Pediatric Obesity Algorithm

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Pediatric Obesity Algorithm

Disclaimer

The Pediatric Obesity Algorithm, was developed to assist health care professionals in medical decision making in the management and care of patients with overweight and obesity. The Pediatric Obesity Algorithm is not intended to be a substitute for a medical professional's independent judgment and should not be considered medical advice. The content herein is based on the medical literature and the clinical experience of obesity medicine specialists. In areas regarding inconclusive or insufficient scientific evidence, the authors used their professional judgment.

The Pediatric Obesity Algorithm is a working document that represents the state of obesity medicine at the time of publication. The Obesity Medicine Association (OMA) encourages medical professionals to use this information in conjunction with, and not as a replacement for, their best clinical judgment. The presented recommendations may not be appropriate in all situations. Any decision by practitioners to apply these guidelines must be made in light of local resources and individual patient circumstances.

Permissions

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Purpose

To provide clinicians an algorithm to guide the treatment of children and adolescents with increased body fat, based upon scientific evidence, supported by the medical literature, and derived from the clinical experiences of members of the Obesity Medicine Association.

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Process

The Pediatric Obesity Algorithm was derived from input by volunteer members of the Obesity Medicine Association consisting of:

- Academicians
- Clinicians
- Researchers

The Pediatric Obesity Algorithm did not receive industry funding, had no input from industry, and the authors received no payment for their contributions.

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Intent of Use

The Pediatric Obesity Algorithm is intended to be a “living document” updated as needed. It is intended to be used as an educational tool to assist in the translation of medical science and clinical experiences of the authors, and to assist clinicians in the improvement of care for their pediatric patients with obesity.

This algorithm is not intended to be interpreted as “rules” and/or directives regarding the medical care of an individual patient.

While the authors hope many clinicians will find this algorithm helpful, the final decision regarding the optimal care of the patient with overweight or obesity is dependent upon the individual clinical presentation and the judgment of the clinician who is tasked with directing a treatment plan that is in the best interest of the patient.

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Overall Management Goals

Pediatric patient with overweight or obesity

- Develop healthy habits and lifestyle patterns through adulthood
- Improve health and quality of life
- Improve body composition
- Prevent future adverse health consequences
- Improve body image and self esteem

Epigenetics

Obesity Begins before Conception

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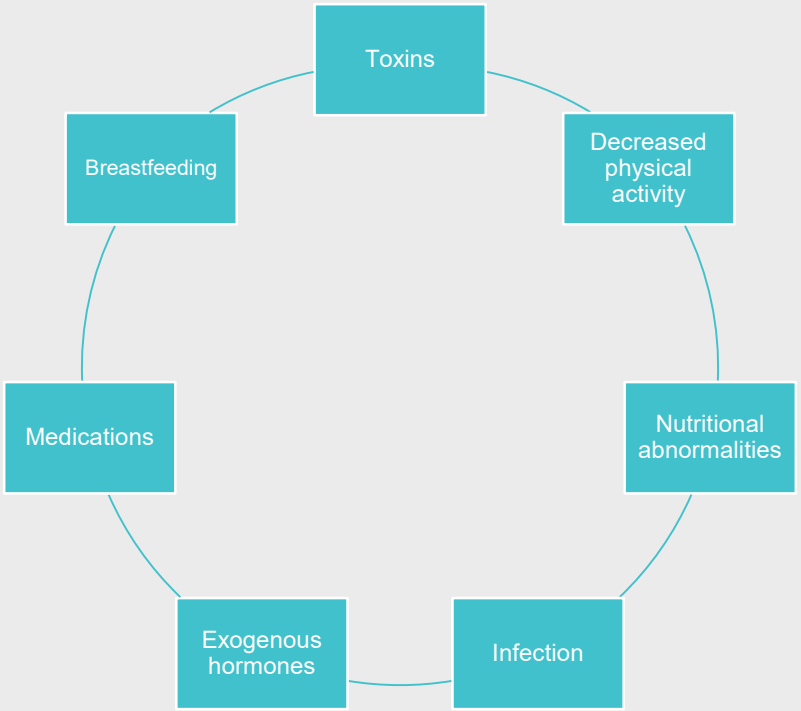
Epigenetics

Epigenetics: Any process that alters gene activity without changing the DNA sequence and leads to modifications that can be transmitted to offspring



 [1] [2] [63]

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Manifestations of Epigenetic Gene Dysregulation

Genomic/parental imprinting	▪ Either the mother or father inherited gene active, and the other silenced
Relaxation of imprinting	▪ A gene segment that should be non-expressed loses its imprint
Deletion of active chromosome	▪ If corresponding part of other homolog is inactive, neither chromosome is functional
Dosage compensation	▪ Ensure equal of X-linked gene products in males and females in species if the sexes differ in number of X chromosomes
Repetitive element repression or “Parent of Origin” effect	▪ Redundant genetic expression is avoided via DNA methylation and histone modification that deactivates one of the repetitive genes
Cell differentiation	▪ Early during the embryonic process the cell undergoes specification when it acquires specific characteristics but can still be influenced by environmental cues

 [1] [2]

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Common Manifestations of Epigenetics in Childhood Obesity

Small for Gestational Age Infants

- Tobacco abuse during pregnancy
  - Use of folic acid may attenuate the effect
- Insufficient gestational weight gain

Large for Gestational Age Infants

- Mothers with preconception BMIs $\geq$ 30 kg/m^2
- Mothers with excessive gestational weight gain
- Gestational diabetes mellitus

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Assessment

Weight Assessment in Children with Obesity

Weight Assessment by Age Group and Disease Severity

Weight Assessment for Children Ages 0-2 Years

BMI Percentile in Children Ages 2-20 Years

BMI for Children with Severe Obesity Ages 2-20 Years

Weight Assessment for Children Ages 0-2 Years

Measurement

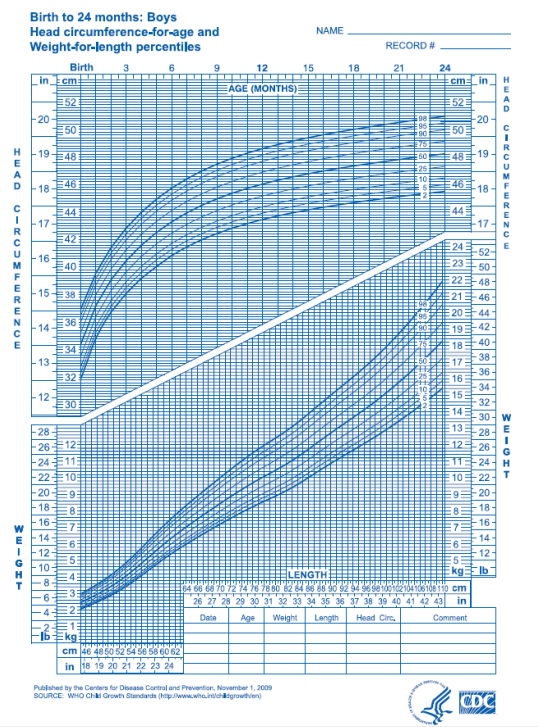
- BMI is not used until 2 years of age
- To assess weight status in an infant, use weight for length

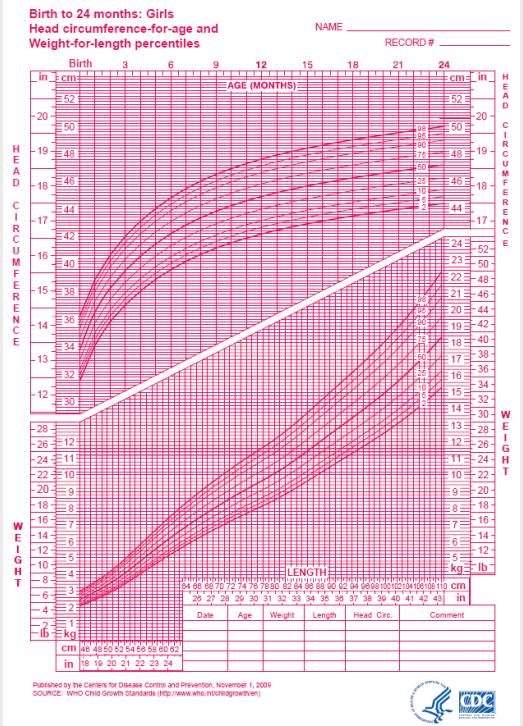
Tool

- Growth charts for infants are available through the CDC and the WHO
  - CDC is based on a cohort of mostly white American children, mostly non-breastfed
  - WHO is based on children from diverse racial and ethnic backgrounds, mostly breastfed

