

Obesity in Children and Adolescents: 2022 Update of Clinical Practice Guidelines for Obesity by the Korean Society for the Study of Obesity

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The prevalence of obesity in children and adolescents has been gradually increasing in recent years and has become a major health problem. Childhood obesity can readily progress to adult obesity. It is associated with obesity-related comorbidities, such as type 2 diabetes mellitus, hypertension, obstructive sleep apnea, non-alcoholic fatty liver disease, and the risk factor for cardiovascular disease. It is important to make an accurate assessment of overweight and obesity in children and adolescents with consideration of growth and development. Childhood obesity can then be prevented and treated using an appropriate treatment goal and safe and effective treatment strategies. This article summarizes the clinical practice guidelines for obesity in children and adolescents that are included in the 8th edition of the Clinical Practice Guidelines for Obesity of the Korean Society for the Study of Obesity.

Key words: Pediatric obesity, Practice guideline, Therapeutics

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INTRODUCTION

Childhood obesity is a major public health issue. It easily progresses to adult obesity, is difficult to treat, and requires a healthy diet and lifestyle throughout life.^{1,2} The prevalence of obesity in children and adolescents has been increasing rapidly owing to changes in diet and lifestyle, such as a decrease in physical activity, an increase in caloric intake, and a decrease in caloric expenditure. The prevalence of

overweight, obesity, and severe obesity has also increased in Korean children and adolescents.^{3,4} According to the Korea National Health and Nutrition Examination Survey of 2019 to 2022, the prevalence of overweight was 23.5%, obesity was 14.2%, class I obesity was 2.5%, and class II obesity was 0.5%.³ Approaches to the prevention of obesity and to early detection and treatment of obesity-related comorbidities are needed to ensure a healthy future for children. This article summarizes the clinical practice guidelines for obesity

in children and adolescents that are included in the 8th edition of the Clinical Practice Guidelines for Obesity of the Korean Society for the Study of Obesity.⁵

Key question 1. How is obesity diagnosed in children and adolescents?
R1-1. The prevention and treatment of childhood and adolescent obesity are recommended because obesity in this age group easily progresses to adult obesity and is associated with a high risk of obesity-related comorbidities (I, A).
R1-2. When diagnosing obesity in children older than two years of age and adolescents, the use of the body mass index (BMI) percentile for age and sex based on the 2017 Korean National Growth Chart for Children and Adolescents is recommended. A BMI in the 85th percentile or higher is considered an indication of overweight, while a BMI in the 95th percentile or higher is considered an indication of obesity (I, A).
R1-3. Individualized medical risk assessment should be considered in children and adolescents with overweight, including obesity (IIa, B).

Overweight, including obesity, in children is associated with multiple comorbidities and complications. Adolescents with obesity have a 2.6-fold higher rate of prediabetes, and overweight in childhood is associated with type 2 diabetes mellitus in adulthood when it continues to puberty or later ages.^{6,7} Children with obesity are more likely to have obstructive sleep apnea, non-alcoholic fatty liver disease, and a risk factor for cardiovascular disease.^{1,8-10} Children with obesity have also been reported to have greater psychological distress and a lower quality of life.¹¹⁻¹³

The BMI is the acknowledged indicator of obesity in both children and adults. However, this method, which measures adiposity simply and accurately, has limitations.¹⁴⁻¹⁸ The subject's height,

weight, and BMI changes during growth and development in childhood and is influenced by racial and ethnic origin.¹⁹ Therefore, for the diagnosis of obesity in children older than 2 years of age and adolescents, a BMI percentile is used for the normal BMI curves for age (months) and sex based on the normal BMI curves of the 2017 Korean National Growth Chart for Children and Adolescents.²⁰ A BMI in the 85th percentile or higher is considered an indication of overweight, while a BMI in the 95th percentile or higher is considered an indication of obesity.^{15,17,21} Various criteria have been proposed for the classification of severe obesity, such as a BMI above the 99th percentile or a BMI at or above 120% of the 95th percentile (Table 1). Screening the status of overweight (BMI \geq 85th percentile to $<$ 95th percentile) and obesity (BMI \geq 95th percentile) in all children 2 to 18 years of age is recommended.²²

