

**Pediatric Obesity—Assessment,
Treatment, and Prevention:
An Endocrine Society Clinical Practice
Guideline**

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I. Overview of *Pediatric Obesity*

The Problem With Obesity

- ▶ The Brookings Institution predicts that if all 12.7 million U.S. youths with obesity became obese adults, the individual average cost would be greater than \$92,000, and the societal costs over their lifetimes might exceed \$1.1 trillion

An In-Depth Look at the Lifetime Economic Cost of Obesity. Brookings. May 12, 2015.

GRADE Classification of Guideline Recommendations

QUALITY OF EVIDENCE		High Quality	Moderate Quality	Low Quality	Very Low Quality
<i>Description of Evidence</i>		<ul style="list-style-type: none"> Well-performed RCTs Very strong evidence from unbiased observational studies 	<ul style="list-style-type: none"> RCTs with some limitations Strong evidence from unbiased observational studies 	<ul style="list-style-type: none"> RCTs with serious flaws Some evidence from observational studies 	<ul style="list-style-type: none"> Unsystematic clinical observations Very indirect evidence observational studies
STRENGTH OF RECOMMENDATION	Strong (1): “We recommend...” <i>Benefits clearly outweigh harms and burdens, or vice versa</i>	1 ⊕⊕⊕⊕	1 ⊕⊕⊕○	1 ⊕⊕○○	1 ⊕○○○
	Conditional (2): “We suggest...” <i>Benefits closely balanced with harms and burdens</i>	2 ⊕⊕⊕⊕	2 ⊕⊕⊕○	2 ⊕⊕○○	2 ⊕○○○

Definition

- ▶ We recommend using body mass index (BMI) and the Centers for Disease Control and Prevention (CDC) normative BMI percentiles to diagnose overweight or obesity in children and adolescents aged 2 years or older. (1|⊕⊕⊕○)
- ▶ We recommend diagnosing a child or adolescent >2 years of age as overweight if the BMI is ≥ 85 th percentile but <95th percentile for age and sex, as obese if the BMI is ≥ 95 th percentile, and as extremely obese if the BMI is $\geq 120\%$ of the 95th percentile or ≥ 35 kg/m² (1|⊕⊕○○). We suggest that clinicians take into account that variations in BMI correlate differently to comorbidities according to race/ethnicity and that increased muscle mass increases BMI. (2|⊕○○○)

CDC BMI Definitions

Percentiles:

