and vegetables each day. Reducing the consumption of calorie-rich foods, such as those high in saturated fats, salty snacks and sugary items, is also important. Eating breakfast every day is essential for overall health. Finally, it’s important to avoid skipping meals to maintain balanced nutrition throughout the day [4].

Increased adipose tissue contributes to low-grade inflammation and metabolic disturbances through mechanisms like oxidative stress and adipocyte dysfunction. Pro-inflammatory cytokines and adipokines such as IL-6 and resistin amplify inflammation. The severity of inflammation is directly linked to adipose tissue

levels, increasing the risk of metabolic syndrome. One study found that a Western-style diet, characterized by high calorie intake, ultra-processed foods, refined grains, high-fat dairy, red meat and low levels of omega-3 fatty acids, leads to increased secretion of inflammatory markers such as hs-CRP and IL-6.

The Mediterranean diet (MD), the Dietary Approaches to Stop Hypertension (DASH) diet and a low glycemic index diet may be beneficial as these diets have been shown to reduce levels of CRP, IL-6 and TNF-α [7]. The Mediterranean diet emphasizes plant-based foods, moderate fish and dairy intake, limited red meat, and uses olive oil as the primary fat source. It is shown that the MD offers a range of health benefits, including lowering lipid levels and reducing inflammation, thanks to its rich content of omega-3 fatty acids, monounsaturated fatty acids, polyphenols, vitamins, and essential minerals [8].

The DASH diet encourages the intake of fruits, vegetables, lean dairy, whole grains, fish, poultry and nuts, while reducing the consumption of red meat and sugary beverages. It has been proven to lower blood pressure and body weight by boosting the intake of potassium, magnesium, calcium and fiber. The DASH diet has proven to be a good choice for adolescents, helping them maintain a healthy body weight while ensuring adequate nutrient intake for growth and development [9].

Physical activity

Obesity is strongly associated with physical inactivity. It is commonly observed that individuals leading a sedentary lifestyle tend to have a slower metabolism, which often results in gradual weight gain and the development of obesity. In contrast, those who engage in regular physical activity, such as exercise or walking, typically experience a higher metabolic rate and maintain a leaner body. Additionally, reduced physical activity means less energy is burned, leading to weight gain over time, while increased activity promotes weight management and prevents excess weight accumulation [10].

Aerobics is strongly connected to notable reductions in visceral adiposity and intrahepatic lipid, along with significant improvements in insulin sensitivity [11]. Engaging in physical exercise, even without changes to diet or other lifestyle factors, leads to higher levels of adiponectin and lower levels of leptin and IL-6 in the plasma of children with obesity, thereby contributing to a reduction in the systemic inflammation commonly associated with obesity [12].

Young children in preschool should participate in a minimum of 180 minutes of physical activity each day, encompassing various types of movement at any intensity. Among this, at least 60 minutes should be spent in moderate-to-vigorous physical activity (MVPA), spread across the day. Children and adolescents (ages 5–18) should engage in at least 60 minutes of moderate-to-vigorous physical activity (MVPA) daily, incorporating a variety of aerobic exercises. Exceeding this 60-minute threshold can offer further health benefits [13]. Sedentary children should gradually work towards achieving the recommended level of physical activity. One way to reduce sedentary behavior is by limiting screen time (for entertainment media) to no more than 1–2 hours of quality programming per day for older children, as advised by the American Academy of Pediatrics [14]. Every additional hour of daily screen time raises the likelihood of obesity by 13% [15].

Pharmacotherapy

Liraglutide

Liraglutide was originally approved for diabetes management after research involving a large cohort of participants showed that it effectively improved blood sugar control and led to notable weight loss [16]. It is also a medication approved by most major regulatory agencies, including the United States Food and Drug Administration (FDA) and the European Medicines Agency (EMA), for the treatment of chronic obesity in adolescents aged 12 to 18. Liraglutide belongs to the class of glucagon-like peptide-1 (GLP-1) receptor agonists. It promotes weight loss by enhancing insulin secretion and inhibiting glucagon release, with its effects being dependent on the levels of blood glucose. It also works by binding to GLP-1 receptors in the hypothalamus, helping to reduce appetite, slow gastric emptying and promote satiety by acting on areas of the brain involved in hunger regulation. It is administered as a daily 3 mg subcutaneous injection [17,18]. GLP-1 agonists are generally well-tolerated, though they can cause side effects, with nausea being the most common, especially during the early stages of treatment. Furthermore, GLP-1 agonists may lead to a modest, sustained increase in heart rate. Nevertheless, preclinical studies suggest that these changes in heart rate are not concerning, as GLP-1 agonists may provide cardiovascular benefits, potentially counterbalancing this mild side effect. Long-term use may raise concerns about pancreatitis, but clinical trials have shown no increased risk. While animal studies suggest a possible link to thyroid cancer, this has not been confirmed in humans [16].

