Update on Pediatric Obesity Treatment

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Outline

• Epidemiology
• Prevention
• Treatment
  – Diet
  – Exercise
  – Pharmacotherapy
  – Surgery
• Approach to the Patient
For Children, BMI Varies with Age

Example:

95\textsuperscript{th} Percentile

<table>
<thead>
<tr>
<th>Age</th>
<th>BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 yrs</td>
<td>19.3</td>
</tr>
<tr>
<td>4 yrs</td>
<td>17.8</td>
</tr>
<tr>
<td>9 yrs</td>
<td>21.0</td>
</tr>
<tr>
<td>13 yrs</td>
<td>25.1</td>
</tr>
</tbody>
</table>
U.S. Definitions of Obesity in children

- Based on new CDC growth charts for the United States (www.cdc.gov/growthcharts) and Expert Committee (15 national organizations).
- **Overweight**: BMI-for-age between the 85th–95th percentile
- **Obese**: BMI-for-age at or above the 95th percentile
- **Extremely Obese**: BMI-for-age at or above 120% of the 95th percentile or 35kg/sqm
Comparison to Adult Standards

Expert Committee recommends that 95\textsuperscript{th} or BMI of 30 be used to define obesity whichever is lower.

http://www.cdc.gov/nccdphp/dnpa/growthcharts
NHANES Obesity Prevalence 2-19y

Table 2. Weighted Prevalence of Obesity and Extreme Obesity in US Children and Adolescents Aged 2 to 19 Years by Sex, Age, and Race/Hispanic Origin: NHANES 2011-2014

<table>
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Obesity (BMI at or above the sex-specific 95th percentile on the CDC BMI-for-age growth charts)

<table>
<thead>
<tr>
<th>All race/Hispanic origin groupsa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Both sexes</td>
</tr>
<tr>
<td>Males</td>
</tr>
<tr>
<td>Females</td>
</tr>
</tbody>
</table>

| Both sexes | 17.0 (15.5-18.6) | 8.9 (7.1-11.0) | 17.5 (15.2-20.1) | 20.5 (17.8-23.5) |
| Males       | 16.9 (15.1-19.0) | 9.2 (6.5-12.4) | 17.6 (14.6-20.9) | 20.1 (16.8-23.6) |
| Females     | 17.1 (15.1-19.3) | 8.6 (6.2-11.6) | 17.5 (14.9-20.3) | 21.0 (17.3-25.2) |

### NHANES Obesity Prevalence 2-19y

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<td></td>
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<td></td>
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<tr>
<td>Both sexes</td>
<td>14.7 (12.3-17.3)</td>
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<td>13.6 (9.8-18.3)</td>
<td>19.6 (14.7-25.3)</td>
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<td>14.3 (11.2-17.9)</td>
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<td>13.0 (9.0-17.9)</td>
<td>18.7 (13.0-25.7)</td>
</tr>
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<td>15.1 (11.7-19.1)</td>
<td>4.4 (2.0-8.2)</td>
<td>14.4 (9.3-20.9)</td>
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NHANES Extreme Obesity Prevalence 2-19y

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</tr>
<tr>
<td>Females</td>
<td>0.43 (0.04-1.77)&lt;sup&gt;b,c&lt;/sup&gt;</td>
</tr>
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NHANES Trend 2-19y/o

Figure 1. Prevalence of Obesity and Extreme Obesity in US Children and Adolescents Aged 2 to 19 Years From 1988-1994 Through 2013-2014

Significance of Pediatric Obesity

• Predictive of Adult Obesity
• Predictive of Cardiovascular Risk Factors
• Predictive of Atherosclerosis
• Increases risk of Death in adulthood
• Increases incidence of
  – Metabolic Syndrome
  – Type 2 Diabetes
  – Hypertension
  – NASH
Obesity Causes

- Genes 70%, Environment 30%
- Increased energy intake
  - Increase in Sugared Drinks
  - Carbohydrates replace fat
  - High fat food
    - School lunches still 37-40% fat
  - Eating out
    - Avg. 45-55% cal from fat
  - Not enough fruits and veg.
- Decreased energy expenditure
  - Decreased PE
  - Decreased walking, biking
  - Increased screen time
    - Replaces activity
    - Induces non-nutritive snacking
    - Decreases BMR
Endocrine Society- CPG 2017 Prevention