85–95th = Overweight

≥95th = Obesity

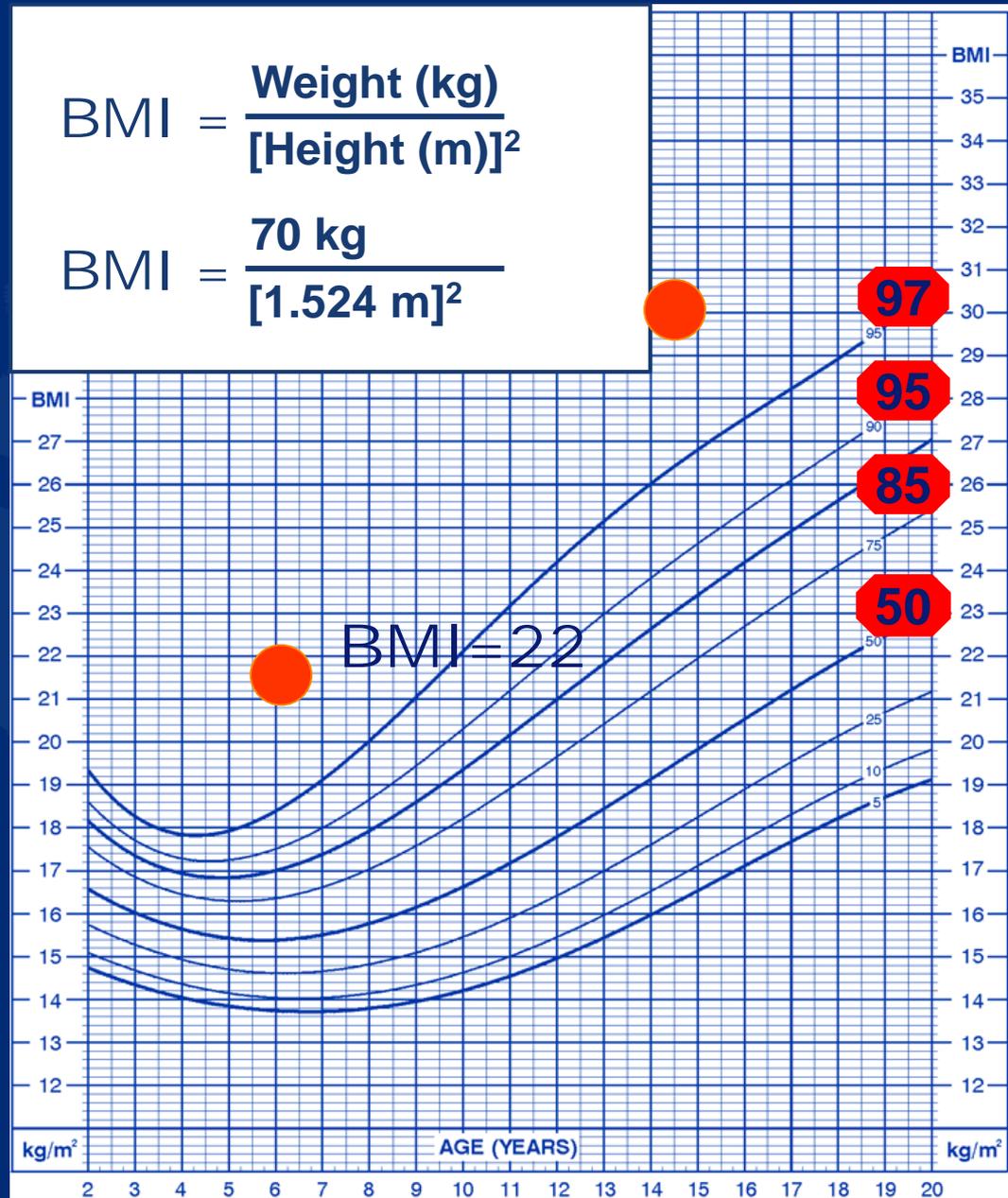
≥120% of 95th = Extreme obesity

Example:

- ▶ Boy, 14.5 years old
- ▶ Weight 154 lbs (70 kg)
- ▶ Height 5'0" (152.4 cm)
- ▶ BMI = 30 kg/m²
- ▶ Extreme/Severe Obesity

$$\text{BMI} = \frac{\text{Weight (kg)}}{[\text{Height (m)}]^2}$$

$$\text{BMI} = \frac{70 \text{ kg}}{[1.524 \text{ m}]^2}$$



- ▶ We suggest calculating, plotting, and reviewing a child's or adolescent's BMI percentile at least annually during well-child and/or sick-child visits. (Ungraded Good Practice Statement)
- ▶ We suggest that a child younger than 2 years of age be diagnosed as obese if the sex-specific weight for recumbent length is greater than or equal to the ≥ 97.7 th percentile on the World Health Organization (WHO) charts. (2|⊕○○○)

II. Assessment of Pediatric Obesity

Assessment of the Child with Obesity

- ▶ We recommend against routine laboratory evaluations for endocrine etiologies of obesity in youths **unless the child's stature and/or height velocity are attenuated** (assessed in relationship to genetic/familial potential and pubertal stage). (1|⊕⊕⊕○)
- ▶ We recommend that children or adolescents with a BMI \geq 85th percentile **be evaluated for potential comorbidities**. (1|⊕⊕⊕○)

Family History:

- ▶ Obesity, bariatric surgery, type 2 diabetes, gestational diabetes mellitus (GDM), hypertension, non-alcoholic fatty liver disease (NAFLD), snoring/sleep apnea, C-Pap use, premature cardiovascular disease (CVD) events/deaths, infertility in women, or polycystic ovary syndrome (PCOS)

Medical History:

- ▶ Polyuria/polydipsia, blurry vision/vision loss, fungal vaginitis/discharge in girls, unexplained weight loss, frequent headaches, snoring, restless sleep, excessive daytime sleepiness, GI discomfort, musculoskeletal symptoms, acne (in girls), hirsutism (in girls), menses (in girls), psychiatric disorders and psych medications, dietary history, voracious appetite, sedentary/ physical activity history

Physical Exam:

- ▶ Weight, Height, and BMI calculations
- ▶ Blood Pressure: Height/age/sex normalized
NHLBI BP Tables
- ▶ Skin: Acanthosis nigricans, skin tags,
hirsutism, extreme acne (girls)
- ▶ Funduscopic exam for pseudotumor cerebrii
- ▶ Thyroid exam for goiter
- ▶ Abdomen/liver exam
- ▶ Tenderness and range of motion of joints
- ▶ Peripheral edema