An individualized medical risk assessment is required for children and adolescents with overweight (Fig. 1).¹⁴ A detailed history of diet, physical activity, lifestyle, family history, comorbidities, and medication is obtained to assess the medical risks. The grade of obesity is verified and the subject is evaluated for obesity-related comorbidities (Table 2). For children aged 2 to 3 years with obesity and children aged 6 to 9 years with overweight, the medical risk assessment of comorbidity is considered. For children and adolescents over 10 years of age with overweight, an annual assessment of obesity-related comorbidities is recommended. For children and adolescents with healthy weight, an annual BMI percentile check-up and obesity prevention education and counseling are nevertheless important.^{14,17,23}

Key question 2. What are the treatment goals and principles for obesity in children and adolescents?
R2. Treatment of obesity in children and adolescents is recommended to achieve an appropriate weight while supplying the energy and nutrients necessary for normal growth and habituating the subject to a healthy lifestyle (I, A).

Table 1. Classification of pediatric obesity

Age	Institute/Researcher	Obesity/Class I	Severe obesity/Class II	Severe obesity/Class III
2–19 years	CDC	BMI \geq 95th percentile	BMI \geq 99th percentile \geq 120% of the 95th percentile	\geq 140% of the 95th percentile
	AHA			
	Skinner			

CDC, Centers for Disease Control and Prevention; BMI, body mass index; AHA, American Heart Association.

The treatment goal for obesity in children and adolescents is to reduce excessive adipose tissue and to develop and maintain a healthy lifestyle for maintaining an appropriate weight. Accordingly, normal growth and development are fostered while the incidence of obesity-related comorbidities is prevented and reduced.^{17,18,24-27} Obesity in children and adolescents is a serious problem that can have life-

long consequences. Accurate assessment and early interventions of obesity in children and adolescents can help prevent or reduce the risk of adult disease, including metabolic syndrome, diabetes, hypertension, dyslipidemia, non-alcoholic fatty liver disease, and atherosclerosis.