• Clinicians to promote healthy dietary and activity education
• Clinicians to recommend avoiding sugar sweetened beverages, sports drinks, fruit drinks, fast foods, foods with added table sugar, foods with high fructose corn syrup, high fat, high sodium, processed foods, calorie dense snacks
• Encourage whole fruits rather than juices
Endocrine Society- CPG 2017 Prevention

• Minimum 20min exercise goal 60 minutes 5x per week
• Healthy sleep patterns
• Balance screen time with activity
• Enlist entire family in obesity prevention
• Breast feeding infants
• Engage with schools and communities
Treatment Modalities

- Diet
- Exercise
- Pharmacotherapy
- Surgery
Dietary Restriction and Height

- Prospective Randomized Controlled Trial
- 150 children, 6-12 years old
- 10 year Followup
- Percent Change in Weight did not contribute to height change
- Obese and non-obese children at 10 years showed no height difference
Dietary Restriction and Nutrition

- 600 children 8-10y/o
- Low fat diet <30% Cal from fat
- Weight reduction does not affect linear growth
- Weight reduction has no adverse effect on Nutrition

<table>
<thead>
<tr>
<th>Anthropometric measures*</th>
<th>( \beta ) Coefficient</th>
<th>P Val</th>
</tr>
</thead>
<tbody>
<tr>
<td>No association between energy intake from fat and:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height (cm)</td>
<td>(-0.0009)</td>
<td>0.6</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>(-0.0011)</td>
<td>0.8</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>(-0.00008)</td>
<td>0.9</td>
</tr>
<tr>
<td>Sum of skinfolds (mm)</td>
<td>(-0.005)</td>
<td>0.2</td>
</tr>
<tr>
<td>Blood biochemical measures†</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower energy intake from fat associated with:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Higher levels of:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Red blood cell folate (ng/mL)</td>
<td>(-0.02)</td>
<td>0.03</td>
</tr>
<tr>
<td>Hemoglobin (g/dL)</td>
<td>(-0.0008)</td>
<td>0.02</td>
</tr>
<tr>
<td>Serum ferritin (ng/mL)</td>
<td>(-0.013)</td>
<td>0.10</td>
</tr>
<tr>
<td>No association between energy intake from fat and:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serum ( \beta )-carotene (µ/dL)</td>
<td>(-0.0008)</td>
<td>0.4</td>
</tr>
<tr>
<td>Serum retinol (µ/dL)</td>
<td>(+0.003)</td>
<td>0.8</td>
</tr>
<tr>
<td>Serum vitamin E (µ/dL)</td>
<td>(+0.01)</td>
<td>0.3</td>
</tr>
<tr>
<td>Serum zinc (µ/dL)</td>
<td>(-0.0009)</td>
<td>0.5</td>
</tr>
<tr>
<td>Serum albumin (g/dL)</td>
<td>(-0.0001)</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Obarzanek E, et al Peds, 100,51,1997
10 year Family-Based Behavioral Therapy Study

- 76 Obese Children age 6-12 and their parents
- Randomized to 3 groups with similar education but differing reinforcement
- Group 1 Both parent and Child reinforced
- Group 2 Child only
- Group 3 neither
Criteria

- >20% over IBW
- Triceps Skinfold >95th Percentile
- No history of Psychiatric illness
- Both Parents live at home
- At least one parent obese
- Parent willing to attend treatment with their child
## Patient Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Children</th>
<th>Mothers</th>
<th>Fathers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>9.9(2.3)</td>
<td>40(7)</td>
<td>43(9)</td>
</tr>
<tr>
<td>Wt</td>
<td>52(13) kg</td>
<td>73(15)</td>
<td>90(14)</td>
</tr>
<tr>
<td>Ht</td>
<td>143(12) cm</td>
<td>162(6)</td>
<td>176(6)</td>
</tr>
<tr>
<td>BMI</td>
<td>25.4, 98%tile</td>
<td>27.8</td>
<td>29.1</td>
</tr>
<tr>
<td>F/M</td>
<td>36/19</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Diet, Exercise Education

• Traffic Light diet- color coded food exchange system
  – Green- go foods <20Cal/ avg. serving
  – Yellow- staples that provide most of the nutrition
  – Red- stop high caloric density foods
  – Color Coded Food lists with Caloric content
  – 2 instructions given
    • 900-1200 or 1200-1500 Cal limit depending on the study
    • No more than 4 red foods/wk
  – Taught diet diary, charting daily wt, cal eaten
  – Aerobic exercise teaching
How restrictive is this 1200Cal diet?

