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CHILDHOOD OBESITY: EPIDEMIOLOGY, RISK FACTORS, AND EVIDENCE-BASED PREVENTION AND TREATMENT — AN UPDATED NARRATIVE REVIEW (2019–2025)

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ABSTRACT

Childhood obesity is a growing global health challenge with serious medical, psychosocial, and economic consequences. Its prevalence has increased substantially over the past decades across both high- and low-income countries, with marked geographic and socioeconomic disparities. This narrative review synthesizes recent evidence (2019–2025) on the epidemiology, risk factors, prevention, and treatment of childhood obesity. Findings indicate that more than one in five children worldwide is overweight or obese, with risk shaped by multiple determinants including ultra-processed food consumption, short sleep, sedentary behaviors, family environment, and genetic predisposition. Preventive strategies at the school and family level show modest effects, whereas structural interventions such as food marketing restrictions and fiscal policies may exert greater population-level impact. Intensive behavioral interventions remain the foundation of treatment, while new pharmacological agents, particularly GLP-1 receptor agonists such as liraglutide and semaglutide, demonstrate unprecedented efficacy but require further long-term evaluation. Bariatric surgery, performed in specialized centers, provides durable weight loss and remission of comorbidities in carefully selected adolescents. Addressing childhood obesity requires integrated, multilevel approaches spanning clinical, familial, educational, and policy domains. Coordinated and sustained action will be essential to reduce the future burden of pediatric obesity and its associated complications.

KEYWORDS

Childhood Obesity, Epidemiology, Risk Factors, Prevention, Treatment

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Introduction

Childhood obesity has emerged as one of the most urgent global health challenges of the 21st century. The prevalence of overweight and obesity among children and adolescents has risen sharply over the past four decades, affecting populations in both high-income and low- and middle-income countries. According to recent global estimates, more than one in five children is now classified as overweight or obese, with substantial geographic and socioeconomic disparities. The coexistence of undernutrition and obesity in many regions further illustrates the complexity of the problem.

Childhood obesity has profound medical, psychosocial, and economic consequences. Affected children are at increased risk of type 2 diabetes, hypertension, dyslipidemia, obstructive sleep apnea, orthopedic complications, and many remain obese into adulthood, with an elevated lifetime risk of cardiovascular disease and premature mortality. Beyond physical health, obesity also impacts quality of life, mental well-being, and academic performance, while at the societal level it generates considerable healthcare costs and economic burden.

The multifactorial etiology of childhood obesity underscores the need for comprehensive approaches. Genetic susceptibility interacts with early-life exposures, family environment, dietary patterns, physical activity, sleep, and the built environment to shape obesity risk. Preventive efforts have spanned family, school, and community-based interventions, while treatment strategies include behavioral therapy, pharmacotherapy, and metabolic/bariatric surgery. The rapid development of new pharmacologic agents, particularly glucagon-like peptide-1 (GLP-1) receptor agonists, has further transformed the therapeutic landscape.

Given the scale and complexity of the epidemic, a continuous synthesis of available evidence is essential to guide clinical practice and policy. The aim of this review is to provide an updated overview of the epidemiology, risk factors, prevention, and treatment of childhood obesity, with emphasis on recent evidence (2019–2025) and implications for future research and public health strategies.

Materials and Methods

This review was conducted as a narrative synthesis of the recent literature on childhood obesity. The search focused on studies published between January 2019 and March 2025 in order to provide an up-to-date overview of the field. A comprehensive search strategy was applied using PubMed/MEDLINE as the primary database, supplemented by the Cochrane Library, reports and guidelines from the World Health Organization (WHO), and selected high-impact journals such as *The Lancet*, *JAMA*, and *The New England Journal of Medicine*. Search terms included combinations of "childhood obesity," "pediatric obesity," "risk factors," "epidemiology," "prevention," "treatment," "pharmacotherapy," "bariatric surgery," and "policy interventions," with Boolean operators (AND/OR) used to refine results. Reference lists of relevant reviews were also screened for additional eligible studies.

Studies were included if they were systematic reviews, meta-analyses, randomized controlled trials (RCTs), large cohort studies, or major policy reports. Only full-text articles published in English and focusing on populations aged 0–18 years were considered. Publications were excluded if they were case reports, small case series, editorials without primary data, studies exclusively on adults, or works unavailable in full text.

