## CHAPTER 5: Pediatric Obesity

References:

- 1. Manuel Moya. Pediatric Overweight and Obesity: Comorbidities, Trajectories, Prevention and Treatments (2023)
- 2. Peter G. Kopelman, Ian D. Caterson, William H. Dietz Clinical Obesity in Adults and Children 4e-Wiley-Blackwell (2022)
- 3. Sharon Akabas, Sally Ann Lederman, Barbara J. Moore Textbook of obesity\_ Biological, psychological and cultural influences-Wiley-Blackwell (2012)

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## Outline

- Assessment
- Complications
- Risk Factors
- Treatment

## Assessment in Pediatric Ages

• Raw and Percentile BMI

The crude BMI (kg/m2) should not be used in pediatrics as its medians change substantially with age:

At birth it is 13 kg/m2; at the age of 1 year, it rises to 17 kg/m2; at 6 years it decreases to 15.5 kg/m2; and at 20 years it is 21 kg/m2.

### Table 11-1 BMI Categories for Children and Teens

Underweight	BMI-for-age <5th percentile
Normal	BMI-for-age 5th percentile to <85th percentile
Overweight	BMI-for-age 85th percentile to <95th percentile
Obese	BMI-for-age ≥95th percentile



## Assessment of Body Fat

- The commonly used BMI does not take into account skeletal size and especially muscularity, examples:
  - Young people who regularly play sport would give values that would place them in the overweight zone.
  - Sedentary children with lower mineral and/or muscle content, means that they might be identifed as "underweight".

Body fat mass/fat-free mass ratio varies with age, race, and especially sex without variations in weight and therefore BMI.

There is a need to assess body fat directly, as well as its distribution.

# Assessment of Body Fat and Its Distribution

- The waist circumference (WC) can be an appropriate anthropometric measurement for screening children.
- Larger perimeters are associated with: higher basal insulin levels, higher insulin resistance, and hypertension.
- By itself WC is also an excellent predictor of visceral fat
  (r = 0.88) in the pediatric population.

### Waist Circumference Cut-off Points?

- The IDF consensus definition of metabolic syndrome in children and adolescents designates the 90th percentile of WC as the cutoff point for defining central obesity, with ethnicity-specific values for European-American, African-American, and Mexican-American populations (see next slide)
- These were developed through a cross-sectional data analysis that included 9713 persons 2 to 18 years of age

### https://www.jpeds.com/article/S0022-3476(04)00553-0/abstract

		Per	centile for	boys		1	Percentile for girls		girls		
	10 <sup>th</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	90 <sup>th</sup>	I 0 <sup>th</sup>	25 <sup>th</sup>	50 <sup>th</sup>	75 <sup>th</sup>	90 <sup>th</sup>	
Intercept	39.7	41.3	43.0	43.6	44.0	40.7	41.7	43.2	44.7	46.1	
Slope	1.7	1.9	2.0	2.6	3.4	1.6	1.7	2.0	2.4	3.1	
Age (y)											
2	43.2	45.0	47.1	48.8	50.8	43.8	45.0	47.1	49.5	52.2	
3	44.9	46.9	49.1	51.3	54.2	45.4	46.7	49.1	51.9	55.3	
4	46.6	48.7	51.1	53.9	57.6	46.9	48.4	51.1	54.3	58.3	
5	48.4	50.6	53.2	56.4	61.0	48.5	50. I	53.0	56.7	61.4	
6	50.1	52.4	55.2	59.0	64.4	50.1	51.8	55.0	59.1	64.4	
7	51.8	54.3	57.2	61.5	67.8	51.6	53.5	56.9	61.5	67.5	
8	53.5	56.1	59.3	64.1	71.2	53.2	55.2	58.9	63.9	70.5	
9	55.3	58.0	61.3	66.6	74.6	54.8	56.9	60.8	66.3	73.6	
10	57.0	59.8	63.3	69.2	78.0	56.3	58.6	62.8	68.7	76.6	
11	58.7	61.7	65.4	71.7	81.4	57.9	60.3	64.8	71.1	79.7	
12	60.5	63.5	67.4	74.3	84.8	59.5	62.0	66.7	73.5	82.7	
13	62.2	65.4	69.5	76.8	88.2	61.0	63.7	68.7	75.9	85.8	
14	63.9	67.2	71.5	79.4	91.6	62.6	65.4	70.6	78.3	88.8	
15	65.6	69.1	73.5	81.9	95.0	64.2	67.1	72.6	80.7	91.9	
16	67.4	70.9	75.6	84.5	98.4	65.7	68.8	74.6	83.1	94.9	
17	69.1	72.8	77.6	87.0	101.8	67.3	70.5	76.5	85.5	98.0	
18	70.8	74.6	79.6	89.6	105.2	68.9	72.2	78.5	87.9	101.0	
					-						

#### Table IV. Estimated value for percentile regression for all children and adolescents combined, according to sex

## International applicability?

- A total of 124,643 adolescents (ethnically Chinese) aged 15 (boys: 63,654; girls: 60,989) were recruited
- Measured waist, and cardiovascular risk factors (elevated SBP or DBP, impaired fasting glucose and an abnormal lipid profile)
- WC was a good predictor for high cardiovascular, but!