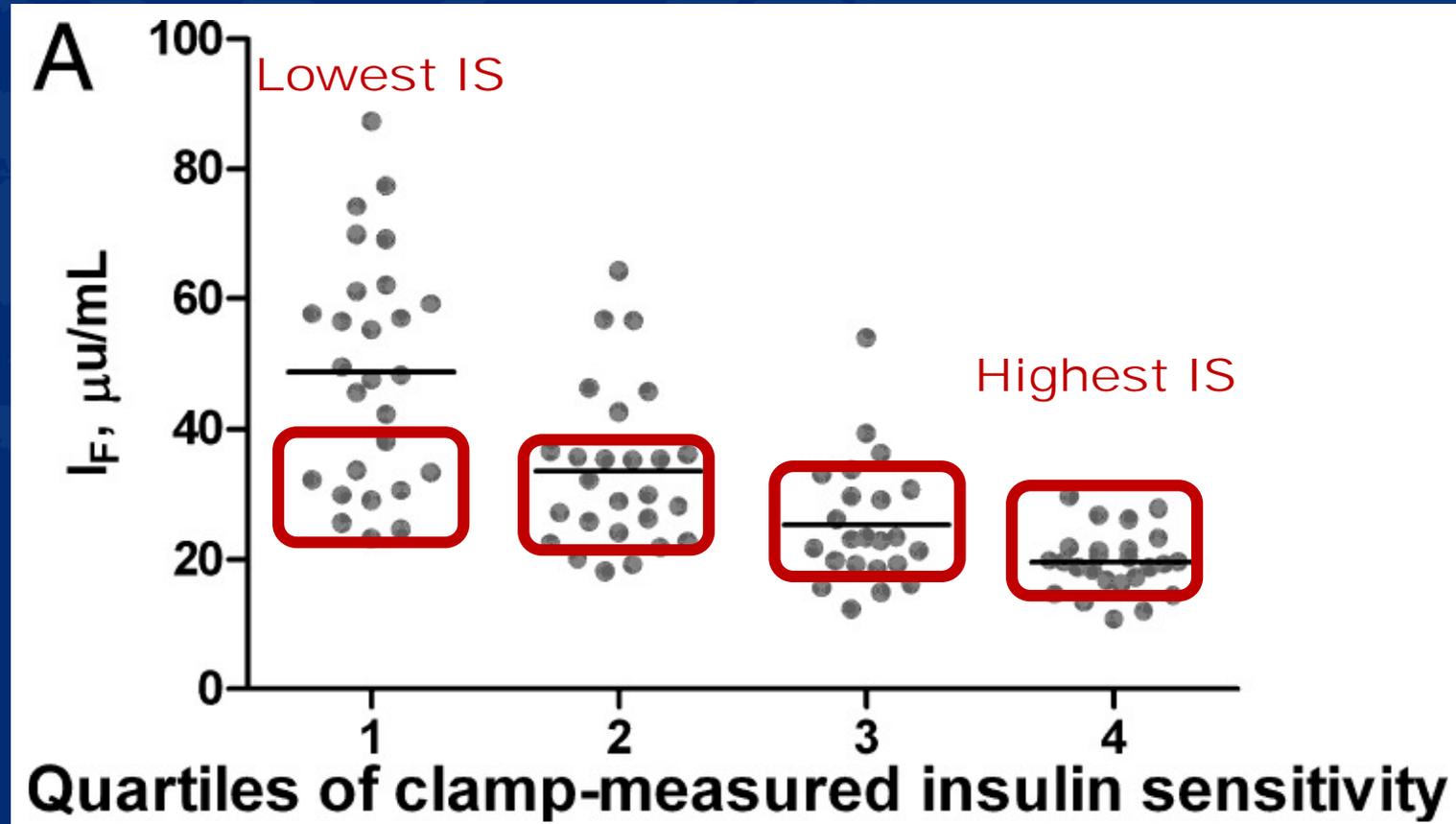
Laboratory Evaluation/Screening Tests:

- ▶ Fasting Lipids
- ▶ HbA1c and random or fasting glucose
- ▶ OGTT if family and medical history positive
- ▶ Liver enzymes
- ▶ Urinalysis: specifically for glucose and protein
- ▶ Free testosterone panel if: **+Hx and PE for PCOS**
- ▶ Thyroid function tests if: **+Hx and PE for thyroid disorder**
- ▶ Refer to pulmonology for PSG if: **+Hx and FHx for SDB**
- ▶ Refer to psychiatry if: **+Hx, FHx, and medications**

- ▶ We recommend against measuring insulin concentrations when evaluating children or adolescents for obesity. (1|⊕⊕⊕○)
- ▶ Evidence: Despite severe deficiency in insulin secretion in youth with type 2 diabetes, fasting insulin concentrations are higher vs. non-diabetic obese peers.
- ▶ Fasting insulin concentrations are similar between obese normal glucose tolerance (NGT) and impaired glucose tolerance (IGT).

Why not measure insulin?

Insulin concentrations show considerable overlap between insulin resistant and insulin sensitive youth



George L, Bacha F, Lee S, Tfayli H, Andreatta E, Arslanian S. Surrogate estimates of insulin sensitivity in obese youth along the spectrum of glucose tolerance... *J Clin Endocrinol Metab* 2011; 96:2136-2145

Case #1: Assessment

A 13-year-old male patient presents:

- ▶ BMI: 35 kg/m² (>97th percentile)
- ▶ PMHx: Adenoidectomy at age 6 years of age for snoring; Blount's disease at 6 years of age
- ▶ Social Hx: lives with parents and grandparents; 10 blocks from nearest playground; 8th grade student
- ▶ ROS: sleep apnea requiring CPAP

Case #1: Assessment

Physical Exam:

- ▶ Height 85th percentile
- ▶ BP 98th percentile systolic/diastolic
- ▶ Generalized obesity, but not Cushingoid
- ▶ Pink abdominal striae; acanthosis nigricans with skin tags present on axillae and neck
- ▶ Liver edge 1 cm below RCM
- ▶ Normal pulmonary and cardiac exams
- ▶ Genitalia stage 2, pubic hair stage 2

Case #1: Assessment

Question

What evaluation will you perform?