The initial search yielded several hundred records. After screening titles and abstracts, duplicates and irrelevant studies were removed. Full-text assessment resulted in a final set of approximately 40 articles and reports, which form the basis of this review. Priority was given to high-quality evidence, particularly Cochrane reviews, large RCTs, and WHO reports. Extracted findings were organized thematically into four domains: epidemiology, risk factors, prevention, and treatment.

Epidemiology

Globally, about one in five children and adolescents now has excess weight. *[Zhang et al., 2024]* A 2024 meta-analysis including 45 million young individuals from 154 countries found the pooled prevalence of obesity to be ~8.5% and combined overweight or obesity to be ~22.2%. *[Zhang et al., 2024]* This reflects a 1.5-fold increase in youth obesity rates in just the last decade (2012–2023 vs 2000–2011). *[Zhang et al., 2024]* This global rise is not a new phenomenon. Between 1980 and 2013, the prevalence of childhood overweight and obesity rose from ~16% to ~23–24% in high-income countries, and from ~8% to ~13% in developing regions. *[Ng et al., 2014]*

Marked geographic and socioeconomic disparities exist in the childhood obesity epidemic. Wealthier nations (including those with a Human Development Index ≥0.8) tend to have higher rates of childhood obesity. *[Zhang et al., 2024]* In contrast, some low-income countries still have relatively low childhood obesity prevalence, although rates are climbing rapidly. *[Ng et al., 2014]* The national prevalence of childhood obesity ranges from under 1% in certain countries to nearly 30% in others. *[Zhang et al., 2024]* Notably, the epidemic is increasingly affecting low- and middle-income countries, creating a "double burden" where undernutrition and obesity now coexist in the same populations. *[World Health Organization, 2025]*

There are also disparities within countries – for example, in many high-income settings, children from socioeconomically disadvantaged families have higher obesity rates. *[Keating et al., 2014]* In the United States, the prevalence of extreme childhood obesity (BMI ≥160% of the 95th percentile) rose from 0.3% in 2008 to 1.1% in 2023, with the highest rates observed in older adolescents and certain ethnic minority groups. *[Münte et al., 2025]* Despite global awareness, progress in curbing childhood obesity has been disappointingly limited, and no country is currently on track to meet the World Health Assembly's target of halting the rise in childhood overweight by 2025 and in fact, few nations have achieved any sustained decline. *[Branca et al., 2023]* The COVID-19 pandemic may have exacerbated the trend, as disruptions in routines and increased intake of high-calorie "comfort foods" likely contributed to excess weight gain in children. *[Anderson et al., 2023]* These realities have prompted experts to call for making childhood obesity prevention a top public health priority worldwide. *[Branca et al., 2023]*

The rationale for urgent action is reinforced by the serious health and economic consequences of childhood obesity. Most obese children remain obese in adulthood, facing higher risks of type 2 diabetes, cardiovascular disease, and other non-communicable diseases at younger ages. *[World Health Organization, 2025]* Childhood obesity also has psychosocial repercussions: affected youth often experience stigma, bullying, and lower quality of life, which can harm their mental health and academic performance. *[World Health Organization, 2025]* From an economic perspective, the burden is substantial: a recent meta-analysis estimated that a child with overweight or obesity incurs about $240 more in annual medical costs compared to a healthy-weight peer. *[Ling et al., 2023]* At the societal level, the global economic cost of obesity (across all ages) is projected to reach $3 trillion per year by 2030, roughly 3% of the world's GDP, and to continue rising thereafter.

[World Health Organization, 2025] Such impacts underscore the need for comprehensive strategies to reverse this epidemic. Without decisive intervention, childhood obesity will remain a serious global health challenge with profound implications for future generations. *[Ng et al., 2014]*