It has been shown that liraglutide, when used alongside lifestyle therapy, significantly reduces BMI in adolescents with obesity compared to a placebo, with a higher percentage of adolescents achieving notable reductions of 5% and 10% in BMI after one year of treatment [19]. Currently, no medications are approved for non-monogenic, nonsyndromic obesity in children under 12. While liraglutide aids in weight loss for adolescents and adults, its safety in younger children is still unclear. One study showed that in obese children aged 6 to 12, 56 weeks of liraglutide treatment combined with lifestyle interventions led to a more significant reduction in BMI compared to placebo with lifestyle interventions. A significant percentage of participants in the liraglutide group (46%) achieved a BMI reduction of at least 5%, whereas only 9% of participants in the placebo group reached this threshold [20].

Semaglutide

Semaglutide is a GLP-1 receptor agonist that emulates the action of endogenous incretin hormones, promoting glucose-dependent insulin secretion, suppressing glucagon release, delaying gastric emptying and contributing to reduced appetite and caloric intake. Semaglutide has been approved by the FDA for pediatric patients aged 12 years and older with a BMI at or above the 95th percentile. The dosing regimen mirrors that used in adults, initiating with the lowest available dose and titrating upward on a monthly basis until optimal weight reduction, improvement in obesity-related comorbidities, or the maximum tolerated dose is attained. Following the recommended titration schedule, the target maximum dose is typically reached within five months [21]. In the scientific study, after 68 weeks of treatment, semaglutide resulted in greater reductions than placebo in waist circumference, glycated hemoglobin levels (excluding participants with type 2 diabetes), total cholesterol, LDL cholesterol, VLDL cholesterol, triglycerides, and ALT levels. Weekly subcutaneous administration of semaglutide at a 2,4 mg dose led to significant reductions in BMI and body weight, with a notably higher percentage of participants in the semaglutide group achieving weight loss of 5 to 20% compared to those in the placebo group [22].

Orlistat

Orlistat (tetrahydrolipstatin) is approved by the FDA for the long-term treatment of obesity in adolescents aged 12 years and older. However, it has not been authorized by the EMA [23].

A semisynthetic derivative of lipstatin, Orlistat is a highly potent and selective inhibitor of gastric and pancreatic lipases, with minimal to no effect on enzymes such as amylase, trypsin, chymotrypsin, or phospholipases. It exerts its action within the gastrointestinal (GI) tract, where it binds covalently to the serine residue at the active site of lipases. When taken with fat-containing meals, Orlistat partially inhibits the hydrolysis of triglycerides, reducing the absorption of monoacylglycerides and free fatty acids [24]. Experimental studies conducted in adolescents have shown that Orlistat significantly affects waist circumference and serum insulin levels. Nevertheless, no notable changes were observed in body weight, body mass index, lipid profile or serum glucose levels [25]. The most prevalent adverse effect associated with orlistat administration is steatorrhea, resulting from the inhibition of dietary fat absorption. Additional reported side effects include fecal incontinence, diarrhea, abdominal discomfort, and the development of anal fissures [26].

Phentermine/Topiramate

Phentermine is a sympathomimetic amine used as an appetite suppressant. Its mode of action is similar to that of amphetamine, as it stimulates the trace amine-associated receptor (TAAR1), triggering the release of norepinephrine and epinephrine. As a result, it acts as a central nervous system stimulant [27]. Phentermine is FDA-approved for short-term treatment of obesity in individuals older than 16. In adolescents, its use is limited to a period of up to 12 weeks [28]. Prolonged use in pediatric and adolescent populations is associated with possible risks such as cardiovascular complications and disrupted growth development [29]. In adolescents with obesity, the addition of phentermine to lifestyle modification therapy resulted in significantly greater weight loss over several months compared to lifestyle intervention alone. Moreover, a significantly higher proportion of patients receiving phentermine achieved a clinically meaningful BMI reduction of at least 5% [30]. Topiramate, as part of the phentermine/topiramate combination therapy, has received FDA approval for managing obesity in adults and adolescents aged 12 years and older [21]. Although the exact biological mechanisms underlying topiramate induced weight loss remain incompletely elucidated, several hypotheses have been proposed. These include reductions in caloric intake, attenuation of adipose tissue accumulation, and decreased circulating levels of triglycerides and cholesterol. Emerging evidence indicates that TPM may reduce energy deposition without significantly affecting food intake, potentially by impairing metabolic efficiency. This effect is thought to involve the activation of lipoprotein lipase in brown adipose tissue and skeletal muscle, thereby enhancing thermogenesis and increasing substrate oxidation [31].