- A. Fasting lipid panel
- B. Free T4 and TSH
- C. Urine free cortisol
- D. Insulin concentration
- E. All of the above

Case #1: Assessment

Answer

What evaluation will you perform?

- A. Fasting lipid panel
- B. Free T4 and TSH
- C. Urine free cortisol
- D. Insulin concentration
- E. All of the above

References

- ▶ *Levy-Marchal C, Arslanian S, Cutfield W, Sinaiko A, Druet C, Marcovecchio ML, Chiarelli F. Insulin resistance in children: consensus, perspective, and future directions. J Clin Endocrinol Metab 2010; 95:5189-5198.*
- ▶ *Flechtner-Mors M, Thamm M, Wiegand S, Reinehr T, Schwab KO, Kiess W, Widhalm K, Holl RW. Comorbidities related to BMI category in children and adolescents: German/Austrian/Swiss Obesity Register APV compared to the GermanKiGGS Study. Horm Res Paediatr 2012; 77:19-26.*

Genetic Evaluation

- ▶ We suggest genetic testing only in patients with:
 - ▷ Extreme early onset obesity (<5 years of age); and
 - ▷ Clinical features of genetic obesity syndromes (in particular extreme hyperphagia); and/or
 - ▷ A family history of extreme obesity.

GRADE (2|⊕⊕○○)

BMI \geq 95th percentile



Early-onset obesity, severe hyperphagia, and/or abnormal Hx/PE



↓ Height
velocity



Endocrine
evaluation



Neuro-developmental
abnormalities or severe
hyperphagia



Genetic obesity
evaluation



CNS
injury



Hypothalamic
obesity

Genetic obesity evaluation indicated

Is there developmental delay?

Yes ↓

Karyotype, DNA methylation

Positive ↓

Prader-Willi Syndrome;
chromosomal abnormality

Negative ↓

Retinal dystrophy,
photophobia
or nystagmus?

Yes ↓

BBS,
Alström, Tub

No ↓

Leptin, proinsulin, and insulin

Positive ↓

Leptin, LepR,
PCSK1

Negative ↓

POMC, **MC4R**,
MRAP2,
SH2B1, KSR

No ↓

AHO, BDNF,
TrkB, SIM1

Case #2 : Assessment

A 6-year-old female patient presents:

- ▶ Weight gain started around age 3 years and now BMI: 34 kg/m² (>99th Percentile)
- ▶ Her mom says she eats a lot of pasta and bread, and that she has food seeking behaviors

Case #2 : Assessment

Past Medical History:

- ▶ Floppy as infant, poor feeder due to weak suckle/low tone with failure to thrive (FTT)
- ▶ Extreme increased appetite at 2 years of age
- ▶ History of developmental motor, cognitive, and speech delay

Family History:

- ▶ Only child of a non-consanguineous marriage

Case #2 : Assessment

Physical Exam:

- ▶ Wt: 47.5 kg (> 95%), Ht: 117 cm (50%)
- ▶ BMI: 34 kg/m² (>97th Percentile)
- ▶ Bilateral epicanthal folds, almond shaped eyes, short philtrum, downturned corners of the mouth, acanthosis nigricans at the neck and axillae, brachydactyly



Case #2 : Assessment

QUESTION

What should you order to evaluate this patient?

- A. Exome sequencing for MC4 receptor
- B. Serum leptin for leptin deficiency
- C. FISH for SNRPN to rule out Prader-Willi syndrome
- D. Methylation test for 15q11.2-q13
- E. PCR for CGG repeats for FMR
- F. None of the above

Case #2 : Assessment

ANSWER

What should you order to evaluate this patient?

- A. Exome sequencing for MC4 receptor
- B. Serum leptin for leptin deficiency
- C. FISH for SNRPN to rule out Prader-Willi syndrome
- D. Methylation test for 15q11.2-q13**
- E. PCR for CGG repeats for FMR
- F. None of the above