 [11] [12]

WHO Weight for Length Growth Charts





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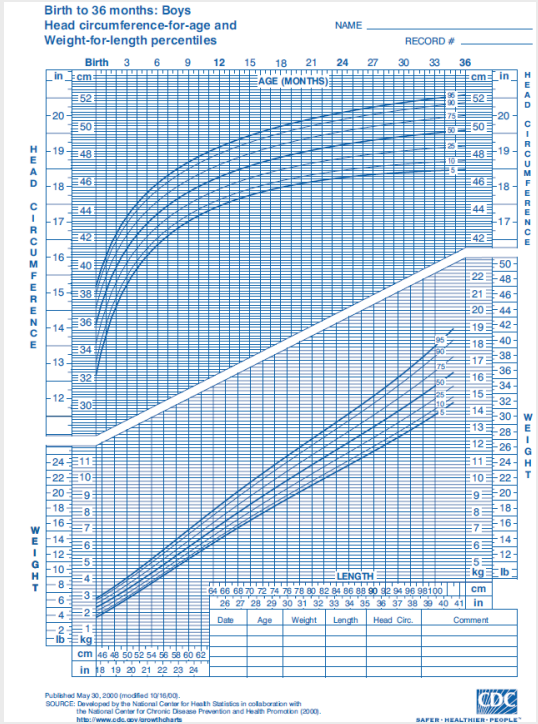
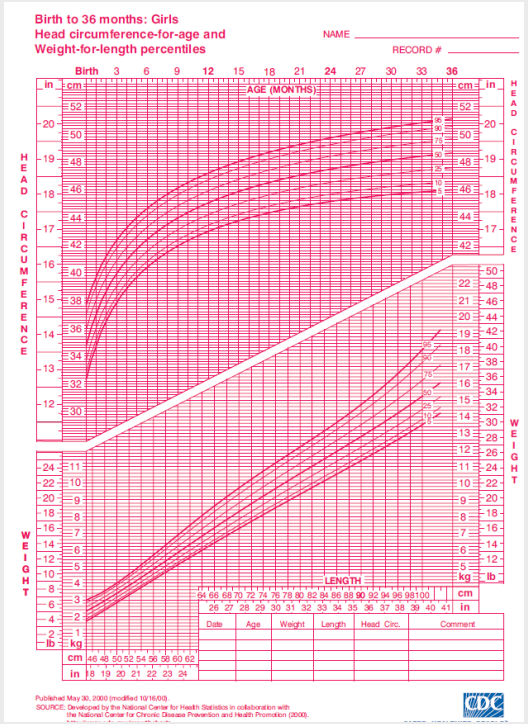
CDC Weight for Length Growth Charts





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Body Mass Index Categories in Children Ages 2-20 Years

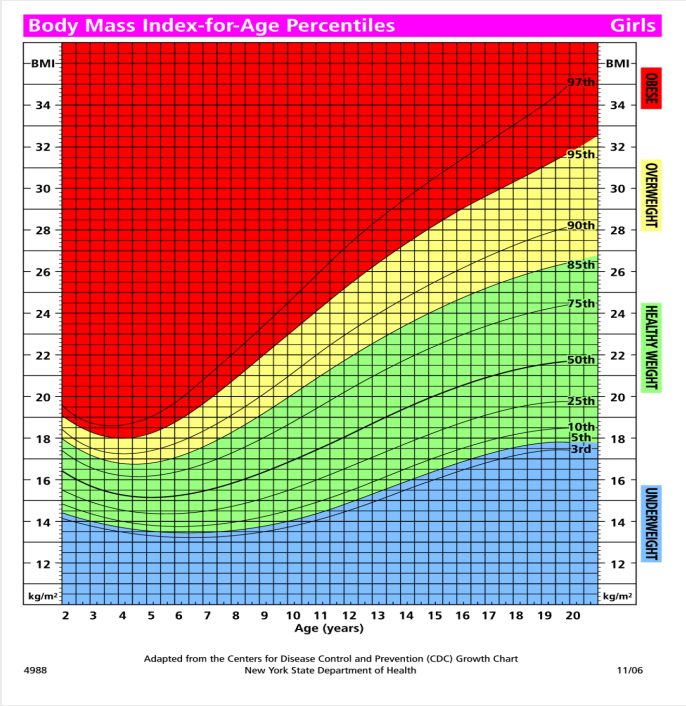
Body Mass Index Percentile
Ages 2-20 Years

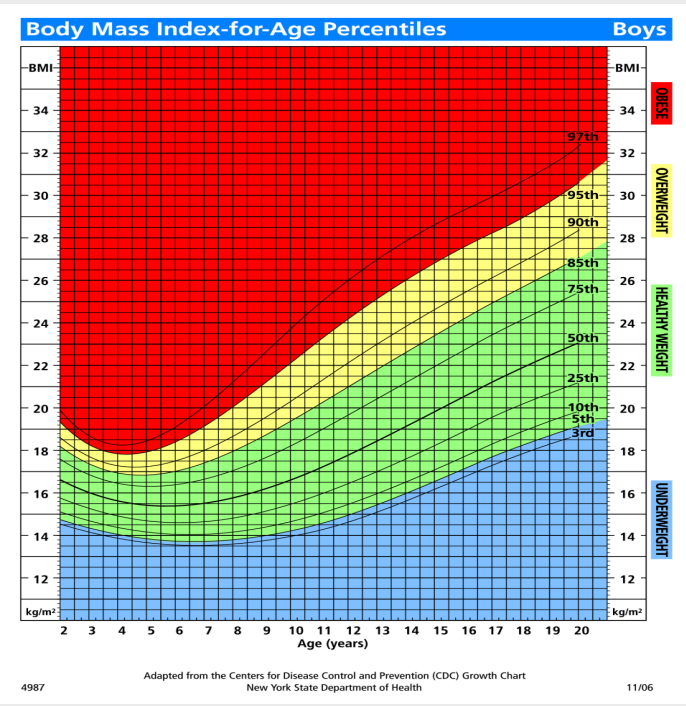
Underweight	Healthy Weight	Overweight	Obesity	Severe Obesity
< 5th percentile	5-84th percentile	85-94th percentile	95-99th percentile or BMI > 30	BMI ≥ 120% of the 95th percentile or BMI ≥ 35 kg/m^2

Caveat: Not all patients with BMI 85% or above have excess adiposity, and many children and adolescents with BMI < 5% are healthy and do not need treatment.

The CDC recommends using the WHO growth charts to monitor growth for infants and children ages 0-2 years in the U.S. and using the CDC growth charts for children 2 years and older.

Body Mass Index Charts for Children with Overweight and Obesity Ages 2-20 Years





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Assessment of BMI in Children with Severe Obesity Ages 2-20 Years

Definition	As Compared to Adult	Pediatric/Specific
BMI ≥ 120% of the 95th percentile (1.2 x 95th percentile) <u>or</u> An absolute BMI ≥ 35 kg/m^2, whichever is lower based on age and sex	The inclusion of an absolute BMI threshold (35 kg/m^2) aligns the pediatric definition with class II obesity in adults, a high-risk category of obesity associated with early mortality in adults	BMI 35 kg/m^2 is a higher threshold than BMI ≥ 120% of the 95th percentile among most children, but it is a somewhat lower threshold (and therefore expands the population that is categorized as having severe obesity) among boys ≈18 years and older and girls ≈16 years and older.