The optimal WC cutoff points were ≥78.9 cm for boys (77th percentile) and ≥70.7 cm for girls (77th percentile).

### The 90<sup>th</sup> percentile of the WC might be inadequate.

STUDENTS-HUB.com <u>https://pmc.ncbi.nlm.nih.gov/articles/PMC4936838/</u> Uploaded By: anonymous

## The consequences of childhood and adolescent obesity include both medical and psychological

#### Box 26.1 Medical and psychological complications of child and adolescent obesity.

#### Cardiovascular

Abnormal blood vessel structure and function Hypertension Dyslipidemia Cardiac muscle abnormalities

#### Endocrine

Type 2 diabetes mellitus Insulin resistance Polycystic ovarian syndrome Altered onset of puberty Pseudo-gynecomastia

#### Respiratory

Sleep-disordered breathing, obstructive sleep apnea Asthma Breathlessness on minimal exertion Obesity hypoventilation syndrome

#### Orthopedic

Pes planus Idiopathic tibia vara (Blount disease) Slipped capital femoral epiphysis Musculoskeletal pain

#### Gastrointestinal

Constipation Nonspecific abdominal pain Gastroesophageal reflux Cholelithiasis Liver dysfunction Nonalcoholic fatty liver disease Nonalcoholic steatohepatitis **Renal** Low level albuminuria Overt proteinuria

Neurologic Idiopathic intracranial hypertension Headache

#### Malignancy\* Esophageal cancer Thyroid cancer Colorectal cancer Renal cancer Endometrial cancer Breast cancer

Dermatologic Acanthosis nigricans Intertrigo Heat rash/intolerance Skin infections Striae

Oral Dental caries

#### Psychological

Low self-esteem Impacts on health-related quality of life Bullying Depression Anxiety Disordered eating behavior

STUDENTS-HUB.Commplication, based on adult data in the absence of data for children and adolescents.

Cardiovascular



Overweight and obesity during adolescence are strongly

associated with increased cardiovascular mortality in adulthood

Atherosclerosis development begins in childhood.

The extent of lesions were significantly correlated with body mass index (BMI), systolic and diastolic blood pressure, total serum cholesterol concentration, serum LDL-C, and serum triglyceride (TG) concentration

### Hypertension

Obesity is the most common cause identified for hypertension in children Prehypertension and hypertension represent concerning levels of cardiovascular risk, especially at such a young age.

Recommendation: Annual blood pressure screening occur for all children 3–17 years of age, irrespective of weight.



 Hypertension categories

### https://phdistrict2.org/wpcontent/uploads/2018/05/BP-Guide-Pediatric.pdf Use this REF for BP percentiles

Blood Pressure Levels for Boys by Age and Height Percentile\*

Age	BP		S	ystolic	BP (m	mHg)	A REAL PROPERTY OF THE PARTY OF	
(Year)	Percentile		← P	ercent	ile of H	leight -	<b>→</b>	
	Ļ	5th	10th	25th	50th	75th	90th	95th
1	50th	80	81	83	85	87	88	89
	90th	94	95	97	99	100	102	103
	95th	98	99	101	103	104	106	106
	99th	105	106	108	110	112	113	114
2	50th	84	85	87	88	90	92	92
	90th	97	99	100	102	104	105	106
	95th	101	102	104	106	108	109	110
	99th	109	110	111	113	115	117	117
3	50th	86	87	89	91	93	94	95
	90th	100	101	103	105	107	108	109
	95th	104	105	107	109	110	112	113
	99th	111	112	114	116	118	119	120

### Box 26.3 Updated definitions for blood pressure categories and stages.

#### For children aged 1 to <13 years

Normal BP: <90th percentile

Elevated BP: ≥90th percentile to <95th percentile or 120/80 mm Hg to <95th percentile (whichever is lower)

Stage 1 HTN: ≥95th percentile to <95th percentile + 12 mmHg, or 130/80 to 139/89 mmHg (whichever is lower)

Stage 2 HTN: ≥95th percentile + 12 mm Hg, or ≥140/90 mm Hg (whichever is lower) For children aged ≥13 years

Normal BP: <120/<80 mm Hg

Elevated BP: 120/<80 to 129/<80 mm Hg

Stage 1 HTN: 130/80 to 139/89 mm Hg

Stage 2 HTN: ≥140/90 mm Hg

BP, blood pressure; HTN, hypertension.