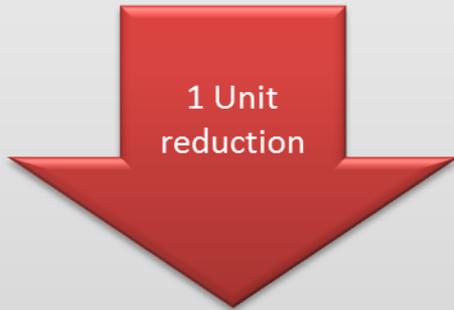
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- ▶ *Goldstone AP, Holland AJ, Hauffa BP, Hokken-Koelega AC, Tauber M; speakers contributors at the Second Expert Meeting of the Comprehensive Care of Patients with PWS. Recommendations for the diagnosis and management of Prader-Willi syndrome. J Clin Endocrinol Metab. 2008 Nov;93(11):4183-97.*
- ▶ *van der Klaauw AA, Farooqi IS. The hunger genes: pathways to obesity. Cell 2015;161: 119-132.*

III. Prevention and Treatment of Pediatric Obesity

- ▶ Since the previous guideline on this topic:
 1. Continued research supports obesity prevention through diet and lifestyle modification
 2. Modest success in treatment has been confirmed with comprehensive lifestyle and dietary interventions involving the whole family

BMI (kg/m²)



SBP(mmHg)* TG (mg/dl)**



**Baseline BMI (median & IQR): 30 (26.1, 35.5)*
***Baseline BMI (median & IQR): 33.2 (26.1, 36.2)*

Weight (kg)



HDL(mmHg)* TG (mg/dl)**



**Baseline weight (median & IQR): 62.5 (52.1, 89.5)*
***Baseline weight (median & IQR): 70.1 (56.4, 87.5)*

Prevention & Treatment Programs

- ▶ Must be family centered
- ▶ Must be culturally relevant
- ▶ Must involve home and school
- ▶ Needs local, state, and federal funding and support to create infrastructure that allows healthy eating and increased daily movement

- ▶ We suggest that clinicians promote and participate in the ongoing healthy dietary and activity education of children and adolescents, parents, and communities, and encourage schools to provide adequate education about healthy eating.
(2|⊕○○○)

- ▶ We recommend that clinicians prescribe and support healthy eating habits in accordance with the following guidelines of the American Academy of Pediatrics and the US Department of Agriculture:
 - ▷ Decreased consumption of fast foods
 - ▷ Decreased consumption of added table sugar and elimination of sugar-sweetened beverages
 - ▷ Decreased consumption of high-fructose corn syrup and improved labeling of foods containing high fructose corn syrup
 - ▷ Decreased consumption of high-fat, high-sodium, or processed foods
 - ▷ Consumption of whole fruit rather than fruit juices

- ▷ Portion control education
- ▷ Reduced saturated dietary fat intake for children and adolescents >2 years of age
- ▷ US Department of Agriculture recommended intake of dietary fiber, fruits, and vegetables
- ▷ Timely, regular meals, and avoiding constant “grazing” during the day, especially after school and after supper
- ▷ Recognizing eating cues in the child’s or adolescents environment, such as boredom, stress, loneliness, or screen time
- ▷ Encouraging single portion packaging and improved food labeling for easier use by consumers

(Ungraded Good Practice Statement)

- ▶ We recommend that children and adolescents engage in at least 20 minutes, optimally 60 minutes, of vigorous physical activity at least 5 days/ week to improve metabolic health, and reduce the likelihood of developing obesity. (1|⊕⊕○○)
- ▶ We suggest fostering healthy sleep patterns in children and adolescents to decrease the likelihood of developing obesity due to changes in caloric intake and metabolism related to disordered sleep. (2|⊕⊕○○)

- ▶ We recommend balancing unavoidable technology related screen time in children and adolescents with increased opportunities for physical activity. (1|⊕⊕○○)
- ▶ We suggest that a clinician's obesity prevention efforts enlist the entire family rather than only the individual patient. (2|⊕○○○)

- ▶ We suggest that clinicians assess family function and make appropriate referrals to address family stressors to decrease the development of obesity. (2|⊕⊕○○)
- ▶ We suggest using school-based programs and community engagement in pediatric obesity prevention. (2|⊕⊕○○)

- ▶ We recommend using comprehensive behavior changing interventions to prevent obesity. Such programs would be integrated with school- or community-based programs to reach the widest audience. (1|⊕⊕○○)
- ▶ We recommend breast-feeding in infants based on numerous health benefits. However, we can only suggest breast-feeding for the prevention of obesity, as evidence supporting the association between breast-feeding and subsequent obesity is inconsistent. (2|⊕○○○)

Lifestyle Modifications to Treat Pediatric Obesity

- ▶ We recommend that clinicians prescribe and support intensive, age-appropriate, culturally sensitive, family-centered lifestyle modifications (dietary, physical activity, behavioral) to promote a decrease in BMI. (1|⊕○○○)
- ▶ We suggest that clinicians encourage and support patients to limit nonacademic screen time to 1 to 2 hours per day and decrease other sedentary behaviors, such as digital activities. (2|⊕○○○)