Risk Factors and Determinants of Childhood Obesity

Childhood obesity is driven by multiple, interrelated determinants, spanning dietary habits, lifestyle behaviors, familial influences, environmental contexts, and biological predispositions. Unhealthy dietary patterns represent one of the most consistent risk factors. In particular, the high consumption of ultra-processed foods (UPFs) has been strongly associated with childhood obesity. A recent systematic review reported that in most included studies, higher intake of UPFs correlated with greater prevalence of overweight and obesity among children and adolescents. *[Gonçalves et al., 2024]* These foods, typically high in calories, sugar, and unhealthy fats, displace nutrient-dense options and promote overconsumption. *[Gonçalves et al., 2024]* Shortened sleep duration is another modifiable determinant: insufficient sleep has been consistently associated with increased risk of obesity in children, likely through alterations in appetite-regulating hormones, increased caloric intake, and reduced energy expenditure. *[Porri et al., 2024], [Calcaterra et al., 2023]*. Furthermore, sedentary lifestyles (characterized by prolonged screen time) limit energy expenditure and are often accompanied by unhealthy snacking, compounding the risk of excess weight gain. *[Robinson et al., 2017]* Equally important are familial and environmental factors that shape children's long-term health behaviors and obesity risk. Beyond individual behaviors, the family environment plays a pivotal role in shaping obesity risk. Parental weight status, dietary habits, and lifestyle behaviors directly influence children's own health trajectories. Evidence indicates that children of overweight parents are significantly more likely to develop obesity, reflecting both genetic predisposition and learned behaviors. *[Maia et al., 2025]* Positive parental practices, such as modeling healthy eating, encouraging physical activity, and maintaining consistent sleep routines, are protective, while chaotic mealtime structures, excessive availability of high-calorie foods at home, and permissive screen-time policies increase risk. *[Clément & Tereno, 2023]* Socioeconomic status further amplifies disparities: children from low-income families face greater barriers to accessing healthy foods and safe spaces for exercise, contributing to unequal burdens of obesity across populations. *[Maia et al., 2025]*

Early-life and biological determinants also contribute significantly. High maternal pre-pregnancy BMI and excessive gestational weight gain have been consistently linked to elevated obesity risk in offspring. [Skrypnik et al., 2019] Infants with rapid weight gain in the first year of life show a markedly higher likelihood of developing overweight by preschool age, while longer breastfeeding duration appears modestly protective. *[Moholdt & Stanford, 2024], [Verduci et al., 2021]* Genetic susceptibility further modifies these risks, with multiple loci implicated in appetite regulation and metabolism. *[Son, 2024]* However, the rapid increase in childhood obesity globally highlights that environmental and behavioral changes, rather than genetics alone, are driving the epidemic. Broader determinants such as the built environment also play a role: neighborhoods lacking safe parks, sidewalks, and recreational facilities tend to discourage physical activity, while environments with high densities of fast-food outlets and limited access to healthy foods promote obesogenic behaviors. *[Galvez et al., 2024], [Malacarne et al., 2022]* Multilevel frameworks emphasize that these determinants operate synergistically across home, school, and community settings, underscoring the need for interventions that address the child's risk environment holistically. *[Porri et al., 2024]* In summary, the evidence demonstrates that childhood obesity cannot be attributed to a single cause but rather results from the convergence of genetic predisposition, early-life exposures, lifestyle factors, and obesogenic environments. Recognition of this multifactorial etiology underscores the importance of comprehensive prevention and treatment strategies

Prevention Strategies for Childhood Obesity

Early-life interventions have shown only modest effects on preventing obesity. A Cochrane review of 2–4 year-olds found that comprehensive programs combining improved diet with increased physical activity led to a small reduction in BMI over ~15 months, whereas single-focus approaches (diet-only or activity-only) had no significant impact. *[Phillips et al., 2025], [Flynn et al., 2022]* Similarly, an updated meta-analysis of 195 studies in school-aged children (6–18 years) reported only a very slight beneficial effect from school-based obesity prevention programs (mean BMI difference ~–0.1, SMD ≈ –0.03) and no significant improvements from after-school, community, or home-based interventions. *[Hodder et al., 2022]* Family-oriented strategies remain a core component – involving parents and siblings in lifestyle changes can improve children's habits – but evidence for their efficacy is mixed. A recent systematic review noted that while several

individual family-based trials reported significant weight improvements, pooled results did not show a clear BMI advantage compared to usual care. *[Guerra Toro et al., 2024], [Flynn et al., 2022] T*he authors emphasized the need for larger, high-quality trials to determine how effective family-centered programs truly are. *[Guerra Toro et al., 2024]* Overall, multi-component interventions (combining diet, physical activity, and behavioral support) delivered across multiple settings (e.g. school plus family/home) appear more promising than isolated efforts but heterogeneity in study quality makes it difficult to issue firm recommendations. *[Denova-Gutiérrez et al., 2023], [Flynn et al., 2022]*

Emerging evidence also highlights sleep duration as an important, yet often overlooked, determinant of childhood obesity risk. *[Porri et al., 2024]*