<table>
<thead>
<tr>
<th>BMI 25.4, IBW 34kg</th>
<th>REE</th>
<th>1.2xREE</th>
<th>1.5xREE</th>
<th>HB 1190</th>
<th>WHO 1264</th>
<th>SCO 1108</th>
<th>WHO 1264</th>
<th>SCO 1108</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.9 y/o girl 52kg, 56.3”</td>
<td>REE</td>
<td>1190</td>
<td>1427</td>
<td>1784</td>
<td>1264</td>
<td>1517</td>
<td>1896</td>
<td>1108</td>
</tr>
</tbody>
</table>

Mildly Restrictive

Depending on activity
Behavioral Procedures

- **Contracting** - $65 deposited, $5 returned at each visit for wt loss (child and parent-group 1, child-group 2, attendance-group 3).

- **Self-Monitoring** - daily observation and recording of caloric intake, exercise, weight (Child and parent-group 1, Child groups 2 and 3)

- **Social Reinforcement and Modeling** - Parents and Children in group 1 and 2 trained to serve as models for other family members. Group 3 no specific training.
Results

• **Group 1** - Significant Decrease in Percent overweight at 5 and 10 years

• **Groups 2, 3** - Significant Increase in Percent overweight at 5 and 10 years

• **Final Height** - No differences

• **Parents** - Returned to baseline at 5 years, Increase by 5-10% at 10 years
Exercise

- 8-12 y/o girls
- >20% over IBW
- Randomized to Diet or Diet plus exercise
- TLD 900-1200 kcal
- 8 wks of intensive tx
- 10 monthly sessions
- Exercise 3d/w x 6w
- Then monthly

Epstein LH, Jpeds 107,358,1985
Aerobic vs. Lifestyle Exercise

- 41 Families, of Obese Parents and Children
- Children 8-12 y/o
- Child and 1 parent >20% over IBW
- Randomized to Diet plus aerobic exercise, diet plus lifestyle exercise, or diet plus Calisthenic exercise.
Aerobic vs. Lifestyle Exercise

• Common Components
  – Traffic light diet 1200 Cal
  – Behavioral program

• Aerobic Exercise
  – Walking 1mi, running 1mi, biking 2mi, or swimming 0.25mi, 3x/wk, advancing to 3mi, 3mi, 6mi, 0.75mi

• Lifestyle Exercise
  – Isocaloric to Aerobic exercise but with choice from exercise menu e.g. walk to school or up stairs

• Calisthenic Exercise
  – 1/3 of energy expenditure of other programs
Results

- Lifestyle Exercise is Superior to Aerobic Exercise
- Parents showed similar results
Summary

• Prevention can work
• Dietary restriction doesn’t affect height
• Various Diets Effective
• Exercise Additive
• Lifestyle Exercise durable
• Kids do better than their parents
Effect of Weight loss on Leptin

Rosenbaum and Leibel JCI 2005
Effect of weight loss on EE

NREE is down

Gross Mechanical Efficiency of skeletal muscle while biking to generate 10W of power is up

Utilize less glucose

Rosenbaum and Leibel JCI 2005
Endocrine Effects of Weight loss

T3, T4 and TSH are down

SNS tone is down
fMRI brain activity
### fMRI brain activity

<table>
<thead>
<tr>
<th>Anatomical region</th>
<th>Weight loss effects</th>
<th>Leptin effects</th>
<th>Putative function in energy intake</th>
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<tr>
<td></td>
<td><strong>WL-10%placebo</strong> &gt; <strong>WL_initial</strong></td>
<td><strong>WL_initial</strong> &gt; <strong>WL-10%placebo</strong></td>
<td></td>
</tr>
<tr>
<td>Amygdala</td>
<td>x</td>
<td></td>
<td>Regulates food intake in response to sensory cues (33)</td>
</tr>
<tr>
<td>Brainstem</td>
<td>x</td>
<td></td>
<td>Processes stimulatory and inhibitory food intake signals</td>
</tr>
<tr>
<td>Cingulate gyrus</td>
<td>x</td>
<td>x</td>
<td>Affects emotional self-control, problem solving, and error recognition (dietary restraint) (34)</td>
</tr>
<tr>
<td>Culmen</td>
<td>x</td>
<td>x</td>
<td>Activity correlated with response-time inhibition (35), creative thinking, working memory, and emotion (36)</td>
</tr>
<tr>
<td>Fusiform gyrus</td>
<td>x</td>
<td></td>
<td>Activity increases with fasting; influences food intake in response to sensory stimuli (37)</td>
</tr>
<tr>
<td>Globus pallidus</td>
<td>x</td>
<td></td>
<td>Mediates the hedonic impact of high-sugar/high-fat foods (10)</td>
</tr>
<tr>
<td>Hypothalamus</td>
<td>x</td>
<td>x</td>
<td>Processes leptin and other humoral signals (26, 38)</td>
</tr>
</tbody>
</table>