The principle of treatment of obesity is an individualized, step-

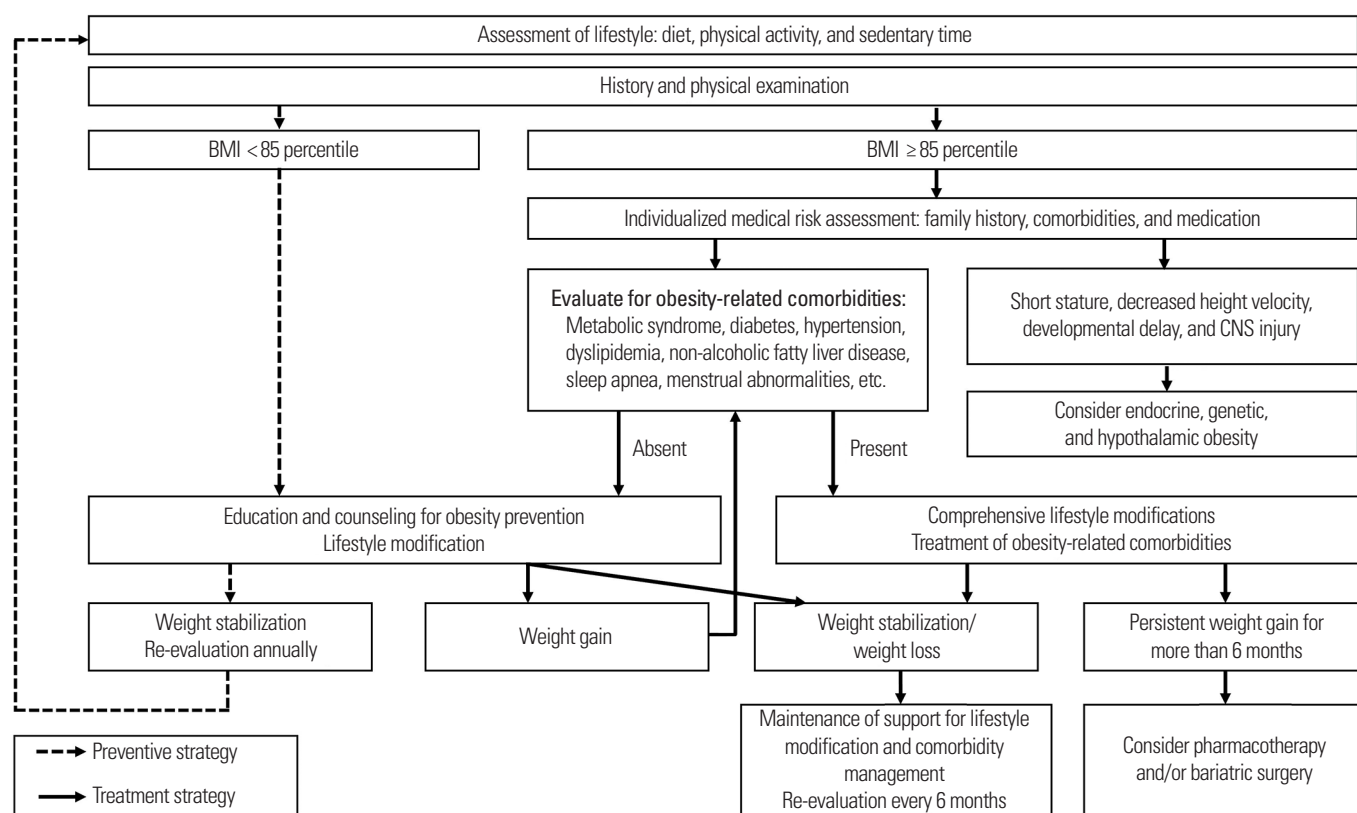


Figure 1. Individualized medical risk assessment and treatment in children and adolescents with obesity. BMI, body mass index; CNS, central nervous system.

Table 2. Evaluation of obesity-related comorbidities in children and adolescents with overweight, including obesity

Obesity-related comorbidities	Test and interpretation
Diabetes mellitus and prediabetes	Fasting plasma glucose, HbA1c, OGTT Diabetes mellitus: fasting plasma glucose ≥ 126 mg/dL, HbA1c $\geq 6.5\%$, 2-hour plasma glucose of ≥ 200 mg/dL during an OGTT Impaired fasting glucose: fasting plasma glucose ≥ 100 mg/mL, < 126 mg/dL Impaired glucose tolerance: 2-hour plasma glucose ≥ 140 mg/mL, < 200 mg/L during an OGTT Prediabetes according to HbA1c $\geq 5.7\%$, $< 6.5\%$
Hypertension	BP (standardized according to sex, age, and height) Hypertension: BP ≥ 95 th percentile Prehypertension: BP > 90 th percentile to < 95 th percentile
Dyslipidemia	Non-fasting non-HDL-cholesterol (total cholesterol–HDL-cholesterol) Check fasting lipids when non-HDL-cholesterol ≥ 140 mg/mL
Non-alcoholic fatty liver disease	ALT Additional assessment when ALT above normal limits according to sex (ALT 26 U/L [boys] and 22 U/L [girls] in USA reference)

HbA1c, glycosylated hemoglobin; OGTT, oral glucose tolerance test; BP, blood pressure; HDL, high-density lipoprotein; ALT, alanine aminotransferase.

by-step approach based on each child's risk level, including age, BMI, and family history, as a means to initiate and maintain a healthy lifestyle.^{14,24,25} Nutritional counseling and a meal prescription for diet control, as well as an exercise prescription for increasing physical activity, are ultimately intended to change the subject's behavior in daily life. It is continuous process of learning and implementing basic knowledge to habituate a healthy lifestyle. It is important to maintain compliance through comprehension of the objective and using communication skills to achieve habituation. Medication or bariatric surgery is considered in certain cases.

Key question 3. What are safe and effective treatment strategies for obesity in children and adolescents?

R3-1. Comprehensive lifestyle modifications, including diet, physical activity, and behavioral therapy, are recommended for treatment of obesity in children and adolescents (I, A).

R3-2. In cases where weight gain and obesity-related comorbidities are sustained even with intensive diet, physical activity, and behavioral therapy, obesity pharmacotherapy by an experienced specialist should be considered (IIa, B).