### Dyslipidemia

The predominant pattern of dyslipidemia in children with obesity is a moderate to severe elevation in TG, normal to mild elevation in LDL-C, and reduced high HDL-C. The Expert Panel on Integrated Guidelines for Cardiovascular Health and Risk Reduction in Children and Adolescents (2011) recommended values for cut-offs in lipid parameters depending

on age

### Acceptable, Borderline-High, and High Plasma Lipid, Lipoprotein, and Apolipoprotein Concentrations for Children and Adolescents

Category	Low, mg/dL <mark>a</mark>	Acceptable, mg/dL	Borderline-High, mg/dL	High, mg/dL_ <sup>a</sup>
TC	_	<170	170-199	≥200
LDL cholesterol	_	<110	110-129	≥130
Non-HDL cholesterol	_	<120	120-144	≥145
Apolipoprotein B	_	<90	90-109	≥110
Triglycerides				
0-9 y	_	<75	75–99	≥100
10-19 у	_	<90	90-129	≥130
HDL cholesterol	<40	>45	40-45	—
Apolipoprotein A-1	<115	>120	115-120	—

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### • Type 2 diabetes mellitus

The most important risk factor for type 2 diabetes mellitus in childhood and adolescence is obesity

Adolescents with obesity show signs of glucose dysregulation (glucose intolerance and/or abnormal fasting glucose), and are more likely to have impaired insulin clearance Risk factors: maternal history of diabetes, type 2 diabetes in a first degree relative, ethnicity, clinical signs of insulin resistance – acanthosis nigricans, other conditions associated with obesity – hypertension, dyslipidemia, fatty liver disease, polycystic ovary syndrome, and small for gestational age

Clinical practice point: Screening for type 2 diabetes should occur in children and adolescents (aged >10 years or at onset of puberty, whichever occurs earlier) who are classed as overweight or with obesity and one or more additional risk factors for diabetes.

Insulin resistance

Increased BMI has been positively associated with insulin levels, with both:

Increased insulin secretion and

Decreased insulin clearance

 $\rightarrow$  Hyperinsulinemia in adolescents with obesity

### Puberty

Overweight and obesity can often drive early puberty in girls Other effects of obesity in young women include subfertility, menstrual irregularities, and polycystic ovarian syndrome (PCOS)

### Gynecomastia

A benign enlargement of male breast glandular tissue, that is usually bilateral An imbalance of estrogen relative to androgen action is proposed as the main pathway

It is uncommon in prepubertal males and should prompt an evaluation for other underlying causes. Most cases are self-resolving, and may improve with

reductions in weight. STUDENTS-HUB.com

- Metabolic syndrome
- → IDF produced a definition of metabolic syndrome for children and adolescent.
- → Insulin resistance was omitted from the definitions due to practicality of measurement.

### Box 26.2 IDF definition of at-risk group and of metabolic syndrome in children and adolescents

### Age 6 to <10 years

Obesity ≥ 90th percentile as assessed by waist circumference

Metabolic syndrome cannot be diagnosed, but further measurements should be made if family history of metabolic syndrome, type 2 diabetes mellitus, dyslipidemia, cardiovascular disease, hypertension, or obesity

### Age 10 to <16 years

Obesity ≥90th percentile (or adult cut-off if lower) as assessed by waist circumference AND two or more of:

TG ≥1.7 mmol/L

HDL-C <1.03 mmol/L

Blood pressure ≥130 mmHg systolic or ≥85 mmHg diastolic

Glucose ≥5.6 mmol/L (oral glucose tolerance test recommended) or known type 2 diabetes mellitus

Age >16 years

Use existing IDF criteria for adults

Obstructive sleep apnea

Approximately 30% of children with obesity have sleeprelated disordered breathing

The diagnosis is particularly important given the negative effects of OSA on cardiovascular morbidity, attention deficit hyperactivity disorder, learning difficulties, and metabolic morbidity

## • Orthopedic, musculoskeletal discomfort and mobility issues

Many of these complications are due to the increased mechanical load on the body, which affects mobility.