**Before weight loss:** Active areas are those that affect metabolic, autonomic, and neuroendocrine aspects of energy homeostasis, emotional control of food intake, integrative cognitive control functions and motor planning.

**After weight loss:** limbic and reward systems as well as systems mediating aspects of executive and decision-making functions.

**Sum effect:** Decreased restraint, more reward.
Summary of effects of wt. loss

Table 1 - Effects of maintenance of a reduced body weight with and without leptin replacement on energy expenditure (Rosenbaum et al., 2005).

<table>
<thead>
<tr>
<th>Phenotypes</th>
<th>Effect of weight loss</th>
<th>Effect of “replacement” leptin after weight loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy expenditure per unit metabolic mass</td>
<td>Decreased, mainly due to decreased energy expended in physical activity and increased skeletal muscle work efficiency</td>
<td>Reversed</td>
</tr>
<tr>
<td>Neuroendocrine axes</td>
<td>Decreased circulating concentrations of bioactive thyroid hormones.</td>
<td>Reversed</td>
</tr>
<tr>
<td>Autonomics</td>
<td>Decreased SNS tone</td>
<td>Reversed</td>
</tr>
<tr>
<td></td>
<td>Increased PNS tone</td>
<td>Unaffected</td>
</tr>
</tbody>
</table>

Table 2 - Effects of maintenance of a reduced body weight with and without leptin replacement on energy intake (Rosenbaum et al., 2005).

<table>
<thead>
<tr>
<th>Feeding behaviors</th>
<th>Effect of weight loss</th>
<th>Effect of “replacement” leptin after weight loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hunger</td>
<td>Possible small increase</td>
<td>Reversed</td>
</tr>
<tr>
<td>Satiety</td>
<td>Decreased</td>
<td>Reversed</td>
</tr>
<tr>
<td>Perception of how much food eaten</td>
<td>Decreased</td>
<td>Reversed</td>
</tr>
<tr>
<td>% total daily energy expenditure consumed at a single meal</td>
<td>Increased</td>
<td>Reversed</td>
</tr>
<tr>
<td>“Liking” of monotonous formula diet</td>
<td>Decreased</td>
<td>Unchanged</td>
</tr>
</tbody>
</table>
Pharmacotherapy

• FDA approved in children
  – Orlistat - ≥12
  – Sibutramine - ≥16 (SNRI, amphetamine like)
    • Pulled by FDA due to Cardiovascular events
  – Rimonobant adults (CB1 inv agonist)
    • Pulled by FDA due to depression, SI, suicide

• FDA approved in children with Off-Label use
  • Metformin ≥ 10y
  • Stimulants- vyvanse, phentermine, dextroamphetamine
  • Topiramate
Pharmacotherapy

• FDA approved in adults for obesity
  – Diethylpropion
  – Liraglutide (Saxenda)
  – Lorcaserin (Belviq)
  – Phentermine/topiramate (Qsymia)
  – Bupropion/naltrexone (Contrave)

• No studies in children
Orlistat RCT

- 52 week RCT
- Orlistat 120mg tid vs. placebo
- Hypocaloric diet 40% reduction
- Received daily MVI
# Orlistat RCT