Broader policy and environmental measures are therefore critical to strengthen obesity prevention. The World Health Organization's 2023 guidelines urge governments to mandate strong restrictions on marketing of unhealthy foods and beverages to children of all ages. *[World Health Organization, 2023]* This recommendation reflects robust evidence that voluntary industry self-regulation has been insufficient, whereas mandatory policies using government-defined nutrient criteria can significantly reduce children's exposure to high-fat, high-sugar food advertisements. *[World Health Organization, 2023], [Harris & Smith Taillie, 2024]* Such regulatory actions are expected to reduce kids' pester power, caloric intake from junk foods, and ultimately obesity risk. In addition, fiscal and labeling policies have shown positive impacts. For example, city-level taxes on sugar-sweetened beverages have been associated with measurable decreases in youth BMI percentiles over a few years, suggesting that taxing sugary drinks can help curb childhood obesity rates. *[Young et al., 2024]* Prominent front-of-pack nutrition labels are another tool to guide consumer choices – notably, Chile's comprehensive policy package (combining stop-sign warning labels on unhealthy foods with advertising limits and school junk-food bans) was linked to a 24% drop in sugary drink purchases nationally. *[Roberto et al., 2021]* These population-wide interventions illustrate how altering the food environment can meaningfully shift behavior. Experts now advocate multi-level prevention frameworks that integrate educational programs with supportive policies (in schools, communities, and broader society). *[Denova-Gutiérrez et al., 2023], [Porri et al., 2024]* Such an approach recognizes that no single intervention is a "silver bullet"; instead, a coordinated mix of behavioral, family, school, and policy actions is needed to generate sustainable declines in childhood obesity. *[Denova-Gutiérrez et al., 2023]* The challenge moving forward is to continue building high-quality evidence on what works best, while scaling up proven strategies to create healthier food and physical activity environments for all children. *[Guerra Toro et al., 2024]*

Treatment

Lifestyle and Behavioral Interventions

Lifestyle modification and behavioral therapy are the cornerstones of pediatric obesity treatment and are recommended as first-line interventions. *[Hampl et al., 2023], [Torbahn et al., 2025]* Comprehensive programs typically include nutritional counseling, increased physical activity, reduced sedentary behavior, and behavior-change techniques involving the child and family. Crucially, higher-intensity interventions yield better outcomes. The most effective behavioral treatments involve ≥26 hours of face-to-face, family-based, multicomponent sessions over 3–12 months, as highlighted by recent guidelines. *[Hampl et al., 2023]* Such intensive health behavior and lifestyle treatment (IHBLT) has been shown to produce modest reductions in BMI (on the order of ~0.5–1.0 kg/m^2 more than minimal interventions) after 6–12 months. *[US Preventive Services Task Force, 2024], [Elvsaas et al., 2017]* While average weight changes are often small, high-contact programs can improve cardiometabolic measures – for example, pooled trials with ≥26 contact hours showed modest reductions in systolic blood pressure (~3–4 mmHg) and fasting glucose. *[US Preventive Services Task Force, 2024]* Importantly, these interventions are safe and not associated with harm; in fact, family-based behavioral treatment may improve quality of life and reduce disordered eating risk. *[Hampl et al., 2023]*, *[US Preventive Services Task Force, 2024]* Major pediatric organizations (USPSTF, AAP) therefore advise that clinicians screen for obesity starting at age 6 and offer or refer to intensive behavioral programs to achieve healthier weight trajectories. *[O'Connor et al., 2024]* However, the availability of multidisciplinary programs is limited in many areas, and delivering ≥26 hours of therapy can be challenging. *[Hampl et al., 2023]* When accessible, a holistic approach that engages the whole family and addresses diet, activity, and behavior consistently over time is the foundation of successful obesity management in youth. *[Hampl et al., 2023]*

Pharmacotherapy

For children and adolescents with moderate-to-severe obesity who do not respond adequately to lifestyle interventions alone, adjunctive pharmacotherapy can be considered. The American Academy of Pediatrics (AAP) in 2023 endorsed the use of weight loss medications as an adjunct to behavioral therapy for adolescents ≥12 years with obesity, after evaluation of risks and benefits. *[Hampl et al., 2023]* In fact, the AAP recommends offering FDA-approved anti-obesity medications to eligible adolescents aged ≥12, and notes that for *younger* children (aged 8–11) with severe obesity, medication may be considered in special circumstances, according to clinical judgment and medication indications. *[Hampl et al., 2023]* All pharmacotherapy should be used in the context of a comprehensive weight management plan, not as a standalone approach.