R3-3. In cases where weight gain and obesity-related comorbidities are sustained even with intensive multidisciplinary treatment and pharmacotherapy for obesity, surgical therapy may be considered in limited cases, only after completion of growth and puberty (IIb, C).

A multidisciplinary therapeutic approach is required for effective obesity treatment.^{14,17,18} A multifaceted patient-centered family treatment program that includes diet, physical activity and behavioral therapy is effective in increasing participation and adherence. To provide a comprehensive lifestyle modification program, it is necessary for each specialist to work together effectively, including physicians, dietitians, psychologists, social workers, and exercise therapists. Each specialist should have a basic understanding of the growth and development of children and adolescents. The support of the healthcare system and public policy are also needed.

It is important to consider the effect of obesity and obesity treatment on growth and development in children and adolescents to avoid unconditional weight loss and to maintain an appropriate weight through lifestyle changes.^{14,17,18,24-29} Treatment goals should

be set to assess readiness, and the behavior should be monitored and recorded. Then, feedback on the behavior should be given, as well as instruction on how to control and respond to stimuli in the environment, while reinforcement through appropriate compensation is needed. To prevent the recurrence of obesity-related behavior, it is necessary to find the causes or antecedent factors for obesity and to establish a problem-solving strategy. Connecting parents, schools, and communities is important to foster family involvement and social support.^{14,18}

Obesity treatment in children and adolescents includes diet, physical activity, behavioral therapy, pharmacotherapy, and surgery. The main treatment strategy is to control and manage diet, daily physical activity, and exercise using comprehensive lifestyle modification.^{14,17,18,24,25,30-32} Pharmacotherapy and surgery are considered in limited cases. The treatment method is tailored to the individual's risk, such as age, BMI percentile, family history, and individual living environments.

A step-by-step approach is recommended for individualized treatment (Table 3).^{14,24,25} It is classified into four stages: stage 1 is a preventive approach; stage 2 is structured weight management; stage 3 is comprehensive multidisciplinary intervention; and stage 4 is tertiary care intervention. The treatment starts at stage 1 and proceeds to the next stage if the expected improvement is not observed after 3 to 6 months.

STAGE 1: PREVENTIVE APPROACH

This stage involves assisting overweight and obese children and their families in learning and adopting healthy eating habits and behavioral patterns. The goal is to prevent further weight gain and to establish a foundation for lifelong healthy habits.

- ✓ Consume an adequate amount of fruit and vegetables.
- ✓ Avoid sugary drinks.
- ✓ Engage in physical activity for at least 1 hour per day.
- ✓ Eat breakfast.
- ✓ Prepare meals at home whenever possible.
- ✓ Eat with family at least five to six times per week.
- ✓ Allow children to make their own meal decisions and do not overly restrict their eating-related behavior.
- ✓ Maintain the current weight, even as height increases, so that

Table 3. Weight target and treatment approach by age and body mass index category

Age	BMI category	Weight target to improve BMI	Initial stage*	Final stage*
2–5 years	5th–84th percentile or 85th–94th percentile without risk factors [†]	Maintain the rate of weight gain	Counseling for obesity prevention	Counseling for obesity prevention
	85th–94th percentile with risk factors [†] > 95th percentile	Maintain weight or slow weight gain	Stage 1	Stage 2
		Maintain weight or slow weight loss (0.5 kg/mo)	Stage 1	Stage 3
6–11 years	5th–84th percentile or 85th–94th percentile without risk factors [†]	Maintain the rate of weight gain	Counseling for obesity prevention	Counseling for obesity prevention
	85th–94th percentile with risk factors [†] 95th–99th percentile > 99th percentile	Maintain weight or slow weight gain	Stage 1	Stage 2
		Slow weight loss	Stage 1	Stage 3
		Weight loss (maximum 1 kg/wk)	Stage 1, or if family motivated Stage 2 or 3	Stage 4 if appropriate
12–18 years	5th–84th percentile or 85th–94th percentile without risk factors [†]	Maintain weight or slow weight gain, or maintain weight if reached final adult height	Counseling for obesity prevention	Counseling for obesity prevention
	85th–94th percentile with risk factors [†] 95th–99th percentile > 99th percentile	Maintain weight or slow weight loss	Stage 1	Stage 2
		Weight loss (maximum 1 kg/wk)	Stage 1	Stage 4
		Weight loss (maximum 1 kg/wk)	Stage 1, or if family motivated Stage 2 or 3	Stage 4

*Treatment stage: stage 1, preventive approach; stage 2, structured weight management; stage 3, comprehensive multidisciplinary intervention; and stage 4, tertiary care intervention—pharmacotherapy and bariatric surgery; [†]Risk factors: obesity of parents, family history, and sedentary lifestyle. BMI, body mass index.

the BMI percentile gradually decreases.