## Table 1. Demographic and Baseline Data

<table>
<thead>
<tr>
<th></th>
<th>Placebo</th>
<th>Orlistat</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All (n = 181)</td>
<td>Completed (n = 117)</td>
</tr>
<tr>
<td><strong>No. (%) of Participants</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>129 (71)</td>
<td>86 (74)</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>141 (78)</td>
<td>93 (80)</td>
</tr>
<tr>
<td>Black</td>
<td>25 (14)</td>
<td>15 (13)</td>
</tr>
<tr>
<td>Other</td>
<td>15 (8)</td>
<td>9 (7)</td>
</tr>
<tr>
<td><strong>Mean (SD)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, y</td>
<td>13.5 (1.2)</td>
<td>13.5 (1.2)</td>
</tr>
<tr>
<td>Anthropomorphic measurements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight, kg</td>
<td>95.1 (14.2)</td>
<td>94.9 (15.3)</td>
</tr>
<tr>
<td>Height, cm</td>
<td>163.7 (7.7)</td>
<td>164.0 (8.2)</td>
</tr>
<tr>
<td>BMI</td>
<td>35.4 (4.1)</td>
<td>35.1 (4.0)</td>
</tr>
<tr>
<td>Waist circumference, cm</td>
<td></td>
<td>104.5 (10.6)</td>
</tr>
<tr>
<td>Blood pressure, mm Hg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diastolic</td>
<td>67 (10)</td>
<td>67 (9)</td>
</tr>
<tr>
<td>Systolic</td>
<td>114 (12)</td>
<td>115 (11)</td>
</tr>
</tbody>
</table>

Chanoine JAMA 2005, 293, 2877
Figure 2. Change in Mean Body Mass Index and Weight

Body Mass Index

- Orlistat
- Placebo

Mean Change vs Week

Weight

Mean Change Kg vs Week

P = .001 for body mass index (orlistat vs placebo), P < .001 for weight change (orlistat vs placebo). Body Mass Index is calculated as weight in kilograms divided by the square of height in meters. Coefficient of variation is about 14% for each data point for body mass index and about 16% for weight.
Orlistat

• Due to side effects
  – 50% of pediatric patients stop it in 1 month
  – 75% of pediatric patients stop it in 3 months
  – 90% of pediatric patients stop it in 6 months
Meta-Analysis of Randomized Trials

<table>
<thead>
<tr>
<th>Interventions</th>
<th>SMD (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pharmacological interventions</strong></td>
<td></td>
</tr>
<tr>
<td>Sibutramine</td>
<td>-1.01 (-1.28, -0.73)</td>
</tr>
<tr>
<td>Orlistat</td>
<td>-0.29 (-0.46, -0.12)</td>
</tr>
<tr>
<td>Metformin</td>
<td>-0.17 (-0.62, 0.28)</td>
</tr>
<tr>
<td><strong>Dietary interventions</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.22 (-0.56, 0.11)</td>
</tr>
<tr>
<td><strong>Physical activity interventions</strong></td>
<td></td>
</tr>
<tr>
<td>Effect on BMI</td>
<td>-0.02 (-0.21, 0.18)</td>
</tr>
<tr>
<td>Effect on fat mass</td>
<td>-0.52 (-0.73, -0.30)</td>
</tr>
<tr>
<td><strong>Combined lifestyle interventions</strong></td>
<td></td>
</tr>
<tr>
<td>Targeting family</td>
<td>-0.64 (-0.88, -0.39)</td>
</tr>
<tr>
<td>Targeting children</td>
<td>-0.17 (-0.40, 0.05)</td>
</tr>
</tbody>
</table>
Bariatric Surgery

Roux-en-Y gastric bypass

AGB

Sleeve Gastrectomy

Inge TH, et al Peds, 114,217,2004
Bariatric Surgery

- Gastric Bypass: 50-85% EWL, 17 point BMI reduction, almost complete remission of co-morbidities, esp DM, 0.5% mortality, leak, SBO, dumping
- AGB (Australia): 79% EWL, 33% needed revision
- SG: dilatation, GERD, leak, 40% EWL at 1y, less morbidity than GB.
Approach to the Patient

- Screening for secondary Causes
- Nutritional Assessment
- Physical Activity Assessment
- Environmental Assessment
- Psychosocial Assessment
- Laboratory Assessment
- Goals of Therapy
- General Management Guidelines
- Diets
History

- Onset before age 5
- Hyperphagia
- Family history, Consanguinity
- Short duration
- HA, vomiting, visual disturbances
- Dry skin, constipation, fatigue
- Short or tall stature
- Frequent infections
- Developmental delay, ASD
- Visual impairment or sensorineural deafness
- Photophobia
- Heart, Kidney disease

- Drugs (GCs, antipsychotics, antidepressants)
- Neonatal Diarrhea, hypoglycemia
- Hypogonadism, Hypotonia
- Diabetes
- Seizure Disorder
- Pain insensitivity
Physical Exam