Several medications have been investigated or approved for pediatric obesity. Until recently, options were limited to older agents with modest efficacy. One long-standing option is orlistat (a gastrointestinal lipase inhibitor approved for ages 12+), which produces only mild-to-moderate weight reductions (a meta-analysis showed ~1 BMI unit greater reduction than placebo over 12 months. *[US Preventive Services Task Force, 2024]* and often causes gastrointestinal side effects (steatorrhea, flatulence) that impact adherence. *[US Preventive Services Task Force, 2024]* Off-label use of metformin (an insulin-sensitizer) has been common in adolescents with obesity and signs of insulin resistance or type 2 diabetes; metformin yields small BMI reductions (generally <5% weight loss) and is not formally approved for obesity, but may help improve metabolic parameters in youth with prediabetes or features of metabolic syndrome. *[Chung, 2024]* Other conventional appetite suppressants (e.g. phentermine) have seen limited pediatric use (phentermine is only FDA-approved for ages ≥16 for short-term use), but combination therapy has been studied: a 2019 trial of phentermine/topiramate extended-release in adolescents showed substantial efficacy at the higher dose (mean BMI reduction ~5.4 kg/m^2 greater than placebo after 56 weeks). *[US Preventive Services Task Force, 2024]* This corresponds to a large relative weight loss (phentermine/topiramate 15/92 mg led to ~ − 15% body weight change vs +3% with placebo in that study. *[O'Connor et al., 2024]* Common side effects of phentermine/topiramate in teens include paresthesia, dry mouth, mood changes, and elevated heart rate, and some patients experienced mood-related side effects (in one trial 8.8% had psychiatric symptoms on medication vs 1.8% on placebo). *[O'Connor et al., 2024]* Nevertheless, this combination represents a potential option for adolescents with severe obesity, although it is not yet widely used in pediatrics pending official regulatory approval.

Newer Pharmacological Therapies

The landscape of pediatric obesity pharmacotherapy has advanced significantly with the advent of "second-generation" anti-obesity medications. These newer agents, originally developed for adults, are characterized by greater efficacy in inducing weight loss (on the order of ~10–15% average reductions in body weight when combined with lifestyle therapy), bridging the gap between lifestyle-only outcomes and the outcomes seen with bariatric surgery. *[Patel & Niazi, 2025], [Cominato et al., 2025]*

The most prominent among these are the glucagon-like peptide-1 (GLP-1) receptor agonists. Liraglutide (a daily injectable GLP-1 analog) was approved in 2020 for adolescents (12–17 years) with obesity, based on trials demonstrating superior weight loss over placebo when added to lifestyle changes. A landmark trial in adolescents reported liraglutide 3.0 mg daily yielded an average BMI reduction ~4% greater than placebo at 56 weeks. *[Nicolucci & Maffeis, 2022], [Jebeile et al., 2022]* More recently, the efficacy of liraglutide has also been tested in younger children. In a 2024 randomized trial in children 6 to <12 years old, liraglutide plus diet/exercise led to a −5.8% mean BMI change from baseline at 56 weeks, versus a +1.6% change in the placebo group (a significant net improvement) However, gastrointestinal side effects were common (experienced by 80% on liraglutide vs 54% on placebo), consistent with the known profile of GLP-1 agonists. *[Fox et al., 2024]*

A particularly impactful new therapy is semaglutide, a weekly injectable GLP-1 agonist. In the 2022 STEP TEENS trial, adolescents receiving semaglutide 2.4 mg weekly plus lifestyle intervention achieved a −16.1% mean change in BMI after 68 weeks, compared to a +0.6% change with placebo (a −16.7 percentage-point difference). *[Weghuber et al., 2022]* This corresponded to three-quarters of treated youth losing at least 5% of their body weight, versus ~18% of adolescents in the placebo group. *[Weghuber et al., 2022]* Many even had transformative weight loss (e.g. nearly 45% of semaglutide-treated adolescents dropped below the clinical obesity threshold). *[Vajravelu, Tas, & Arslanian, 2023]* Along with BMI reduction, semaglutide therapy led to improvements in waist circumference and metabolic markers (HbA1c, lipids, liver enzymes) relative to placebo. *[Maffeis et al., 2023], [Dira et al., 2025], [Vajravelu, Tas, & Arslanian, 2023]* Following

this trial, semaglutide 2.4 mg (originally approved for adults as an anti-obesity medication) was approved in late 2022 for adolescents ≥12 years with obesity. This approval marked a major milestone in pediatric obesity pharmacotherapy. *[Maffeis et al., 2023], [Vajravelu, Tas, & Arslanian, 2023]*