 [4] [5] [6] [7] [8] [9]

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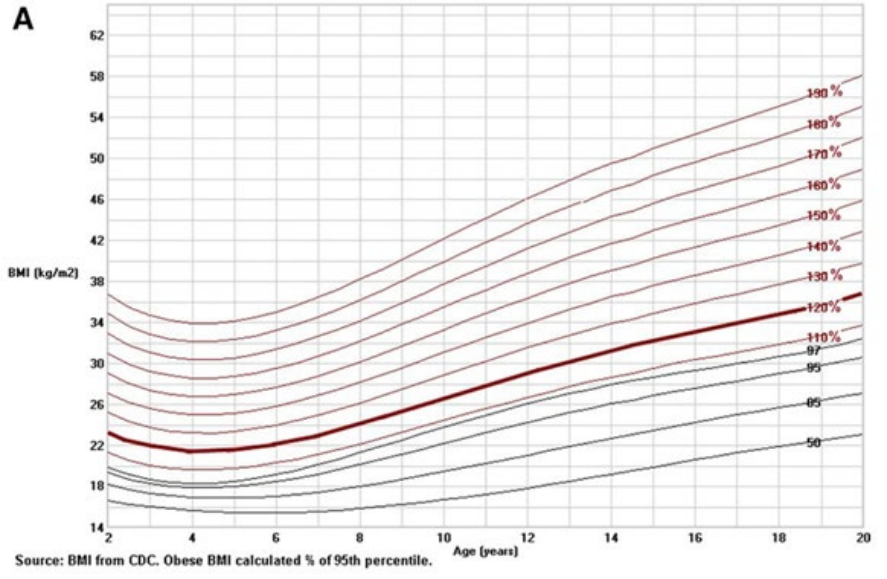
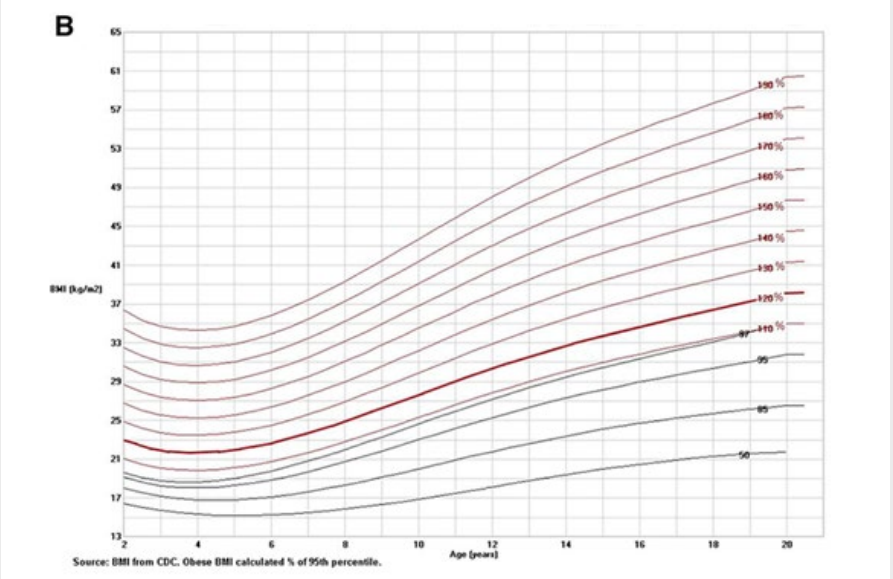
Body Mass Index Charts for Children with Severe Obesity Ages 2-20 Years





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Obesity as a Disease

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Obesity as a Disease

Endocrine/Immune Response

Adiposopathy

- Impaired fasting glucose
- Metabolic syndrome
- Hypertension
- Menstrual dysfunction (girls)
- Early puberty (girls)
- Delayed puberty (boys)
- NAFLD
- Dyslipidemia
- Insulin resistance
- Type 2 Diabetes Mellitus
- Increased uric acid, microalbuminuria
- Gynecomastia
- Cholecystitis

Physical Response

Fat Mass Disease

- Asthma
- Immobility
- Lipomastia
- Tissue compression (sleep apnea, GERD, HTN)
- Tissue friction (intertrigo)
- Stress on weight-bearing joints (slipped capital femoral epiphysis, Blount disease, scoliosis, osteoarthritis)

Psychological Response

Quality of Life

- Isolation from peers
- Decrease in ability to participate in normal childhood activities
- Subject to bullying
- Lack of social/age-appropriate relationships
- Anxiety/depression
- Binge-eating disorder
- Night-eating disorder
- Bulimia

 [13] [14] [15]

Differential Diagnosis

Childhood Obesity: Differential Diagnosis

Linear growth in pre-pubertal and pubertal children	
Consistent or accelerated linear growth	Decreased linear growth
▪ Consider exogenous obesity; nutritional origin ▪ Consider precocious puberty if secondary sexual development at < 8 yrs for girls (breast development) and < 9 yrs for boys (enlarged testicular size) ▪ Consider bone age	▪ Consider endocrinopathy ▪ Test for TSH, free T4, dexamethasone suppression, 24-hour urinary free cortisol if indicated

Developmental delay; suspect syndromal obesity
▪ Can be associated with decreased linear growth ▪ Evaluation dependent on presentation and family history ▪ Refer to genetics

 [16] [17] [18] [19]

Review of Systems

Focused Review of Systems

Symptoms	Related Co-morbidity
Nervousness, school avoidance, social inhibitions	Depression, anxiety, bullying
Fatigue, muscle aches	Vitamin D deficiency
Polyuria, polydipsia, fatigue, nocturia	Type 2 Diabetes (T2DM)
Headaches, facial numbness	Pseudotumor cerebri
Skin pigmenting, skin tags	Insulin resistance (IR)
Daytime somnolence, loud snoring, witnessed apnea	Obstructive sleep apnea (OSA)
Abdominal pain, indigestion	Gastroesophageal reflux disease (GERD), gall bladder disease, constipation
Hip or knee pain	Slipped capital femoral epiphysis (SCFE), early osteoarthritis
In-toeing, leg bowing, mild knee pain	Blount's disease
Hirsutism, acne, irregular menses	Polycystic Ovarian Syndrome (PCOS)

Diagnostic Work-up

Diagnostic Work-up: Taking the History in Infants Ages 0-12 Months

Family History/ Prenatal Factors

- Maternal/paternal obesity
- Gestational DM/ Weight gain
- Siblings with obesity
- Birth weight (small or large for gestational age)
- Family Hx of early CVD

Feeding

- Duration of exclusive breast feeding
- Timing of early introduction to complementary foods
- Early introduction of cereal (< 6 months of age)

Miscellaneous

- Amount of screen time
- Juice
- Sugar-sweetened beverages
- Sleep duration

 [16] [17] [18] [19]

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Diagnostic Work-up: Taking the History in Children with Obesity Ages 1-18 Years

	Toddler (Ages 1-4 years)	Early Childhood (Ages 5-9 years)	Puberty (Ages 10-14 years)	Adolescent (Ages 15-18 years)
Exercise	▪ Active play		▪ Vigorous exercise for 60 minutes or more every day	
Feeding	▪ Food as reward or punishment ▪ Diversity in diet	▪ Family meals ▪ Eating out ▪ Fast food/ Sugar-sweetened beverages	▪ Modified meals or pack lunch ▪ Continue to challenge vegetables and fruits	
Miscellaneous	▪ Screen time ▪ Parents as role models	▪ Bullying	▪ Sedentary time ▪ Sleep duration	▪ Snoring

 [16] [17] [18] [19]

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Diagnostic Work-up: Labs and Studies