- Weight, height, BMI SDS, growth pattern, compare with TH, blood pressure
- Fat mass, distribution pattern
- Microcephaly, macrocephaly, craniosynostosis
- Visual acuity, visual fields, nystagmus, retinal exam
- Large ears, hearing
- Teeth, incisors
- Goiter
- hypoplastic nipples, gynecomastia
- Heart exam
- Testes, penis, pubertal signs
- Small hands and feet, polydactyly, Brachydyactyly, tapering fingers
- Ulnar skeletal defects
- Skin color, hair color, skin ossifications
- Striae, hirsutism, acne
- Nociception
## Review of Systems

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Possible Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anxiety, school avoidance, social isolation</td>
<td>Depression</td>
</tr>
<tr>
<td>Severe recurrent headaches</td>
<td>Pseudotumor cerebri</td>
</tr>
<tr>
<td>Shortness of breath, exercise intolerance</td>
<td>Asthma, lack of physical conditioning</td>
</tr>
<tr>
<td>Snoring, apnea, daytime sleepiness</td>
<td>Obstructive sleep apnea, obesity hypoventilation syndrome</td>
</tr>
<tr>
<td>Sleepiness or wakefulness</td>
<td>Depression</td>
</tr>
</tbody>
</table>
| Abdominal pain                               | Gastroesophageal reflux disease, constipation, gallbladder disease, NAFLD\
| Hip pain, knee pain, walking pain            | Slipped capital femoral epiphysis, musculoskeletal stress from weight (may be barrier to physical activity) |
| Foot pain                                    | Musculoskeletal stress from weight (may be barrier to physical activity) |
| Irregular menses (<9 cycles per y)           | Polycystic ovary syndrome; may be normal if recent menarche |
| Primary amenorrhea                            | Polycystic ovary syndrome, Prader-Willi syndrome     |
| Polyuria, polydipsia                         | Type 2 diabetes mellitus\(a\)                        |
| Unexpected weight loss                       | Type 2 diabetes mellitus\(a\)                        |
| Nocturnal enuresis                           | Obstructive sleep apnea                              |
| Tobacco use                                  | Increased cardiovascular risk; may be used as form of weight control |

\(a\) These conditions are often asymptomatic.
# Physical Exam Findings

<table>
<thead>
<tr>
<th>System</th>
<th>Findings</th>
<th>Possible Explanations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anthropometric features</td>
<td>High BMI percentile</td>
<td>Overweight or obesity</td>
</tr>
<tr>
<td></td>
<td>Short stature</td>
<td>Underlying endocrine or genetic condition</td>
</tr>
<tr>
<td>Vital signs</td>
<td>Elevated blood pressure</td>
<td>Hypertension if systolic or diastolic blood pressure &gt; 95th percentile for age, gender, and height on ≥ 3 occasions</td>
</tr>
<tr>
<td>Skin</td>
<td>Acanthosis nigricans</td>
<td>Common in obese children, especially when skin is dark; increased risk of insulin resistance</td>
</tr>
<tr>
<td></td>
<td>Excessive acne, hirsutism</td>
<td>Polycystic ovary syndrome</td>
</tr>
<tr>
<td></td>
<td>Irritation, inflammation</td>
<td>Consequence of severe obesity</td>
</tr>
<tr>
<td></td>
<td>Violaceous striae</td>
<td>Cushing syndrome</td>
</tr>
<tr>
<td>Eyes</td>
<td>Papilledema, cranial nerve VI paralysis</td>
<td>Pseudotumor cerebri</td>
</tr>
<tr>
<td>Throat</td>
<td>Tonsillar hypertrophy</td>
<td>Obstructive sleep apnea</td>
</tr>
<tr>
<td>Neck</td>
<td>Goiter</td>
<td>Hypothyroidism</td>
</tr>
<tr>
<td>Chest</td>
<td>Wheezing</td>
<td>Asthma (may explain or contribute to exercise intolerance)</td>
</tr>
<tr>
<td>Abdomen</td>
<td>Tenderness</td>
<td>Gastroesophageal reflux disorder, gallbladder disease, NAFLDα</td>
</tr>
<tr>
<td>Reproductive system</td>
<td>Hepatomegaly</td>
<td>NAFLDα</td>
</tr>
<tr>
<td></td>
<td>Tanner stage</td>
<td>Premature puberty in &lt; 7-y-old white girls, &lt; 6-y-old black girls, and &lt; 9-y-old boys</td>
</tr>
<tr>
<td></td>
<td>Apparent micropenis</td>
<td>May be normal penis that is buried in fat</td>
</tr>
<tr>
<td></td>
<td>Undescended testes</td>
<td>Prader-Willi syndrome</td>
</tr>
<tr>
<td>Extremities</td>
<td>Abnormal gait, limited hip range of motion</td>
<td>Slipped capital femoral epiphysis</td>
</tr>
<tr>
<td></td>
<td>Bowing of tibia</td>
<td>Blount disease</td>
</tr>
<tr>
<td></td>
<td>Small hands and feet, polydactyly</td>
<td>Some genetic syndromes</td>
</tr>
</tbody>
</table>
Chart review