Notably, gastrointestinal side effects were frequent – about 62% of adolescent patients on semaglutide reported GI symptoms (typically nausea, vomiting, or diarrhea) versus 42% in the placebo, and gallstones occurred in 4% of patients. *[Weghuber et al., 2022]* Despite these side effects, adherence in trials has been high and discontinuation rates low for GLP-1 therapies; in the STEP TEENS study, ~90% of participants completed the 68-week course. *[Weghuber et al., 2022], [Torbahn et al., 2025], [Katole et al., 2024]* Clinicians must counsel that GI symptoms are common and initiate/titrate doses carefully, but these events are usually mild to moderate and manageable.

Another emerging medication of great interest is tirzepatide, a once-weekly dual GLP-1/GIP receptor agonist, which in adults has shown even greater weight loss (~20% on average). While tirzepatide is not yet approved for pediatric obesity (trials in adolescents are forthcoming), it is considered a "second-generation" therapy and may expand options in the near future. *[Jastreboff et al., 2022], [Lin et al., 2023], [Abu Dayyeh & Wilding, 2023]* Additionally, for rare cases of monogenic obesity, a targeted therapy now exists: setmelanotide, a melanocortin-4 receptor agonist, is approved for children ≥6 years with obesity due to certain genetic defects (e.g. biallelic *POMC* or *LEPR* deficiency). In those specific patients, setmelanotide can dramatically reduce hunger and lead to significant weight loss highlighting the potential of precision medicine in obesity management. *[Vajravelu, Tas, & Arslanian, 2023] [Trapp & Censani, 2023]* Genetic screening for children with extreme early-onset obesity or clinical features of genetic syndromes may therefore identify candidates for such tailored treatment. *[Vajravelu, Tas, & Arslanian, 2023], [Trapp & Censani, 2023], [Loos & Yeo, 2022]*

When using pharmacotherapy for pediatric obesity, it is essential to consider safety and limitations. All medications should be prescribed with full awareness of potential side effects and the need for close monitoring. Additionally, anti-obesity drugs typically must be continued long-term to maintain benefits; studies show that weight is rapidly regained if medication is stopped *[Chivate et al., 2024]*, *[US Preventive Services Task Force, 2024]* Moreover, most pediatric trials have followed patients for only 6–17 months, so data on long-term safety (>2 years) or effects on hard outcomes (e.g. adult diabetes, cardiovascular disease) are still lacking. *[Hampl et al., 2023], [Chivate et al., 2024]* Cost and access are additional considerations – newer agents can be expensive, and insurance coverage varies. Despite these caveats, the arrival of effective pharmacotherapies marks a new era in pediatric obesity treatment. *[Hampl et al., 2023], [Chivate et al., 2024]* These medications significantly improve weight and health outcomes. When used appropriately, they can be life-changing for adolescents with severe obesity. *[Fox et al., 2024]* Ongoing research and post-marketing surveillance will continue to assess their long-term impact in youth. For now, expert consensus is that pharmacotherapy should be offered to adolescents with obesity who have an inadequate response to lifestyle therapy alone, as part of a multimodal and closely monitored treatment plan. *[Hampl et al., 2023]*

Metabolic and Bariatric Surgery

Metabolic or bariatric surgery is the most effective intervention for severe obesity, and in carefully selected adolescents it can result in dramatic and sustained weight loss with improvement or resolution of comorbidities. *[Chalklin, Ryan Harper, & Beamish, 2021]* Modern bariatric procedures (particularly laparoscopic sleeve gastrectomy and Roux-en-Y gastric bypass) have been performed in teenagers with outcomes approaching those seen in adults. *[Chalklin, Ryan Harper, & Beamish, 2021]* The AAP and other expert groups endorse consideration of surgery for adolescents (~13–19 years old) with severe obesity – generally defined as a BMI ≥120% of the 95th percentile (or BMI ≥40 kg/m², roughly equivalent to adult class III obesity) or BMI ≥35 kg/m² with significant comorbid conditions. [*Elkhoury, Elkhoury, & Gorantla, 2023]*, *[Armstrong et al., 2019]* Evaluation for surgery should include a thorough assessment by a multidisciplinary team (pediatric obesity specialist, surgeon, psychologist, dietitian, etc.) to ensure the patient and family are prepared for the lifestyle changes and lifelong follow-up required. *[Armstrong et al., 2019]* Importantly, chronological age is not the sole determinant – physiological maturity (e.g. near completion of linear growth) and the ability to adhere to post-surgery recommendations are key factors. There is no benefit in delaying intervention once an adolescent is severely obese with comorbidities; evidence indicates that younger patients may have equal or greater health gains and no greater risks compared to waiting until adulthood. *[Calcaterra et al., 2021]*