Infancy (0-24 months)	Toddler (Ages 2-4 years)	Early Childhood (Ages 5-9 years)	Puberty (Ages 10-14 years)	Adolescent (Ages 15-18 years)
Weight > Length	BMI ≥ 95th percentile or ≥ 85th percentile with two or more risk factors (24-48 months)	BMI ≥ 95th percentile or ≥ 85th percentile with two or more risk factors	BMI ≥ 95th percentile or ≥ 85th percentile with two or more risk factors	BMI ≥ 95th percentile or ≥ 85th percentile with two or more risk factors
	▪ Fasting blood glucose and/or HgA1c ▪ Fasting lipid panel/Non-fasting if fasting not feasible ▪ ALT, AST, consider GGT ▪ Consider 25 OH Vitamin D			
		▪ Consider sleep study ▪ Consider liver ultrasound ▪ Consider uric acid ▪ Consider fasting serum insulin		
			▪ Consider urine microalbumin/creatinine ratio ▪ Consider C-peptide, hs-CRP	

 [20] [21]

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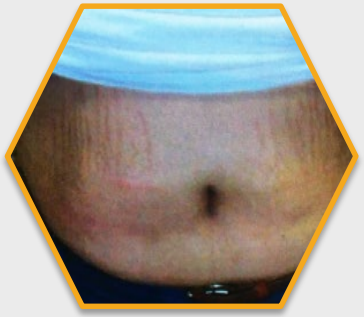
Physical Exam

Physical Exam: Common Clinical Findings

Acanthosis nigricans

Abdominal striae



Gynecomastia

Pictures taken with consent of patients

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Physical Exam: Common Clinical Findings

Hirsutism

 Pictures taken with consent of patients

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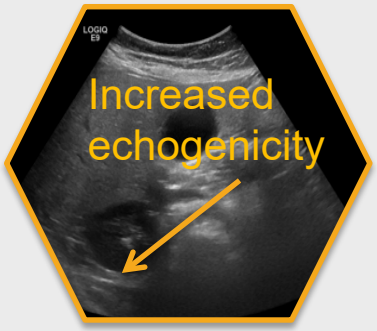
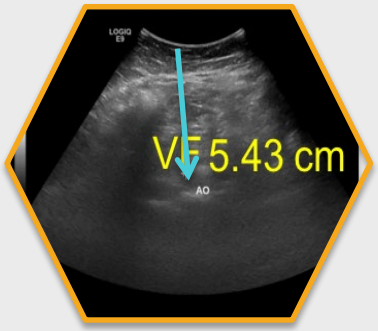
Common Physical and Radiologic Findings

Tonsillar Hypertrophy

Steatosis and Increased Abdominal Visceral Fat





Blount's Disease

 Pictures taken with consent of patients

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Nutritional Recommendations

Nutritional Therapy: Comparison of Common Recommendations

Portion Control or Balanced	CHO Restricted or Reduced	Low Glycemic Index	Low Fat	Elimination
▪ Tolerance is high ▪ Useful in toddlers and young children ▪ Small amount of weight loss	▪ Adherence to diet is approximately 50% ▪ Weight loss is moderate to good ▪ Lowers fasting insulin and triglyceride levels ▪ Amount of protein is not associated with effect on muscle sparing	▪ Tolerance is high ▪ Small amount of weight loss ▪ Favorable for high fasting insulin level	▪ Tolerance is high ▪ No weight loss or minimal ▪ Favorable for high LDL levels	▪ Easy to use in small children ▪ Weight loss is small to moderate ▪ Tolerance is high

[22] [23] [24] [25]

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General Intake Guidelines (Normal Weight): 0-12 Months

	Birth-4 months	4-6 months	6-8 months	8-10 months	10-12 months
Breast milk and/or fortified infant formula	8-12 feedings 2-6 oz per feeding (18-32 oz per day)	4-6 feedings 4-6 oz per feeding (27-45 oz per day)	3-5 feedings 6-8 oz per feeding (24-32 oz per day)	3-4 feedings 7-8 oz per feeding (24-32 oz per day)	3-4 feedings 24-32 oz per day
Cereal, breads, starches	None	None	2-3 servings of iron-fortified baby cereal (serving = 1-2 tbsp)	2-3 servings of iron-fortified baby cereal (serving = 1-2 tbsp)	4 servings of iron-fortified bread or other soft starches or baby cereal (serving = 1-2 tbsp)
Fruits and vegetables	None	None	Offer plain, cooked, mashed, or strained baby foods vegetables and fruits. Avoid combination foods. No juice.	2-3 servings (1-2 tbsp) of soft, cut-up, and mashed vegetables and fruits daily. No juice.	4 servings (2-3 tbsp) daily of fruits and vegetables. No juice.
Meats and other protein sources	None	None	Begin to offer plain-cooked meats. Avoid combination dinners.	Begin to offer well-cooked, soft, finely chopped meats.	1-2 oz daily of soft, finely cut or chopped meat, or other protein foods

While there is no comprehensive research indicating which complementary foods are best to introduce first, focus should be on foods that are higher in iron and zinc, such as pureed meats and fortified iron-rich foods.

 [26] [27]

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General Intake Guidelines (Normal Weight): 1-4 Years

	12-23 months	2-3 years	3-4 years
Milk and Milk Products	2 cups/day (whole milk or milk products)	2-2.5 cups/day	2.5-3 cups/day
	Serving: 1 cup of milk or cheese, 1.5 oz of natural cheese, 1/3 cup shredded cheese		
Meat and Other Protein Foods	1.5 oz/day	2 oz/day	2-3 oz/day
	Serving: (1 oz equivalent) = 1 oz beef, poultry, fish, ¼ cup cooked beans, 1 egg, 1 tbsp peanut butter*, ½ oz of nuts* *peanut butter and nuts may be a choking hazard under the age of three		
Breads, Cereal, and Starches	2 oz/day	2 oz/day	2-3 oz/day
	Serving: 1 oz = 1 slice whole grain bread, ½ cup cooked cereal, rice, pasta, or 1 cup dry cereal		
Fruits	1 cup/day	1 cup/day	1-1.5 cups/day
	Serving: 1 cup of fruit or ½ cup dried fruit; NO JUICE		
Vegetables (non-starchy vegetables to include sources of vitamin C and A)	3/4 cup/day	1 cup/day	1-1.5 cups/day
	Serving: (1 cup equivalent) = 1 cup of raw or cooked vegetables; 2 cups of raw leafy green greens		
Fats and Oil	Do not limit* *Low-fat products are not recommended under the age of 2	3 tsp	3-4 tsp/day
Miscellaneous (desserts, sweets, soft drinks, candy, jams, jelly)	None	None	None

 [26] [27]

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General Intake Guidelines (Normal Weight): 5-18 Years

	5-9 years	10-14 years	15-18 years
Milk and Milk Products	2.5-3 cup/day	3 cups/day	3 cups/day
Serving: 1 cup of milk or cheese, 1.5 oz of natural cheese, 1/3 cup shredded cheese; encourage low-fat dairy sources			
Meat and Other Protein Foods	4-5 oz/day	5 oz/day	5-6 oz/day
Serving: (1 oz equivalent) = 1 oz beef, poultry, fish, ¼ cup cooked beans, 1 egg, 1 tbsp peanut butter, ½ oz of nuts			
Breads, Cereal, and Starches	5-6 oz/day	5-6 oz/day	6-7 oz/day
Fruits	1.5 cups/day	1.5 cups/day	1.5-2 cups
Serving: 1 cup of fruit or ½ cup dried fruit			
Vegetables (non-starchy vegetables to include sources of vitamin C and A: broccoli, bell pepper, tomatoes, spinach, green beans, squash)	1.5-2 cups/day	2-3 cups/day	3+ cups/day
Serving: (1 cup equivalent) = 1 cup of raw or cooked vegetables; 2 cups of raw leafy green greens			
Fats and Oil	4-5 tsp/day	5 tsp/day	5-6 tsp//day
Miscellaneous (desserts, sweets, soft drinks, candy, jams, jelly)	None	None	None