STAGE 2: STRUCTURED WEIGHT MANAGEMENT

This stage focuses on supporting the behavior changes initiated in stage 1 with structured resources and interventions. The goal is to help children and their families integrate these changes into their daily lives and establish them as sustainable lifestyle habits.

- ✓ Plan a balanced diet containing essential nutrients.
- ✓ Reduce intake of high-calorie foods.
- ✓ Provide a structured meal and snacks (breakfast, lunch, dinner, and one to two snacks per day).
- ✓ Engage in physical activity under supervision for at least 1 hour per day.
- ✓ Limit screen time to 1 hour or less per day.
- ✓ Monitor and record this behavior (food intake and eating out, physical activity, screen time, etc.) by the subject or by their family. Provide planned reinforcement when the proper behavior is achieved.

STAGE 3: COMPREHENSIVE MULTIDISCIPLINARY INTERVENTION

This stage involves a more intensive and structured behavior modification program. The program aims to strengthen behavior change strategies, increase patient-healthcare contact, and involve experts in treatment. It is typically recommended for children who have not responded sufficiently to stage 2 interventions.

- ✓ Plan for structured meals and physical activity to achieve a proper energy balance.
- ✓ In the structured behavior modification programs, plan to monitor food and physical activity and to achieve goals in a short period.
- ✓ In children under 12 years of age, involve parents and primary caregivers, and train all family members to improve the family environment.
- ✓ Require visits weekly for 8 to 12 weeks and then monthly to help maintain behavioral habits.
- ✓ Conduct group visits, which are cost-effective and have the advantage of treatment.
- ✓ The goal is to maintain weight and reduce BMI to below the 84th percentile.

Table 4. Obesity pharmacotherapy in children and adolescents

Drug name	Mechanism of action	Indication	Consideration
Orlistat	Pancreatic and gastric lipase inhibitor	Obesity ≥ 12 years of age	Steatorrhea, bloating, flatulence, and vitamin/mineral deficiency
Phentermine	Release catecholamine	Obesity ≥ 16 years of age, short-term use	Increased heart rate and blood pressure, dry mouth, insomnia, constipation, and irritability
Liraglutide	GLP-1 agonist	Obesity ≥ 12 years of age	Nausea/vomiting, abdominal pain, risk of hypoglycemia, contraindicated with family history of medullary thyroid carcinoma, MEN type 2, and ESRD
Phentermine-topiramate	Release catecholamines, activation of GABA and inhibition of glutamate	Obesity ≥ 12 years of age (in USA, not approved in Korea)	Mood change (discontinue when depression or suicidal ideation occurs), insomnia, growth retardation, increase heart rate, acute myopia, glaucoma, metabolic acidosis, and decrease renal function

GLP-1, glucagon-like peptide-1; MEN, multiple endocrine neoplasia; ESRD, end-stage renal disease; GABA, γ -aminobutyric acid.

- √ The cooperation of various professional groups is essential (physicians, dietitians, psychiatrists, psychologists, social workers, and exercise therapists).

STAGE 4: TERTIARY CARE INTERVENTION-PHARMACOTHERAPY AND BARIATRIC SURGERY

This stage involves intensive treatment for children who have not responded to previous stages and have severe obesity. Treatment options may include pharmacotherapy or bariatric surgery.