Outcomes of bariatric surgery in youth are very positive. On average, adolescents lose 25–30% of their body weight (ΔBMI of 10–15 kg/m²) within 1–2 years after surgery, far exceeding what is achievable with nonsurgical therapy. *[Chalklin, Ryan Harper, & Beamish, 2021], [Nicolucci & Maffeis, 2022]* Comorbid conditions often improve markedly: for example, type 2 diabetes and prediabetes remission rates are high (often >80% remission in youths with T2D), hypertension and dyslipidemia frequently improve, and obstructive sleep apnea and orthopedic complications are alleviated in many patients. Quality of life scores also rise significantly post-surgery as physical and social functioning improve. Perhaps most critically, longitudinal studies suggest that adolescent surgery patients maintain most of their weight loss into young adulthood, with lasting health benefits (a lower incidence of new-onset diabetes, heart disease risk factors, etc., compared to peers who did not undergo surgery). *[Chalklin, Ryan Harper, & Beamish, 2021], [Nicolucci & Maffeis, 2022]*

The safety profile of bariatric surgery in adolescents is excellent when performed at experienced centers. Serious perioperative complications are uncommon, and overall safety outcomes in adolescents are comparable to those in adults. A recent review concluded that metabolic surgery is safe even for teenagers with extremely high BMI (≥50), with no higher risk of adverse events in this group. *[Chalklin, Ryan Harper, & Beamish, 2021], [Maffeis et al., 2023] T*he most common complications are manageable issues such as dehydration, marginal ulcers, gallstones, or micronutrient deficiencies; these can be mitigated by careful postoperative monitoring, patient education, and routine supplementation (e.g. daily vitamins, minerals, vitamin B_{12} injections if needed). Long-term, adolescents require lifelong nutritional follow-up to prevent deficiencies (especially after gastric bypass, which can cause malabsorption of iron, B_{12}, calcium, etc.). There may be a need for future revisional procedures in a minority of patients, but overall, the risk-benefit profile heavily favors surgery for severe obesity. Importantly, studies have not found any negative impact of adolescent bariatric surgery on growth or development; many patients actually experience improved linear growth or bone health as their nutrition and mobility improve post-weight loss. *[Chalklin, Ryan Harper, & Beamish, 2021]*

In summary, bariatric surgery is a proven and highly effective therapy for adolescents with severe obesity, offering substantial and sustained weight loss, improved comorbidities, and enhanced quality of life. *[Chalklin, Ryan Harper, & Beamish, 2021]* It should be considered early for eligible youth, rather than viewed as a "last resort," since timely intervention maximizes benefits and prevents irreversible complications of long-standing obesity. The decision must be individualized – involving the adolescent's assent and family's consent – and performed in centers with pediatric expertise. When appropriately indicated, surgery can be transformative, putting adolescents with severe obesity on a healthier trajectory as they enter adulthood.

Discussion

Childhood obesity remains a major global health challenge driven by complex biological, behavioral, environmental, and social interactions. The evidence synthesized in this review highlights that obesity in childhood is not solely the result of individual choices but rather the outcome of multilevel influences operating across home, school, and community environments. Rapid nutrition transitions, widespread availability of ultra-processed foods, insufficient physical activity, and inadequate sleep combine with socioeconomic disadvantage to promote excessive weight gain from early life.

These findings underscore that effective prevention requires strategies extending beyond education and lifestyle counseling. Although school- and family-based programs can modestly improve behaviors and body composition, their population-level impact remains limited when implemented in isolation. Greater and more sustained effects have been demonstrated through structural actions such as fiscal measures, marketing restrictions, and nutritional labeling reforms, which shift the broader food environment toward healthier defaults. Collectively, this evidence supports a systems-oriented approach, where individual interventions are embedded within supportive policy frameworks.

From a therapeutic perspective, the management of established obesity in children and adolescents has entered a new era. Intensive, family-centered behavioral interventions remain the cornerstone of care, yet access to such programs is uneven across countries. The advent of pharmacological options, particularly GLP-1 receptor agonists such as liraglutide and semaglutide—has significantly expanded treatment possibilities, providing clinically meaningful weight reductions and metabolic benefits. Nevertheless, their high cost, limited long-term data, and unequal availability pose challenges for equitable implementation.