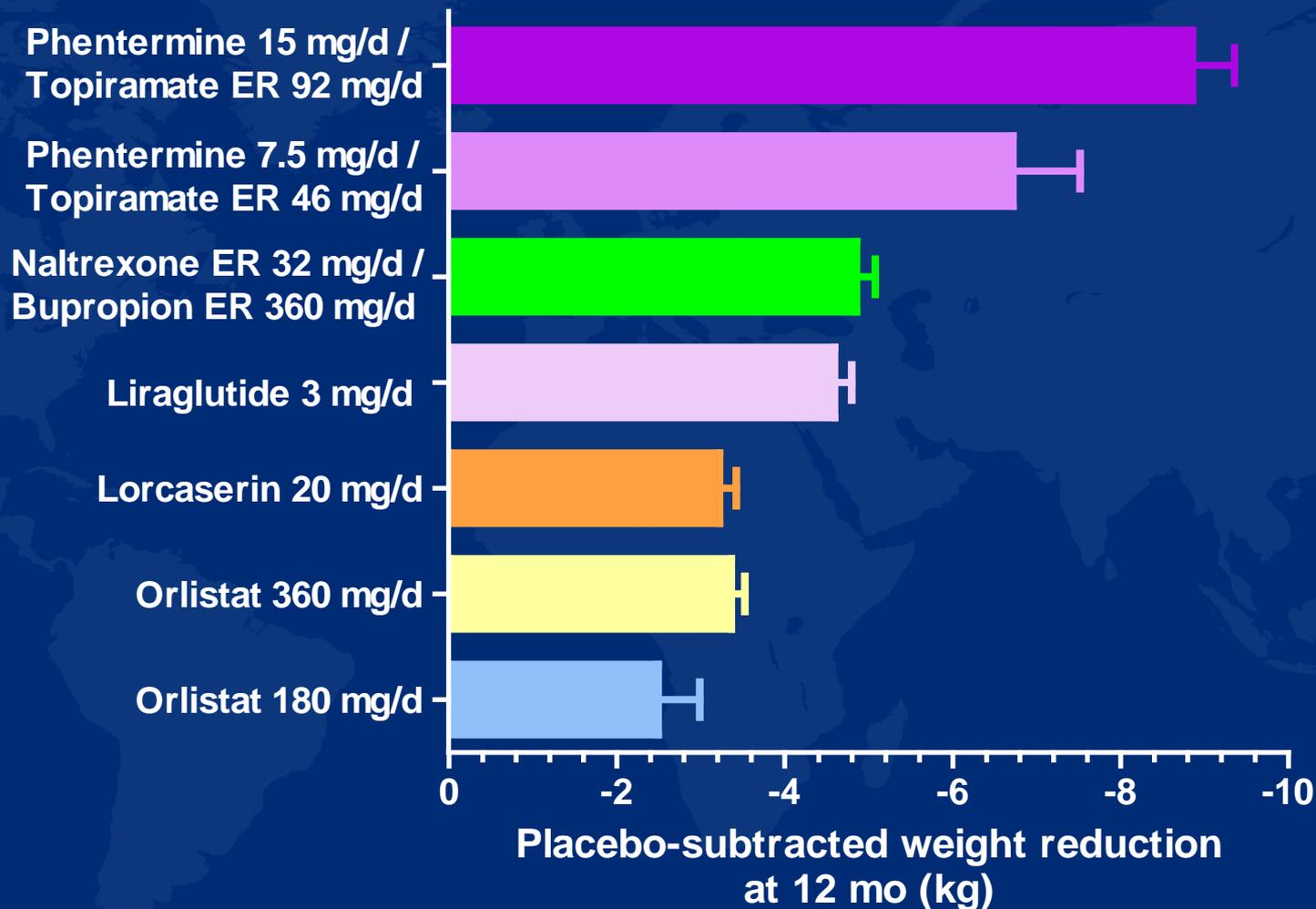
Pharmacotherapy to Treat Pediatric Obesity

- ▶ We suggest pharmacotherapy for children or adolescents with obesity only after a formal program of intensive lifestyle modification has failed to limit weight gain or to ameliorate comorbidities. (2|⊕○○○)
- ▶ We recommend against using obesity medications in children and adolescents <16 years of age who are overweight but not obese, except in the context of clinical trials. (1|⊕○○○)

- ▶ We suggest that FDA-approved pharmacotherapy for obesity be administered:
 - ▷ Only with a concomitant lifestyle modification program of the highest intensity available
 - ▷ Only by clinicians who are experienced in the use of anti-obesity agents and are aware of potential adverse reactions