- TSH, FT4
- PTH, Ca, Phos
- Glucose, A1c, Insulin
- CD4 counts
- Hypogonadism testing
- Renal, Cardiac studies
- Ophtho exams
- Hearing tests
- Neurology visits, EEGs
- Pulmonary visits
- Genetics visits, testing
Flowchart

History, PE

Suspect Genetic Cause?

No

Suspect Endocrine Disorder (height)?

No

Common Obesity

Yes

Thyroid, GH, Cushing’s

Yes

Developmental Delay?

No

Syndromes

Yes

Syndromes
Obesity without Developmental Delay

→ Photophobia/Nystagmus

Yes

→ Yes

Alstrom Syndrome
(Alstrom Syndrome (ALMS1 CMP, deaf, retinopathy, T2DM))

No

→ Recessive

Leptin level

Yes

→ Leptin Receptor (HG, central hypothyroidism)

POMC (red hair or pale skin isolated ACTH def.)

PC1/3 (enteropathy, adrenal insufficiency, postprandial hypoglycemia, high proinsulin, HG)

No

→ Leptin Deficiency (HG, Infections)

Tall >+2SD

High insulin

Yes

→ MC4R

No

→ Sim1
Obesity with Developmental Delay

Identifiable syndrome?

SNP Array

Retinal Disease

Short?

Yes

BDNF (hyperactivity impaired pain)
NTRK2 (hyperactivity impaired pain)
Sim1 (mild neurobehavioral phenotype)
SH2B1 (IR, top decile)
BFL (Sz, HG, large ears, Xq26.3)
Wilson Turner (tapering fingers, gynecomastia)

No

PHP (brachydacyly, facies, SC ossification, TSH, PTH res.)
Carpenter (craniosynostosis, polysyndactyly, cardiac)
Rubenstein-Taybi (facies, broad thumbs, eye, heart, kidney, teeth)
ROHHAD (hypoventilation, HD, AD, NET )

Yes

No

Positive

Negative
Nutritional Assessment

• Identify Problem Behaviors
  – Sweetened beverages, Juice, Milk
  – Large portions
  – High calorie snacks
  – Eating out, ordering in
  – Family meals vs. TV
  – Food preparation techniques
  – 3 day food record
    • 2 weekdays, 1 weekend with food frequency list
    • Underreporting
Physical Activity Assessment

• Scheduled vs. Lifestyle
  – Barriers to increasing
  – Exercise preferences
    • Child and parents
    • goals

• Time on TV, Computer, video games
Environmental Assessment

- Family composition, SES
- Family schedules, Childcare arrangements
- Food Availability
- School lunch, Al a Carte, Vending Machines, opportunities for PE
- Homework load
- Safety of neighborhood, availability of playgrounds, courts
- Climate and season
Psychosocial Assessment

• Child’s Readiness for lifestyle change
• Family’s Readiness for lifestyle change
  – Stages of readiness
    • Precontemplation- none
    • Contemplation- Intending to change in 6mo
    • Preparation- Intending to change in 1mo
    • Action- Have made changes
    • Maintenance- Well controlled
Laboratory Assessment

- BMI > 85\textsuperscript{th} %tile
  - BP, Cholesterol
- BMI > 95\textsuperscript{th} %tile
  - BP, Fasting lipid profile (Total cholesterol, LDL, HDL, TG) Fasting glucose, A1c, TSH, LFTs, 25OHD level
- BMI > 99\textsuperscript{th} %tile, or Acanthosis Nigricans
  - All above plus fasting Insulin
Pediatric Obesity—Assessment, Treatment, and Prevention: An Endocrine Society Clinical Practice Guideline