 [26] [27]

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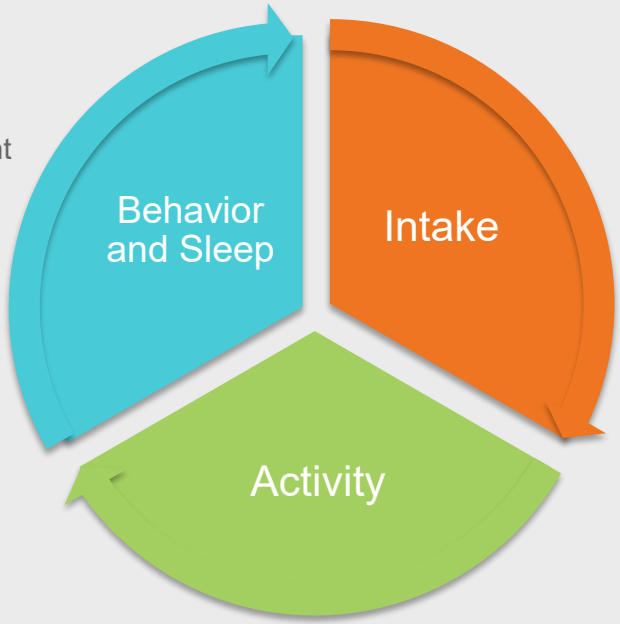
Management

Management of the Infant with Obesity: 0-24 Months

- NO screen time
- NO TV in bedroom
- Allow infant to feed themselves
- Do not force/finish foods when infant indicating refusal
- 12-18 hours of sleep



- Exclusive breastfeeding for 6-12 months
- Appropriate formula feeding ingestion for age
- Delay complementary foods until 6 months
- NO juice/sugar-sweetened beverages
- NO fast food
- NO desserts

- Keep active in playpen/floor
- Encourage direct interaction with parents as much as possible
- No media

 [16] [17] [18] [19]

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Management of the Infant with Obesity: 0-24 Months

Weight/length percentile appropriate	Weight/length percentile crossing lines	Weight/length percentile exceeding 85th for age	Weight/length percentile exceeding 95th for age
▪ Exclusive breast feeding for as long as possible, complementary foods at 6 months ▪ No media	• Exclusive breast feeding for as long as possible • If formula feeding, review dietary history; if no complementary foods, intake 27-47 oz/day; if complementary foods (after 6 months of age) intake 24-32 oz/day • No media	▪ Exclusive breast feeding for as long as possible ▪ If formula feeding, reduce intake to lower limits, 24 oz/day, feedings should be every 4-5 hours for < 6 months, 3 times per day for > 6 months. Review appropriate intake of complementary foods after 6 months of age, consider limiting cereal ▪ No media	▪ Exclusive breast feeding for as long as possible ▪ If formula feeding, reduce intake to lower limits, 24 oz/day, 3 times per day, minimal intake of complementary food after 6 months of age, consider excluding cereal ▪ No media

 [16] [17] [18] [19]

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Management of the Toddler with Obesity: 2-4 Years

- Routine sleep pattern
- No TV in bedroom
- 11-14 hours of sleep
- All meals at the table/highchair
- Parents as role models
- Food not used as reward
- Parents should not be over-controlling
- Family-based therapy

- Three meals plus snack(s)
- 3 servings of protein (1-3 oz)/day
- 2-2.5 cups dairy/day
- 3 servings non-starchy vegetables (3/4 cup to 1.5 cups)/day
- 1 cup/day of fruit
- Dessert only on special occasion
- NO sugar-sweetened beverages
- NO fast food
- Age-appropriate portion sizes
- Praise for trying new foods

- Active play almost constantly
- Minimal sedentary time
- No screen time < 2 years, < 1 hour/day for 2-4 years

 [16] [17] [18] [19]

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Management of the Toddler with Obesity: 2-4 Years

BMI < 85th percentile	BMI 85th-95th percentile	BMI 95th-120th percentile	BMI > 120th percentile
▪ 1-1.5 cups each of fruits and vegetables/day ▪ < 2 hours screen time/day if 2-4 years ▪ Free play for as many hours as possible/day ▪ No sugar-sweetened beverages	▪ 1-1.5 cups each of fruits and vegetables/day ▪ 1-2 hours of screen time/day if 2-4 years ▪ Free play for as many hours as possible/day ▪ No sugar-sweetened beverages	▪ Restricted carbohydrate (CHO)/low glycemic index (LGI) /elimination diet ▪ < 1 hour of screen time/day ▪ Reduce sedentary activity ▪ Free play for as many hours as possible/day ▪ No sugar-sweetened beverages	▪ Restricted CHO/LGI /elimination diet ▪ Screen time 50% of active time up to 1 hour/day ▪ Reduce sedentary activity ▪ Free play for as many hours as possible/day ▪ No sugar-sweetened beverages

 [16] [17] [18] [19]

Management of the Young Child with Obesity: 5-9 Years

- Minimize obesogenic medications especially second-generation antipsychotics (SGAPs)
- Treat asthma with controller meds to minimize systemic steroid use
- Consider ACE inhibitor for persistent hypertension

- Three meals; 1-2 snacks
- 3 servings of protein/day
- 2-3 servings of dairy/day
- 1.5-2 servings of fruit/day
- 4-5 servings non-starchy vegetables
- Dessert only on special occasion
- NO sugar-sweetened beverages
- NO fast food
- Age-appropriate portion sizes
- Praise for trying new foods
- Consider LGI/reduced-CHO diet

- Screen time < 1-2 hours
- Routine sleep pattern
- No TV in bedroom
- 11-14 hours of sleep
- All meals at the table
- Parents as role models
- Parents should not be over-controlling
- Sleep study if severe obesity and/or symptoms
- Tonsillectomy and adenoidectomy if indicated

Moderate to vigorous activity for 60 minutes or greater each day; can be organized or not

 [16] [17] [18] [19]

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Management of the Young Child through Adolescence

BMI < 85th percentile	BMI 85th-95th percentile	BMI 95-120th percentile	BMI > 120th percentile
▪ 1.5-2 cups of fruits and 3+ cups vegetables/day ▪ < 2 hours screen time/day ▪ At least 60 minutes of age-appropriate activity/day ▪ No sugar-sweetened beverages	▪ 1.5-2 cups of fruits and 3+ cups vegetables/day ▪ < 1-2 hours of screen time/day ▪ At least 60 minutes of age-appropriate activity/day ▪ No sugar-sweetened beverages	▪ Restricted CHO/LGI/elimination diet ▪ < 1 hour of screen time/day ▪ Reduce sedentary activity ▪ At least 60 minutes of age-appropriate activity/day ▪ No sugar-sweetened beverages	▪ Restricted CHO/LGI/elimination diet ▪ Screen time 50% of active time up to 1 hour/day ▪ Reduce sedentary activity ▪ At least 60 minutes of age-appropriate activity /day ▪ No sugar-sweetened beverages

 [16] [17] [18] [19]

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Management of the Pubertal Child with Obesity: 10-14 Years

- Orlistat (Xenical) FDA-approved for ≥ age 12
- Minimize obesogenic medications, especially SGAPs
- Treat asthma with controller meds to minimize systemic steroid use
- Consider ACE inhibitor for persistent hypertension
- Metformin FDA-approved for T2DM ≥ age 10 and PCOS

- Screen time less than 1-2 hours/day
- 10-12 hours of sleep
- Routine sleep pattern
- No TV in bedroom
- Parents should not be over-controlling
- Peer groups become increasingly important
- All meals at the table with family and encourage socialization
- Recommend meal and exercise tracking

- 3 meals; 1-2 nutritious snacks
- 3 servings of protein/day
- 3 servings of dairy/day
- 1.5-2 servings of fruit/day
- 4-5 servings of non-starchy vegetables
- Dessert only on special occasion
- No sugar-sweetened beverages
- No fast food
- Age-appropriate portion sizes
- Allow child to leave food on plate