Bariatric surgery continues to offer the most durable outcomes for severe adolescent obesity, leading to substantial and sustained weight loss as well as remission of comorbidities. Importantly, accumulating

evidence suggests that earlier intervention in eligible adolescents may prevent irreversible cardiometabolic damage and improve long-term quality of life. Future research should focus on optimizing multimodal treatment pathways, integrating behavioral, pharmacologic, and surgical components according to patient needs.

Ultimately, addressing childhood obesity requires coordinated action across health systems, education, food industries, and public policy. Tackling upstream drivers—such as food marketing, urban design, and socioeconomic inequities—is essential to complement clinical care and to reverse the current trends. The growing body of research offers promising solutions, but their success will depend on political will, resource allocation, and the sustained engagement of families and communities.

Strengths and weaknesses of the research

The body of evidence on childhood obesity has notable strengths. First, epidemiological data are robust, derived from large-scale international surveillance systems (e.g., WHO COSI, Global NCD monitoring) and meta-analyses including tens of millions of participants. This provides high confidence in the accuracy of prevalence estimates and temporal trends. Second, multiple systematic reviews and Cochrane analyses have synthesized evidence on prevention and treatment, offering comprehensive overviews that inform guidelines. Third, the emergence of randomized controlled trials testing newer pharmacologic agents such as liraglutide and semaglutide represents a major methodological advance, with rigorous design, clinically meaningful outcomes, and reproducibility across studies. Moreover, policy-level interventions such as marketing restrictions and fiscal measures have been evaluated in real-world contexts, with evidence suggesting population-wide impact.

Despite these advances, important weaknesses limit the current research landscape. Most pharmacotherapy trials have relatively short follow-up (typically 6–17 months), leaving uncertainty about long-term safety and durability of weight loss. Preventive interventions are heterogeneous in design, intensity, and outcome measures, making comparisons across studies challenging. Many studies focus on intermediate outcomes (BMI z-scores, behavior change) rather than long-term endpoints such as incidence of type 2 diabetes, cardiovascular disease, or mortality. There is also a scarcity of research in younger children (<6 years) and in low- and middle-income countries, which reduces generalizability. Furthermore, behavioral and family-based interventions often suffer from high attrition rates, limiting external validity. Finally, potential conflicts of interest exist in some pharmacological trials sponsored by industry, underscoring the need for independent replication.

In summary, current research provides a strong foundation for understanding and addressing childhood obesity, but critical gaps remain. Strengthening long-term studies, ensuring diversity in study populations, and standardizing outcome measures are essential to advance the field and translate evidence into effective and equitable practice.

Conclusions

Childhood obesity embodies one of the most pressing and complex public health challenges of the 21st century. Evidence consistently shows that sustainable progress cannot be achieved through individual-level interventions alone. A coordinated, multisectoral response—linking healthcare, education, policy, and community action—is required to alter the structural drivers that perpetuate obesogenic environments.

Integrating behavioral, pharmacologic, and surgical options within equitable health systems offers a pathway to personalized and effective care. However, the ultimate success of these measures depends on broader social transformation: ensuring healthy food environments, safe spaces for physical activity, and early-life support for families.

Addressing childhood obesity is not solely a clinical task, but a societal responsibility. Collaborative, evidence-based strategies aligning prevention, treatment, and policy are essential to safeguard future generations and reduce the long-term burden of obesity-related disease.

New directions and recommendations

Future progress in the field of childhood obesity requires addressing current gaps and implementing evidence-informed strategies. Key priorities include:

1. **Long-term pharmacotherapy data** – conduct extended trials to evaluate safety and durability of new medications beyond 2–3 years.
2. **Standardization of outcomes** – adopt uniform measures (e.g., BMI z-scores, metabolic endpoints, quality of life) to improve comparability across studies.
3. **Equity in research** – expand studies to younger children (<6 years) and underrepresented populations, particularly in low- and middle-income countries.
4. **Integration of interventions** – design and test multimodal approaches combining behavioral, pharmacological, and environmental strategies.
5. **Policy implementation and evaluation** – strengthen regulation of food marketing, taxation of unhealthy products, and labeling schemes, with rigorous monitoring of real-world impact.
6. **Multidisciplinary clinical care** – promote access to specialized pediatric obesity centers that provide long-term, family-based, and individualized support.

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