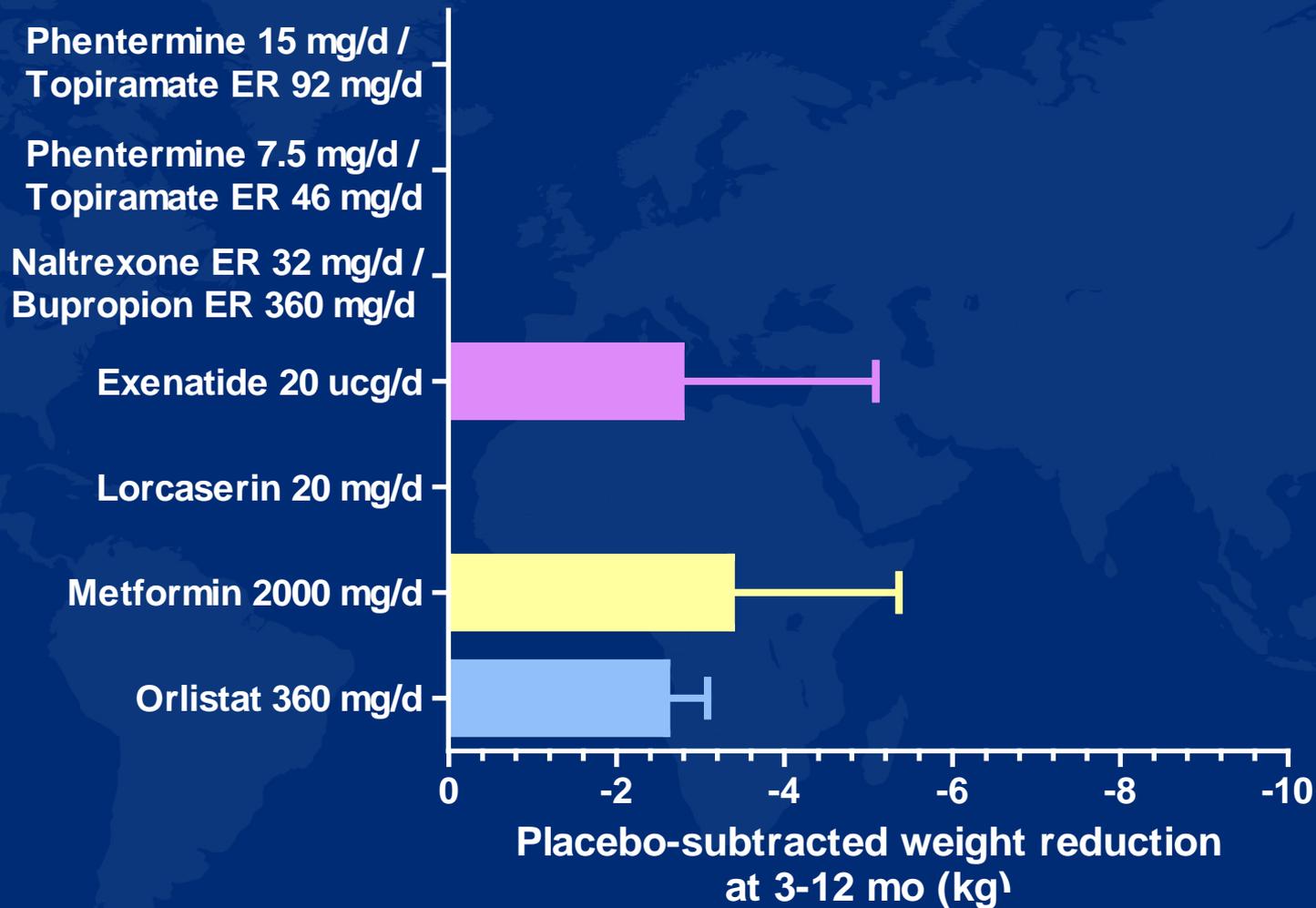
(2|⊕○○○)

Efficacy of Obesity Medications: Adults



Yanovski SZ, Yanovski JA. Long-term Drug Treatment for Obesity: A Systematic and Clinical Review. JAMA 2014; 311:74-86

Efficacy of Obesity Medications: Pediatric



Yanovski SZ, Yanovski JA. Long-term Drug Treatment for Obesity: A Systematic and Clinical Review. JAMA 2014; 311:74-86

- ▶ We suggest clinicians should discontinue medication and re-evaluate the patient if the patient does not have a $>4\%$ BMI/BMI z score reduction after taking anti-obesity medication for 12 weeks at the medication's full dosage.
(2|⊕○○○)

Candidates for Bariatric Surgery

We suggest bariatric surgery only under the following conditions:

- ▶ The patient has attained Tanner 4–5 pubertal development and final/near-final adult height
- ▶ BMI measurement of:
 - ▷ BMI >35 kg/m² and extreme comorbidities of obesity (e.g. type 2 diabetes, moderate to extreme sleep apnea) OR
 - ▷ BMI >40 kg/m² with mild comorbidities (e.g. HTN, dyslipidemia extreme psychological distress secondary to their obesity)

- ▶ Extreme obesity and comorbidities persist despite compliance with a formal program of lifestyle modification, with or without pharmacotherapy
- ▶ Psychological evaluation confirms the stability and competence of the family unit
 - ▷ Impaired quality of life (QOL) from obesity may be present, but the patient does not have an underlying untreated psychiatric illness.
- ▶ The patient demonstrates the ability to adhere to the principles of healthy dietary and activity habits

- ▶ There is access to an experienced surgeon in a pediatric bariatric surgery center of excellence that provides the necessary infrastructure for patient care, including a team capable of long term follow-up of the metabolic and psychosocial needs of the patient and family
(2|⊕○○○)

Evidence for Efficacy of Surgery

- ▶ Reversal of type 2 diabetes
- ▶ Improved glucose homeostasis in nondiabetics
- ▶ Improved insulin sensitivity and secretion
- ▶ Resolution of sleep apnea
- ▶ Improvement in:
 - ▷ NASH
 - ▷ Severe arthropathy
 - ▷ CVD risk factors (dyslipidemia, HTN, inflammation) with ↓cardiac workload.