- Vigorous activity for 60 minutes or more daily; can be organized or not
- Monitor for changes in decreased activity level
- Decrease non-academic sedentary time as much as possible

[16] [17] [18] [19]

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Management of the Adolescent with Obesity: 15-18 Years

- Orlistat (Xenical) ≥ age 12, Phentermine approved for ≥ age 16
- Minimize obesogenic medications especially SGAPs
- Treat asthma with controller meds to minimize systemic steroid use
- Consider ACE inhibitor for persistent hypertension
- Metformin FDA-approved for T2DM ≥ age 10 and PCOS

- Screen time less than 1 hour/day
- 10-12 hours of sleep
- Routine sleep pattern
- No TV in bedroom
- Parents should not be over-controlling
- Friends and relationships are important
- Recommend meal and exercise tracking or monitoring

- 3 meals; nutritious snacks
- 3 servings of protein/day
- 3 servings of dairy/day
- 1.5-2 servings of fruit/day
- 4-5 servings of non-starchy vegetables
- Dessert only on special occasion
- No sugar-sweetened beverages
- No fast food
- Age-appropriate portion sizes
- Allow adolescent to leave food on plate

- Vigorous activity for 60-90 minutes or more daily
- Planned intervention with structured physical activity
- Decrease non-academic sedentary time as much as possible

[16] [17] [18] [19]

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Activity Recommendations

Activity Recommendations (Normal Weight): 0-12 Months

- Infants should interact with caregivers in daily physical activities that are dedicated to exploring movement and the environment.
- Caregivers should place infants in settings that encourage and stimulate movement experiences and active play for short periods of time several times a day.
- Infants' physical activity should promote skill development in movement.
- Infants should be placed in an environment that meets or exceeds recommended safety standards for performing large-muscle activities.
- Those in charge of infants' well-being are responsible for understanding the importance of physical activity and should promote movement skills by providing opportunities for structured and unstructured physical activity.

 [28] [29]

Activity Recommendations (Normal Weight): 12-36 Months

- Toddlers should engage in a total of at least 30 minutes of structured physical activity each day.
- Toddlers should engage in at least 60 minutes (and up to several hours) per day of unstructured physical activity and should not be sedentary for more than 60 minutes at a time, except when sleeping.
- Toddlers should be given ample opportunities to develop movement skills that will serve as the building blocks for future motor skillfulness and physical activity.
- Toddlers should have access to indoor and outdoor areas that meet or exceed recommended safety standards for performing large-muscle activities.
- Those in charge of toddlers' well-being are responsible for understanding the importance of physical activity and promoting movement skills by providing opportunities for structured and unstructured physical activity and movement experiences.

Active Play

- Walking in the neighborhood
- Unorganized free play outdoors
- Walking through a park or zoo

 [28] [29]

Activity Recommendations (Normal Weight): 3-5 Years

- Preschoolers should accumulate at least 60 minutes of structured physical activity each day.
- Preschoolers should engage in at least 60 minutes (and up to several hours) of unstructured physical activity each day, and should not be sedentary for more than 60 minutes at a time, except when sleeping.
- Preschoolers should be encouraged to develop competence in fundamental motor skills that will serve as the building blocks for future motor skillfulness and physical activity.
- Preschoolers should have access to indoor and outdoor areas that meet or exceed recommended safety standards for performing large-muscle activities.
- Caregivers and parents in charge of preschoolers' health and well-being are responsible for understanding the importance of physical activity and for promoting movement skills by providing opportunities for structured and unstructured physical activity.

Active Play

- Throwing/catching
- Running
- Swimming
- Tumbling
- Walking

 [28] [29]

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Activity Recommendations (Normal Weight): 5-12 Years

- Children should accumulate at least 60 minutes (and up to several hours) of age-appropriate physical activity on all or most days of the week. This daily accumulation should include moderate and vigorous physical activity with the majority of the time being spent in activity that is intermittent in nature.
- Children should participate in several bouts of physical activity lasting 15 minutes or more each day.
- Children should participate in a variety of age-appropriate physical activities designed to achieve optimal health, wellness, fitness, and performance benefits.
- Extended periods (periods of two hours or more) of inactivity are discouraged for children, especially during the daytime hours.

Aerobic/ endurance	Bone-building	Muscle strengthening	Active play	
Running Jumping	Hopping Jumping Running	Push-ups Tree climbing Sit-ups	Competitive sports: Soccer Baseball	Free Play: Walking Dancing Jump roping

 [28] [29]

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Activity Recommendations for Various Ages (Normal Weight)

	9-13 Years	14-18 Years
Aerobic/Endurance	Running Dancing Swimming Bicycle riding	Running Bicycle riding Soccer Swimming
Bone-Building	Basketball Tennis Running	Running Jumping
Muscle Strengthening	Push-ups Use of resistance bands	Use of free-weights of 15-20 pounds with high repetitions
Active Play	Football Basketball Ice hockey Volleyball Tennis Track and Field Running Swimming Dancing	Yoga Dancing Running Walking Cycling Household chores Competitive or noncompetitive sports

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Co-morbidities

Hypertension

Diagnosis	Evaluation	Treatment
▪ Three separate measurements at least one week apart, BP > 95th percentile but < 99th percentile + 5 mm Hg, or BP > 99th percentile + 5 mm Hg ▪ Normative data is available for systolic and diastolic blood pressure based on age, sex, and height (See selection of data on slide 59)	▪ Look for end organ damage ▪ Consider renal doppler/US ▪ Consider ECHO ▪ Serum uric acid ▪ Proteinuria ▪ BUN/Cr	▪ Weight loss: Diet and lifestyle interventions before medication ▪ Low Na (< 1500 mg/day) or DASH diet ▪ Follow clinically if BP > 90th percentile but < 95th percentile ▪ Consider treatment if BP > 95th percentile x 3 separate measurements ▪ The primary treatment is weight loss

 [30] [31] [32] [33]

Systolic BP (mm Hg), by Height Percentile

		Systolic BP (mm Hg), by Height Percentile from Standard Growth Curves						
Age	BP Percentile	5%	10%	25%	50%	75%	90%	95%
1	90th	94	95	97	98	100	102	102
	95th	98	99	101	102	104	106	106
2	90th	98	99	100	102	104	105	106
	95th	101	102	104	106	108	109	110
3	90th	100	101	103	105	107	108	109
	95th	104	105	107	109	111	112	113
4	90th	102	103	105	107	109	110	111
	95th	106	107	109	111	113	114	115
5	90th	104	105	106	108	110	112	112
	95th	108	109	110	112	114	115	116
6	90th	105	106	108	110	111	113	114
	95th	109	110	112	114	115	117	117

Sleep Apnea

Diagnosis	Evaluation	Treatment
▪ History of snoring or disrupted sleeping ▪ Daytime sleepiness ▪ Hyperactivity ▪ Depression ▪ Audible pauses in breathing ▪ New onset nocturnal enuresis ▪ Irritability, learning difficulties	▪ Sleep study ▪ Evaluation by ENT for obstruction ▪ Titration of O2 saturation ▪ Consider EKG ▪ Consider ECHO	▪ Weight loss ▪ Routine sleep pattern ▪ No TV in bedroom ▪ Use of CPAP if indicated ▪ Tonsillectomy and adenoidectomy (T&A) if indicated ▪ Repeat sleep study after T&A

Guidelines for Sleep Duration

	National Sleep Foundation (hours)	National Institutes of Health (hours)	Mayo Clinic (hours)	Not Recommended (hours)*
Newborn	14-17	16-18	9-10 with 3+ hours of naps	< 11 or > 19
Infants	12-15			< 10 or > 18
Toddler	11-14		9-10 with 2-3 hours of naps	< 9 or > 16
Preschool	10-13	11-12		< 8 or > 14
School-Aged	9-11	10	9-11	< 7 or > 12
Teenager	8-10	9-10		< 7 or > 11
Young Adult	7-9			< 6 or > 11
Adult	7-9	7-8	7-8	< 6 or > 10