Dennis M. Styne, Silva A. Arslanian, Ellen L. Connor, Ismaa Sadaf Farooqi, M. Hassan Murad, Janet H. Silverstein, and Jack A. Yanovski
Treatment

- Decrease fast food
- Decrease table sugar, eliminate sugar-sweetened beverages
- Decrease high fructose corn syrup
- Decrease high-fat, high sodium, or processed foods
- Whole fruit rather than fruit juice
- Portion control education
Treatment

• Decrease saturated fat >2y/o
• Increase fiber, fruits and vegetables
• Timely meals avoid grazing
• Recognize eating cues boredom, stress, loneliness, screen time
• Minimum 20min, goal 60 min moderate to vigorous exercise
• Limit screen time to 1-2 hours per day
Treatment

• Pharmacotherapy for obesity not overweight only after intensive lifestyle changes has failed
• Pharmacotherapy only by clinicians experienced in their use
• Discontinue medication if not effective
Treatment

• Bariatric surgery
  – Tanner 4-5
  – Near or at final adult height
  – BMI >40 or BMI >35 with significant extreme comorbidities
  – Extreme obesity and comorbidities persist despite compliance with formal lifestyle modification +/- pharmacotherapy
  – Stable family unit, no untreated psych illness
Treatment

• Bariatric surgery
  – Patient able to adhere to healthy habits
  – Access to experienced surgeon in pediatric bariatric surgery center of excellence
My Treatment Recommendations

• Avoid shopping for foods that you don't want your child to eat.
• Stop all soda, fruit juice, milk and any other calories that come in liquid form (smoothies, coffees etc).
• May use green juice that has less than 100Kcal per serving (this is a good substitute for a snack).
My Treatment Recommendations

• Use plant based milk for cereal but not to drink (flax, soy, almond)
• Increase vegetables, fruits, beans. Have fish once a week.
• Reduce all meat (beef, pork, chicken etc.) intake to 2-3 times a week
• Replace all white foods (bread, pasta, rice) with brown foods.
My Treatment Recommendations

• Avoid all packaged snacks.
• Avoid all foods with high fructose corn syrup.
• Avoid eating out more than 1 time per week
• Avoid dessert except once a week (small portion)
• Snacks should be limited to veggies (such as celery, cucumber, carrots) and fruits (with low glycemic index).
My Treatment Recommendations

• Eat breakfast every day (e.g. grits, amaranth, quinoa, buckwheat, millet, or oatmeal no butter), sweeten with stevia and a small amount of honey or maple syrup.

• Replace one meal a day (preferably dinner) with a large salad no meat. Include a large portion of sprouts (sunflower, alfalfa) with the salad. Use olive oil, lemon, vinegar or other low calorie dressing vinaigrette type dressing.
My Treatment Recommendations

• Look up the glycemic index online and choose foods with a glycemic index <30
• Eat dinner early 5-6pm
• Avoid eating after dinner
• Exercise goal is 1h of vigorous exercise every day (find something you love)
• Take Lifestyle exercise opportunities (stairs, bike, walk)
• Monitor weight
Adapt Treatment to Severity

**Mild**
- Weight Maintenance
- Increase Physical activity
- Modest changes in meal plan

**Moderate**
- Weight loss
- Specific Diet
- Self Monitoring
- Family participation
- Exercise prescription
- 1-2x / m follow-up
- Consider meds*

**Severe**
- Morbid obesity (>99th Percentile and complications)
- Intense 12 week interdisciplinary intervention
- More rigorous family involvement
- PSMF, low Carb*
- Pharmacotherapy*
- Surgery*
Adapt Treatment to Severity
Weight gain/loss goals

Assumptions
110 lbs at age 9
Completes growth
At age 15
No weight gain
After age 15
Goal weight 160lb
50lbs in 6 years
No more than 8 lbs per year
How Hard is it?

- It is variable
- Prevention is generally easy with minimal targeted changes
- Treatment to achieve normal rate of weight gain is a “C” effort
- Treatment to achieve slower than normal weight gain in a growing child or no weight gain in a fully grown adolescent is a “B-C” effort
- Treatment to achieve no weight gain in a growing child or weight loss in a fully grown adolescent is an “A” effort
- Maintenance of weight loss is an “A+” effort