- ▶ We suggest against bariatric surgery in:
 - ▷ preadolescent children
 - ▷ pregnant or breast-feeding adolescents
 - ▷ those planning pregnancy within 2 years of surgery
 - ▷ those who have not mastered the principles of healthy dietary and activity habits
 - ▷ those with an unresolved:
 - substance abuse
 - eating disorder, or
 - untreated psychiatric disorder
- (2|⊕○○○)

Teen-Labs 3 Year F/U - Surgical Adverse Events

47 Repeat abdominal surgeries in 30 patients (13%)

- ▶ 27 related to the previous surgery
- ▶ 24% in first year post-op
- ▶ 55% in second year
- ▶ 21% in third year

7 had major complications (0.4%)

- ▶ Suicidal ideation
- ▶ GI leaks
- ▶ Anticoagulation for pulmonary embolus

27 had minor complications (11.2%)

- ▶ Wound infection, stenosis of stoma, hernias and ulcers at incision site
- ▶ GI leaks, small bowel obstruction/ileus
- ▶ *Abdominal pain, nausea, diarrhea, dehydration

*Most common complication with both RYGB and VSG

Inge TH, Courcoulas AP, Jenkins TM, et. al. Weight Loss and Health Status 3 Years after Bariatric Surgery in Adolescents. N Engl J Med 2016; 374:113-123

Common Problems with Bariatric Surgery

- ▶ Major and Minor Surgical Complications
- ▶ Vitamin Deficiencies
- ▶ Mineral Deficiencies
- ▶ Poor Adherence to Nutritional follow up

Case #1 Revisited: Treatment

A 13-year-old male patient presents:

- ▶ BMI: 35 kg/m² (>97th percentile)
- ▶ Liver edge 1 cm below RCM
- ▶ Genitalia stage 2, pubic hair stage 2
- ▶ Laboratory assessment
 - ▷ A1C 6%
 - ▷ Dyslipidemia
 - ▷ No NASH
 - ▷ Mild OSA

Case #1 Revisited: Treatment

Laboratory Assessment:

- ▶ HbA1c 6.0% (0.06)
- ▶ Fasting blood glucose 105 mg/dL (5.8 mmol/L)
- ▶ ALT 56 U/L (NL < 25 U/L)
[0.94 μ kat/L (NL < 0.42 μ kat/L)]

Lipid profile:

- ▶ Total cholesterol 251 mg/dL (6.5 mmol/L)
- ▶ HDL-C 64 mg/dL (1.66 mmol/L)
- ▶ Triglycerides 150 mg/dL (3.9 mmol/L)
- ▶ LDL-C 184 mg/dL (2.08 mmol/L)

Case #1 Revisited: Treatment

QUESTION

Besides treating his hypertension and dyslipidemia, what would you do next?

- A. Enroll in intense lifestyle modification program
- B. Prescribe Orlistat 120 mg TID
- C. Prescribe Atkins diet
- D. Refer for bariatric surgery
- E. Both A and B

Case #1 Revisited: Treatment

ANSWER

Besides treating his hypertension and dyslipidemia, what would you do next?

- A. Enroll in intense lifestyle modification program
- B. Prescribe Orlistat 120 mg TID
- C. Prescribe Atkins diet
- D. Refer for bariatric surgery
- E. Both A and B

Psychosocial Issues

- ▶ We suggest that the healthcare team evaluate for psychosocial comorbidities and prescribe assessment and counseling if psychosocial problems are suspected. (2|⊕○○○)

- ▶ We suggest that the healthcare team identify maladaptive rearing patterns related to diet and activity, and educate families about healthy food and exercise habits. (2|⊕○○○)
- ▶ We suggest that the health care team probe for and diagnose unhealthy intrafamily communication patterns and support rearing patterns that seek to enhance the child's or adolescent's self-esteem. (2|⊕○○○)

Recommended Future Research Aims

- ▶ Understand genetic and biological factors
- ▶ Implement systemic changes in the food and activity culture for preventing and treating obesity
- ▶ Examine the degree of BMI or weight change that translates to improve health
- ▶ Develop transition programs for adolescents with obesity entering adulthood
- ▶ Discover methods to sustain healthy BMI changes