*Guidelines from the National Sleep Foundation

Prediabetes

Diagnosis	Evaluation	Treatment	Clinical Findings
▪ HbA1c ≥ 5.7% but < 6.5% x 2 measurements ▪ FBG ≥ 100 mg/dl but < 126 mg/dl on repeat measurements (Impaired fasting glucose) ▪ 2 hour oral glucose tolerance test (OGTT) for blood glucose ≥ 140 mg/dl but < 200 mg/dl (Impaired glucose tolerance)	▪ Fasting blood glucose ▪ Consider fasting insulin, may be falsely low if disease is severe or mildly elevated during pubertal growth spurt ▪ 2 hour OGTT	▪ Weight loss: Aggressive diet and lifestyle intervention ▪ Restricted-carbohydrate diet ▪ Consider Metformin for HbA1c ≥ 5.8% when compliant with diet	▪ Acanthosis nigricans, hyperpigmentation in axillae, umbilicus, groin, popliteal fossae ▪ Skin tags

 [37] [104]

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Dyslipidemia

Diagnosis	Evaluation	Treatment	Pharmacology
▪ Although any dyslipidemia can co-exist with obesity, obesity is directly associated with: TG > 100 mg/dl if < 10 yrs, > 130 mg/dl if > 10 yrs, or HDL < 50 mg/dl if female and < 40 mg/dl if male ▪ If pattern of dyslipidemia is different than high TG/low HDL, pursue work-up and treatment per NHLBI guidelines and consider referral to a lipidologist	▪ Fasting lipid profile every 3-6 months if abnormal ▪ May monitor with non-fasting lipid profile if more feasible ▪ Family history of premature cardiovascular disease (may help differentiate dyslipidemia of obesity from heterozygous familial hypercholesterolemia) ▪ Consider genetic testing for persistent elevations of LDL > 190 mg/dl, TG > 500 mg/dl	▪ Weight loss: Aggressive diet and lifestyle intervention ▪ Restricted CHO/LGI/elimination diet ▪ Decreased saturated fat diet for LDL > 130 mg/dl ▪ HDL may increase with exercise, especially vigorous exercise	▪ The dyslipidemia of obesity is not usually treated with medication but the following applies to other dyslipidemias which may co-exist with the dyslipidemia of obesity ▪ Statin for FC or LDL > 190 mg/dl and failure to respond to weight loss/phytosterols/ increased fiber ▪ Phytosterols 2 grams per day to achieve an LDL < 130 mg/dl ▪ Increased fiber to 12 grams per day to achieve an LDL < 130 mg/dl ▪ Omega-3 to 1-4 grams per day to achieve TG < 100 mg/dl

 [38] [39]

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PCOS/Menstrual Irregularity

Diagnosis (Menstrual Irregularity)	Diagnosis (PCOS)	Evaluation	Treatment
▪ Excessive weight gain can be associated with menstrual irregularity ▪ Irregular menses: Less than 21 days or > 45 day interval, treat for > 3 month intervals or less than 9 cycles in 12 months at gynecological age > 18 months and HCG negative	▪ Oligomenorrhea/amenorrhea and clinical or biological hyperandrogenism with frequent presence of: obesity, glucose intolerance, dyslipidemia, and OSA ▪ PCOS can present in lean adolescents and those with obesity ▪ Not every adolescent with obesity and menstrual irregularity has PCOS ▪ Hirsute (may or may not be clinically evident)	▪ Provera challenge if oligomenorrhea ▪ Prolactin, Estradiol, consider LH/FSH ▪ T4/TSH ▪ Free testosterone, total testosterone, sex hormone-binding globulin ▪ 17 OH progesterone ▪ Consider pelvic US ▪ Consider 2 hour OGTT	▪ Symptomatic and individualized ▪ Oral contraceptive pills (OCPs) is first line treatment for most, progestin monotherapy is an alternative if OCPs are contraindicated ▪ Lifestyle modification and dietary control ▪ Consider Metformin: most effective in combination with weight loss ▪ Metformin clearly indicated for abnormal glucose tolerance

Orthopedic Conditions

	Diagnosis	Evaluation	Treatment
Blount's Disease	▪ Early walking (before the age of 12 months) in a child with severe obesity ▪ Dome-shaped metaphysis, open growth plate, and disruption of the continuity between the lateral borders of the epiphysis and metaphysis, with inferomedial translation of the proximal tibial epiphysis	▪ AP and lateral views of the tibia	▪ Surgical correction
Slipped Capital Femoral Epiphysis	▪ Hip pain or limp ▪ M:F = 1.5:1 ▪ Age of onset in males = 12.7-13.5 years ▪ Age of onset in females = 11.2-12 years	▪ AP and lateral views of the hips ▪ Ultrasound ▪ Degree of severity depends on avascular necrosis and/or instability	▪ Surgical emergency ▪ In situ pinning ▪ Intertrochanteric osteotomy
Scoliosis	▪ Physical findings may be obscured by obesity ▪ Increased curve magnitude at presentation	▪ Shoulder height asymmetry or use of a scoliometer in addition to the traditional Adam Forward Bend Test	▪ Determine whether curve is great enough to require surgery (> 45 degrees)

 [41] [42] [43] [44]

Miscellaneous Topics Associated with Children with Obesity

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Miscellaneous Topics Associated with Children with Obesity

- Genetic Syndromes
- Vitamin D Deficiency
- Bariatric Surgery

Genetic Syndromes Associated with Childhood Obesity*

Prader Willi Syndrome	▪ Hypotonia at birth, difficult feeding followed hyperphagia, hypogonadism, MR, deletion of q11-13 region.
Bardet-Biedl Syndrome	▪ Retinitis pigmentosa, polydactyly, MR, hypogonadism, renal abnormalities.
Fragile X Syndrome	▪ Macro-orchidism, MR, prominent jaw, large ears.
Albrights Hereditary Osteodystrophy	▪ Short stature, skeletal defects, resistance to several hormones.
Alstrom Syndrome	▪ Photophobia, nystagmus, deafness, blindness, diabetes.
Congenital Leptin Deficiency	▪ Hypogonadism, intense hyperphagia, absence of growth spurt, T-immune dysfunction, frequent infections.
POMC Deficiency	▪ Hyperphagia and early-onset obesity; adrenal crisis due to ACTH deficiency, hypopigmentation.
MC4R Deficiency	▪ Increased linear growth and final height, severe hyperinsulinemia.
Cohen Syndrome	▪ Chromosome 8q22 mutation. Obesity (central only-thin arms and legs), MR, head/face defects (small jaw, shortened area between the nose and upper lip, high raised palate). Some children have seizures and deafness.

 [45][46] [*This list is not comprehensive.]