Setmelanotide

Setmelanotide is a melanocortin-4 receptor (MC4R) agonist approved by the FDA for the treatment of obesity in patients aged 6 years and older with one of three rare genetic disorders: proopiomelanocortin (POMC) deficiency, proprotein convertase subtilisin/kexin type 1 (PCSK1) deficiency, or leptin receptor (LEPR) deficiency. Eligibility for treatment requires genetic confirmation of pathogenic, likely pathogenic, or variants of uncertain significance in the associated genes. Beyond its approved indications, setmelanotide is currently being evaluated in clinical trials for additional rare, genetically based forms of obesity, including Bardet-Biedl syndrome, Alström syndrome, heterozygous deficiencies in POMC or other components of the MC4R signaling pathway and epigenetic disorders affecting POMC regulation [23].

Bariatric surgery

Bariatric procedures are prescribed by clinicians for adolescents struggling with extreme obesity, as nonsurgical treatments often do not succeed in achieving or sustaining meaningful weight loss [32]. The eligibility criteria for bariatric surgery set by the American Society for Metabolic and Bariatric Surgery for adolescent candidates require either class II obesity with associated comorbidities or class III obesity without comorbidities. The comorbidities that justify the need for surgery include non-alcoholic fatty liver disease, type 2 diabetes mellitus, obstructive sleep apnea syndrome, cardiovascular risk factors, orthopedic conditions, physical limitations, gastroesophageal reflux disease, idiopathic intracranial hypertension, and a diminished quality of life. The two most frequently carried out bariatric surgeries are Roux-en-Y gastric bypass (RYGB) and sleeve gastrectomy [33].

Bariatric surgery is considered safe for adolescents and has shown lasting long-term weight loss, as well as improvements in obesity-related health conditions. A multi-center study found that after three years, adolescents who underwent BS procedures experienced reductions in BMI ranging from 3.8 kg/m² to 15.1 kg/m² [34]. Several months post-gastric bypass surgery, adolescent participants demonstrated significant improvements in self-reported anxiety, depression, and self-concept. These findings suggest an enhancement in emotional symptoms and self-perception [35].

RYGB surgery provides benefits for adolescents, but it can also be associated with long-term nutritional challenges, such as mild iron deficiency anemia and low vitamin D levels. Many patients require supplements and regular monitoring, particularly for bone health. Ongoing supplementation with multivitamins, B12, D, calcium, and iron is necessary, along with additional vitamin D for those with elevated PTH. Because it is challenging for adolescents to consistently follow supplement regimens, there needs to be more emphasis on self-management, proper nutritional monitoring by primary care providers within the medical home and research to identify which patients are most at risk for micronutrient deficiencies [36].

Conclusions

Childhood obesity has emerged as a global epidemic, with its prevalence increasing in both developed and developing countries. This condition represents a significant public health challenge due to its association with a range of serious health complications, including cardiovascular diseases, type 2 diabetes, stroke and various forms of cancer. In addition to the physical health consequences, childhood obesity also carries substantial psychological burdens, such as elevated levels of anxiety, depression, and diminished self-esteem, all of which adversely affect the overall well-being and quality of life of affected children. Given the long-term impact on both physical and mental health, childhood obesity constitutes an urgent public health concern.

Effective management and prevention of childhood obesity require a multifaceted approach, encompassing dietary interventions, physical activity, pharmacotherapy, and, in some cases, bariatric surgery. Dietary strategies focused on increasing the consumption of fruits, vegetables and low-calorie, nutrient-dense foods are fundamental for weight management. Additionally, evidence suggests that specific dietary patterns, such as the Mediterranean and DASH diets, are particularly beneficial in reducing systemic inflammation and improving metabolic parameters. Regular physical activity, particularly aerobic exercise, plays a crucial role in not only promoting weight loss but also in mitigating obesity-related inflammation. Furthermore, reducing sedentary behavior, such as excessive screen time, is essential in preventing the onset of obesity in children. Pharmacological interventions, including liraglutide, semaglutide, orlistat, phentermine/topiramate, and setmelanotide, have shown efficacy in promoting weight loss through various mechanisms such as appetite suppression, enhanced insulin sensitivity, and modulation of lipid metabolism. However, while these pharmacotherapies are effective, their safety profiles, especially in pediatric populations, warrant ongoing research to better understand their long-term impacts. For adolescents with severe obesity unresponsive to

conventional interventions, bariatric surgery may be considered as a last-resort treatment. Procedures such as Roux-en-Y gastric bypass and sleeve gastrectomy have demonstrated significant weight loss and improvement in obesity-related comorbidities. However, these interventions are not without risks, including potential nutritional deficiencies, which necessitate careful long-term follow-up and supplementation.

In conclusion, the management of childhood obesity demands a comprehensive, integrated approach that combines prevention strategies with therapeutic interventions. While pharmacological treatments and bariatric surgery can be valuable in certain cases, prevention remains the most effective strategy. Early intervention, alongside robust community support and healthcare guidance, is crucial to reducing the prevalence of childhood obesity and mitigating its long-term health effects. Ongoing research is essential to further refine treatment modalities and ensure the safety and efficacy of interventions, ultimately improving outcomes for children affected by obesity.

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