Common physical consequences include slipped capital epiphyses, flat feet (pes planus), ankle sprains, and increased risk of fractures

Slipped upper femoral epiphysis (SUFE) is a fracture through the growth plate, which leads to a slippage of the overlying end of the femur. It presents with hip or knee pain, and limitation of movement. Slipped capital femoral epiphysis



### Functional gastrointestinal disorders

Chronic abdominal symptoms occurring in the absence of clear organic etiology.

Functional abdominal pain, functional constipation, and irritable bowel syndrome are common in children with obesity

Contributors: Dietary factors, hormonal influences, differences in activity level, emotional and behavioral issues may lead to higher somatic complaints and functional abdominal pain

**Clinical practice point**: Screening for functional gastrointestinal disorders with appropriate management can help to improve long-term outcomes and reduce disability.

### Gastroesophageal reflux disease

Childhood obesity increases the risk of experiencing gastroesophageal reflux disease

Signs and symptoms of gastroesophageal reflux disease are broad, but include abdominal pain and "boarthurp"/chost pain

"heartburn"/chest pain

## Psychosocial Problems: Stigma

- The stigma of weight is experienced by both the child and adolescent and their family.
- The most important aspect of stigma is poor integration in the network of friends in their social environment → passive marginalization
- This affects the psychosocial wellbeing of the child or adolescent.
- Other problems include bullying or victimization, which is followed by reduced self-esteem and, more rarely and in severe and prolonged cases, a depressive state.

## Psychosocial Problems: Stigma

- Most cases, the bullies are the classmates, but it could also be adults (gym teachers, parents). The first to recognize the abuse is the child herself/himself (25%), the teacher (34%), and the mother (45%).
- Predisposing factors: unfavorable school environment, a poor relationship with parents, suffering from other form of violence.
- Low self-esteem is manifested by: High self-criticism and dissatisfaction, hypersensitivity to criticism, chronic indecision, irrational irritability, pessimism, and a general negative perception.
  - Fortunately, not all of these reactions are present in pediatric obesity.
- Low self-esteem usually manifests in the form of school absenteeism, school failure, perception of incompetence in sports, poor physical appearance, and poor relationship with their peers → isolation and nervousness, and, more

STUDENTS-HUB.com disorders

## **Risk Factors**

- Birth weight (> 4.0 kg) and rapid growth during the first 6 months of life.
- 2. Sleep deprivation (< 10.7 hours/day at 2–6 years of age)
- The establishment and duration of breastfeeding has a protective action
- 4. The "contagion" of obesity, which leads to normalizing excess weight
- 5. The speed of meal intake, or the number of meals. the slow rhythm of eating is associated (OR: 5.22) with normal weight

### The effect of Mastication

 Patients with obesity demonstrated a significantly shorter chewing duration and lower chewing frequency.

#### Assessment of mastication and food items

Mastication was evaluated by attaching an earphone-type masticatory meter called "earable" (eRCC, Hiroshima, Japan) to the outer ear opening. It is plugged into the opening of the external auditory canal and utilizes infrared light. In addition, an optical distance sensor (LED and phototransistor) was installed to determine the number of chews and chewing duration by measuring the minute changes in the external auditory canal. The measured changes are displayed as waveforms; a proprietary algorithm is used to detect mastication and displays the mastication data on a tablet screen in real-time. Since the user is only required to wear an earphone, the device can measure masticatory indices under conditions closer to those experienced in everyday life than the conventional masticatory meters that are worn on the chin (Fig. 2).







Comparison of the rate of changes in body composition and biochemical indicators between the CTG and MIG

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https://bmcendocrdisord.biomedcentral.com/articles/10.1186/s12902-023-018/9-2#Figs By: anonymous

## **Risk Factors**

- 6. Medications: The use of inhaled corticoid in small children is associated with BMI increase at the age of 6. Antibiotic exposure during the frst 6 months of life has also been described.
- 7. Current famines suffered by the pregnant woman have shown an association with higher BMIs later in life.
- 8. Obesity of the father, independently of the mother, is associated with higher birth weight and subsequent BMIs
- 9. The correct administration of vitamin D during the first 3 years of life is associated with a predominance of later lean mass

## Initial Approach

- First of all, it must be established that there is no underlying endocrinological or monogenic pathology.
- Then: it is important to accurately diagnose and manage co-morbidities.
- The second task is weight control.
- Treatment should be initiated when the values of anthropometric assessments are ≥95th percentile.
- Weight loss:
  - If the child is growing: the most useful policy is not to gain weight as he/she gets taller.
    Rapid weight loss by a strict diet slows down the growth rate.
  - Severe obesity and complications: A maximum weight loss target of 0.5 kg/month can be considered
  - In adolescents who have finished growing: up to 0.5 kg/week but with close monitoring.