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Prader-Willi Syndrome

Presentation

- Small and unusually floppy at birth
- Almond-shaped eyes, thin upper lips, thin faces
- Low muscle mass, small hands and feet
- Delayed motor development
- Intellectual and speech delay

Behaviors

- Voracious and insatiable appetite, which often leads to obesity, usually starts around 2 years
- Severe behavioral problems

Complications

- Scoliosis
- Sleep apnea
- Osteoporosis
- Infertility due to lack of development of secondary sexual characteristics

Prader-Willi Syndrome

Diagnosis

- Paternal chromosome 15q partial deletion or unexpression

Special Characteristics

- Hypotonia, poor suck, characteristic facial features
- Bitemporal narrowing of the head, almond-shaped eyes, elongated face, and thin upper lip
- May have relatively normal weight until 2-5 years of age, then have rapid weight gain
- Prader-Willi patients can be ketotic at levels of carbohydrate intake that are higher than normally expected
- Hunger control is a major issue for parents

Treatment

- Calorie control and behavioral management
- Growth hormone therapy and replacement of sex hormones at puberty

Additional Genetic Disorders Causing Obesity

Bardet-Biedl Syndrome

- Ciliopathic genetic disorder
- Obesity, visual problems including loss of vision, polydactyly, hypogonadism, and often mental retardation and kidney failure

Cohen Syndrome

- Chromosome 8q22 mutation
- Obesity (central only, thin arms and legs), MR, head/face defects (small jaw, shortened area between the nose and upper lip, high raised palate)
- Some children have seizures and deafness

Alstrom Syndrome

- Very rare ALMS 1 mutation
- Childhood obesity, blindness and hearing loss
- Can have endocrine issues, such as type 2 diabetes, high insulin, and high triglycerides

POMC Deficiency

- Hyperphagia and early-onset obesity; adrenal crisis due to ACTH deficiency, hypopigmentation

Additional Genetic Disorders Causing Obesity

Fragile X Syndrome

- Macro-orchidism
- Mental retardation
- Prominent jaw
- Large ears

Albright's Hereditary Osteodystrophy

- Short stature
- Skeletal defects
- Resistance to several hormones

Congenital Leptin Deficiency

- Hypogonadism
- Intense hyperphagia,
- Absence of growth spurt
- T-immune dysfunction
- Frequent infections

MC4R Deficiency

- Hyperphagia and early-onset obesity
- Adrenal crisis due to ACTH deficiency
- Hypopigmentation

Vitamin D Deficiency

Significance

- Fat soluble vitamin essential for skeletal health in growing children
- Important role for bone health through the absorption of calcium from small intestine
  - Available in diet and through synthesis from sunlight

Diagnosis

- Deficiency defined by Institute of Medicine and Endocrine Society clinical practice guidelines as serum 25-hydroxyvitamin D [25(OH)D] < 20 ng/mL

Treatment

Children aged 1–18 years:

1. 2000 IU/d of vitamin D2 or vitamin D3 for at least 6 weeks or
2. 50,000 IU of vitamin D2 or D3 once a week for at least 6 weeks to achieve a blood level of 25(OH)D above 30 ng/ml, followed by maintenance therapy of 600-1000 IU/d

Special Considerations

- Children who have obesity have malabsorptive syndromes, or are on medications affecting vitamin D metabolism (anticonvulsants, glucocorticoids, antifungals, and antiretrovirals may require 2 to 3 times the dose of vitamin D to achieve the same serum 25(OH)D levels as children without these conditions)

[48] [49] [50] [51] [51] [52] [53] [55] [56]

Bariatric Surgery in Adolescents (U.S. Data)

Pediatric Specific

- Increasing each year
- Gastric sleeve is the procedure of choice
- Surgical complications are the same or less than adult
- Recommended participation in a weight-loss program but demonstrated weight loss controversial
- Females counseled on increased fertility
- All adolescents give informed consent

Recommendations

- No universally recognized recommendations
- Skeletal and sexual maturity (generally age 14 for girls and 15 for boys)
- BMI > 35 kg/m^2 with moderate to severe co-morbidities or BMI > 40 kg/m^2

Exclusions

- Significant psychiatric disease and possibly long distance from a surgical center

Limited Outcomes (3 Years)

- Mean percent weight loss = 27%
- Normalized blood pressure in 74%
- Normalized lipid levels in 66%
- Over 50% with T2DM in remission
- 57% low ferritin levels
- 8% vitamin B12 deficiency
- 16% vitamin A deficiency
- No change in vitamin D deficiency (37% before and after surgery)

[57] [58] [59] [60] [61] [62]

Pharmacology

Pharmacology

Orlistat (Xenical)

- FDA-approved for children ≥ 12 years
- Weight loss is small
- Side effects preclude usage in most patients
- May cause oily stools

Metformin

- FDA-approved for children with T2DM ≥ 10 years
- Weight loss is small
- Useful for elevated serum insulin levels
- May prolong duration of time before onset of T2DM
- May cause gastrointestinal upset, especially in first few weeks

Topiramate

- Not FDA-approved for weight loss in children
- Has been used for seizure control in children for years
- May control cravings
- Can cause cleft palate in fetus
- May cause paresthesias of extremities, cognitive disruption (confusion, difficulty concentrating)

Phentermine

- FDA-approved for weigh loss in children ≥ 16 years
- Has been used in adolescents
- Weight loss is small to moderate
- May cause anxiety, tremors, slightly increased blood pressure

 [33] [64] [65] [66]

Medication-related Weight Gain

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Review of Medications: ADHD, Anti-seizure, Migraine, Diabetes and Other Medications

	Significant Weight Gain		Small to Neutral Weight Gain		Weight Loss (neutral to mild)
ADHD			Guanfacine		Atomoxetine Lisdexamfetamine Amphetamine Methylphenidate
Anti-Seizure	Valproate Vigabatrin	Pregabalin Gabapentin	Carbamazepine Oxocarbazepine	Lamotrigine Levetoracetam Phenytoin	Topiramate Zonisamide Felbamate
Migraine	Amitriptyline Divalproex Flunarizine	Gabapentin Metoprolol Propranolol	Timolol Levetiracetam		Zonisamide Topiramate
Diabetic Medications	Insulin and analogs				GLP-1 Receptor Agonists Metformin
Other Medications	Glucocorticoids Gleevac Depo Provera		Benzodiazepines Statins Antihistamines (Cyproheptadine) Carvedilol Oral Contraceptive Pills		

[65] [67] [68] [69] [70] [71] [72] [73] [74] [75] [76] [77] [78] [79] [80] [81] [82] [83] [84] [85] [86] [87]

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Review of Medications: Psychiatric Medications

	Significant Weight Gain	Small to Neutral Weight Gain	Weight Loss
Antipsychotics	Clozapine Olanzapine Chlorpromazine Quetiapine Risperidone	Aripiprazole Haloperidol Ziprasidone	
Special considerations: "Youth may be particularly sensitive to weight gain, especially with olanzapine, as well as extrapyramidal side effects and metabolic changes." Many of the medications listed here have only been well-studied in adults.			
Antidepressants	Paroxetine* Amitriptyline Olanzapine Citalopram Nortriptyline Doxepin Lithium Desipramine Imipramine Duloxetine Escitalopram	Venlafaxine Fluvoxamine Sertraline Trazodone Fluoxetine	Bupropion*
Mood Stabilizers	Valproate Lithium Gabapentin		Topiramate
Anxiolytics		Lorazepam Diazepam Oxazepam	

[65] [88] [89] [90] [91] [92] [93] [94] [95] [96] [97] [98] [99] [100] [101] [102] [*Black box warning]

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Appendix:
Staged Treatment Approach

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Identification and Management

First Steps

- Initial identification of children with overweight or obesity done in primary care office
- First approach is counseling on consuming 5 or more fruits and vegetables/day, < 2 hours screen time, 1 hour of play or exercise, and no sugar-sweetened beverages
- Family-based counseling
- Motivational interviewing

Second Steps

- If child not losing weight, child is usually referred to weight-management clinic or, if no clinic is available, to see a dietitian

Staged Treatment

- Recommendations for staged management were first published in 2007 in Pediatrics: AAP Expert Committee Recommendations

Staged Treatment Approach

Prevention Plus

- BMI < 85th percentile or < 95th percentile with no health risk factors
- Basic Healthy Behaviors

Structured Weight Management

- BMI ≥ 95th percentile or ≥ 85th percentile with health risk factors
- Monthly visits working on behavior change and motivational interviewing
- Dietitian evaluation

Comprehensive Multidisciplinary Intervention

- Structured intervention at more frequent intervals (weekly for 8-12 weeks) by team experienced with care of children with obesity
- Family involvement, supervised activity
- Negative energy balance through diet and exercise
- May include medication management, meal replacements

Tertiary Care Intervention

- Tertiary care center with designed protocol
- May include meal replacements, weight-loss medications
- May include weight-loss surgery

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