- √ Obesity pharmacotherapy and bariatric surgery are considered only in patients with obesity who experience weight gain and obesity-related comorbidities despite participating in an intensive lifestyle modification program.^{14,17,29,33,34} It is considered if the patients fully understand the side effects of pharmacotherapy or surgery and can continue to maintain physical activity, diet, and behavior modification.
- √ Orlistat (12 years of age or older), phentermine (16 years of age or older), and liraglutide (12 years of age or older) are currently approved by the Ministry of Food and Drug Safety for obesity pharmacotherapy in children and adolescents (Table 4).^{29,33-35} In 2021, liraglutide was approved for obese children over 12 years of age who weighed more than 60 kg and whose BMI by age and sex corresponded to a BMI of 30 kg/m² or higher for adults (Table 5).³⁶ The dosage of liraglutide begins at 0.6 mg/day, with a weekly dose increment, and is maintained at a maximum dose of 3.0 mg/day. In June 2022, phentermine-topiramate extended release was approved by the U.S. Food and Drug Administration for obesity

Table 5. International Obesity Task Force (IOTF) BMI cut-off for obesity by sex between the ages of 12 and 18

Age (yr)	BMI equivalent to an adult BMI 30 kg/m ² according to IOTF	
	Boys	Girls
12	26.02	26.67
12.5	26.43	27.24
13	26.84	27.76
13.5	27.25	28.20
14	27.63	28.57
14.5	27.98	28.87
15	28.30	29.11
15.5	28.60	29.29
16	28.88	29.43
16.5	29.14	29.56
17	29.41	29.69
17.5	29.70	29.84
18	30.00	30.00

BMI, body mass index.

treatment in children and adolescents aged 12 years and older, although it was not approved in Korea.³⁷ Metformin is an approved medication for type 2 diabetes mellitus in patients aged 10 years and older. Owing to its ability to enhance insulin sensitivity, metformin may be considered a treatment option for severe insulin resistance caused by obesity, even though it is not currently approved for the treatment of obesity.

- √ Obesity pharmacotherapy is an adjunct to an intensive lifestyle modification. The side effect of the medication should be monitored. The medication is not effective if the BMI or BMI z-score decreases by less than 4% in 12 weeks. It should then be discontinued.¹⁶⁻¹⁸ Common side effects include steatorrhea, bloating, and flatulence with orlistat, dizziness, head-

ache, palpitations, diarrhea, and constipation with phentermine, and nausea, vomiting, diarrhea, dizziness, and fever with liraglutide. Phentermine-topiramate may influence growth; thus, regular growth evaluation is required. The treatment should be discontinued if depression or suicidal thoughts occur.³⁷

- √ Pharmacotherapy is not indicated in pre-pubertal children owing to insufficient evidence of effectiveness. Although there are several drugs recently approved for adult obesity, clinical studies in children and adolescents with obesity remain lacking. Further studies in children and adolescents are required to establish appropriate dose, effectiveness, and safety profile.²⁹
- √ No universally accepted recommendation for surgery exists for children and adolescents with obesity. Surgery may be considered only in limited cases in adolescents who have completed growth and puberty.^{14,16,38-40} Surgery may be considered in cases where the BMI is 35 kg/m² or more, or 120% of the 95th percentile, where major comorbidities (e.g., type 2 diabetes mellitus, sleep apnea, non-alcoholic fatty liver disease, and idiopathic intracranial pressure elevation) are present, or where the BMI is 40 kg/m² or more, or 140% of the 95th percentile.^{18,38-40} Prior to surgery, evaluation of multidisciplinary treatment and pharmacotherapy is necessary. Research on the impact of surgery on the growth and development of adolescents is limited.⁴¹

CONCLUSION

Obesity in children and adolescents is difficult to treat. It can easily progress to adult obesity and is associated with obesity-related comorbidities. Therefore, a policy of appropriate assessment, prevention, and early detection of obesity is necessary. Comprehensive lifestyle modification, including diet, physical activity, and behavior therapy, is a cornerstone of treatment for obesity in children and adolescents. In limited cases, obesity pharmacotherapy and surgery may be considered.

CONFLICTS OF INTEREST

Sochung Chung is an editorial board member of the journal, but she was not involved in the peer reviewer selection, evaluation, or

decision process of this article. No other potential conflicts.

AUTHOR CONTRIBUTIONS

Study concept and design: all authors; acquisition of data: YHH, JK, and SC; drafting of the manuscript: EK; critical revision of the manuscript: all authors; and study supervision: YJR.

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