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## Initial Approach

- Consider incorporating the family into the treatment.
- Parental awareness of children's excess weight is a particularly crucial step in tackling childhood obesity.
- Some research strongly indicates that parents are *poor judges* of overweight in themselves and their children
- Studies of parents report that from 32% to 90% of both overweight and healthy-weight parents do not recognize that their overweight child is overweight.



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The 2007 Expert Committee recommendations encourage a stagedtreatment approach for children 2–18 years whose BMI is above the 85<sup>th</sup> percentile.

Stage 1: Prevention Plus 5-2-1-0

- 5 fruits and vegetables/day
- 2 or less hours of screen time/day
- 1 hour or more of physical activity/day
- 0 sweetened beverages/day
- •facilitate daily family meals; limit meals outside the home
- •weight maintenance; growth results in decreasing BMI

•Stage 2: Structured Weight Management

•dietary plan emphasizes low amounts of energy-dense foods

•increased monitoring of screen time, physical activity, dietary and restaurant logs

•weight maintenance results in decreasing BMI as age and height increase

•weight loss not to exceed 1 lb./mo. for ages 2-11 yrs.; 2 lb./mo. if older

- •Stage 3: Comprehensive Multidisciplinary Intervention
- •eating and activity as Stage 2
- •activities structured with goals and monitoring
- •involve primary caregivers/families in behavioral training
- •weight maintenance or gradual weight loss until BMI is less than 85th percentile

•Stage 4: Tertiary Care Intervention

- •referral to pediatric weight management center
- •multidisciplinary team with diet- and activity- counseling

STU pensider-meal-replacement, very low calorie diet, medication, or surgery

## Non-drug Therapeutic Approach

- Lifestyle Change Interventions should be aimed at modifying the family attitude or behavior towards obesity
- All available resources can be used, from simple programs well proven in adults to mobile phones with accelerometry (physical activity) and food intake applications, setting a bed-time routine, and creating an overall anti-obesogenic climate.

# Targeting Behaviors Related to Childhood Obesity

- **Sugar sweetened beverages**: Support limiting consumption of sugar-sweetened beverages.
- Fruit and vegetable consumption: An inverse relationship between adiposity and eating fruit and vegetables. Encouraging consumption 9 servings per day of fruits and vegetable.
- Television and screen time: Max. 2 hours of screen primary sleeping areas. (None before 2 years of age.
- **Breakfast eating**: Encourage eating breakfast daily.
- Meals outside the home: Limiting eating out at resta
- Family meals: Make family mealtime a priority and a their children to emulate → associated with a high-qu
- Portion sizes: Limiting portion size, and note the ser
- Parental feeding practices: Increased child weight i of food as a reward)

Amount per serving	160
% Di	aily Value*
Total Fat 10g	13%
Saturated Fat 1.5g	7%
Trans Fat 0g	
Cholesterol Omg	0%
Sodium 170mg	7%
Total Carbohydrate 15g	6%
Dietary Fiber 1g	5%
Total Sugars less than 1g	
Protein 2g	
Vitamin D 0mcg	0%
Calcium 10mg	0%
ron 0.6mg	2%
Potassium 350mg	6%
Vitamin C	6%
Not a significant source of adde	d sugars.
The % Daily Value (DV) tells you how mu in a serving of food contributes to a daily calories a day is used for general nutritio	ich a nutrient diet. 2,000 n advice.

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## **Special Approaches**

Weight-Management Medications for Children

- Drug therapy in children is not usually recommended, but may be warranted in adolescents with comorbid conditions or in those at highest risk for adult disease.
- Medications should always be used in conjunction with lifestyle changes.
- Currently, The FDA has approved 3 medications for chronic weight management in the pediatric population 12 years and older: Orlistat, Liraglutide and Semaglutide

## **Special Approaches**

Surgical Intervention for Weight Management for Children

• Because of growth requirements and the nutritional risks, bariatric surgery for adolescents is controversial.

### • AAP Policy Statement on Bariatric Surgery:

- Medical or lifestyle treatments are not sufficient
- Class 3 obesity (BMI ≥ 140% of the 95<sup>th</sup> percentile or BMI ≥ 40 kg/m<sup>2</sup>) or class 2 obesity (BMI ≥ 120 to 140% of the 95<sup>th</sup> percentile or BMI ≥ 35 kg/m<sup>2</sup>) with a comorbidity
- Full physical maturation (bone age).
- Assessment of adherence to the therapeutic program by both the adolescent and the family (difficult to assess, but is decisive)
- The age limit has been reduced (now 12 years)

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