disclosures

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Drugs and devices unapproved by
the FDA will be discussed

I have no financial or other conflicts of interest
LEARNING OBJECTIVES

At the end of this activity, participants will be able to...

- Define pediatric obesity
- Recognize the many factors leading to obesity
- Identify the co-morbidities associated with obesity
- Evaluate the pediatric patient with obesity
Prevalence of Overweight and Obesity among Low-Income U.S. Children 2 to 5 Years of Age Who Are Enrolled in Federally Funded Health Programs.

The Financial Costs of Childhood Obesity

- Incremental lifetime medical cost of an obese child relative to a normal weight child who maintains weight throughout adulthood: $16,310 - $19,350.

### Old Definition | New Definition | BMI percentile
---|---|---
Overweight | Obese | > 95<sup>th</sup> percentile
At risk of overweight | Overweight | 85<sup>th</sup>-95<sup>th</sup> percentile

### Definitions of Severe/Extreme/Morbid Obesity

<table>
<thead>
<tr>
<th>Class</th>
<th>BMI percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&gt;95&lt;sup&gt;th&lt;/sup&gt; percentile to &lt;120% of 95&lt;sup&gt;th&lt;/sup&gt; centile</td>
</tr>
<tr>
<td>2</td>
<td>&gt;120&lt;sup&gt;th&lt;/sup&gt; percentile to &lt;140% of 95&lt;sup&gt;th&lt;/sup&gt; centile</td>
</tr>
<tr>
<td>3</td>
<td>&gt;140&lt;sup&gt;th&lt;/sup&gt; percentile of 95&lt;sup&gt;th&lt;/sup&gt; centile</td>
</tr>
</tbody>
</table>
PREVALENCE OF OBESITY AND SEVERE OBESITY IN US CHILDREN (2-17 YRS), 1999-2014

OBESITY BMI GROWTH CHART, GIRLS 2-19 YRS

PREVALENCE OF SEVERE OBESITY BY ETHNICITY, 2-19 YR OLD 2011-2014

Extreme Obesity, BMI ≥ 120% of 95th %ile

Incident obesity between ages 5-14 years was more likely to have occurred at earlier ages.... and just “gets worse”.

### Relation of Childhood BMI to Adult Obesity

<table>
<thead>
<tr>
<th>N</th>
<th>Childhood</th>
<th>Adulthood ($X_{age} = 26 \pm 5\text{yr}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BMI%ile</td>
<td>Age</td>
</tr>
<tr>
<td>1161</td>
<td>0 - 49</td>
<td>13 ± 2</td>
</tr>
<tr>
<td>832</td>
<td>50 - 84</td>
<td>12 ± 2</td>
</tr>
<tr>
<td>130</td>
<td>85 - 89</td>
<td>13 ± 2</td>
</tr>
<tr>
<td>121</td>
<td>90 - 94</td>
<td>12 ± 2</td>
</tr>
<tr>
<td>122</td>
<td>95 - 98</td>
<td>13 ± 2</td>
</tr>
<tr>
<td>26</td>
<td>$\geq99$</td>
<td>12 ± 3</td>
</tr>
</tbody>
</table>

Values are mean ± SD.

Risk Factors for Pediatric Obesity

- Parental and family obesity
- Increased intake of sugar-sweetened beverages, fast food, & processed food
- Decreased physical activity
- Increased screen time
- Shorter sleep duration
- Parental stress
- Mother’s pre-pregnancy BMI & gestational weight gain
- High birth weight and rapid infant weight gain
Genetics of Obesity

Single nucleotide polymorphism in an obesity susceptibility gene

Dietary Fats
Dietary Carbohydrates
Unknown Factors
Psychological
Sociological
Physical Inactivity

Positive energy balance responsible for weight gain
Hereditability of BMI is approximately 70%

Although monogenic obesity is rare, several genes have been associated with obesity.

Syndromes associated with obesity include Prader-Willi and Bardet-Biedl Syndromes.

Genes include leptin, leptin receptor, & melanocortin 4 receptor.

Common phenotypic features include markedly increased appetite, reduced duration of satiety, & increased food-seeking behavior.

? Neurobehavioral effect

O’Rahilly S. Clin Med 2016;16:551
Congenital Leptin Deficiency

3-year-old weighing 42 kg  
7-year-old weighing 32 kg

O’Rahilly S. Clin Med 2016;16:551
COMORBIDITIES ASSOCIATED WITH PEDIATRIC OBESITY
MEDICAL COMPLICATIONS OF OBESITY IN CHILDHOOD

- Abnormal Glucose metabolism
- Insulin resistance
- Acanthosis nigricans
- Type 2 diabetes
- Hypertension
- Hyperlipidemia
- Metabolic Syndrome
- Polycystic ovarian disease
- Nonalcoholic fatty liver disease
- Sleep apnea
- Pseudotumor cerebri
- Cholelithiasis
- Psychosocial complications
- Orthopedic complications
- Focal segmental glomerulosclerosis
Prevalence of Abnormal Values by Weight Category, 3-19 yrs of age

Skinner AC et al. NEJM 2015;373;:1307-1317
Changing Incidence: Type 2 DM and Obesity

Alberti G et al. Diabetes Care 27,#7:1798-1811, 2004
Polycystic Ovary Syndrome

- Heterogeneous familial disorder characterized by hyperandrogenism and chronic anovulation.
- In adolescent girls, persistent menstrual irregularity beyond 2 years after menarche or primary amenorrhea with complete puberty may suggest androgen excess.
- Insulin resistance and obesity are common features. But, they should not be used as diagnostic criteria for PCOS.

Insulin Resistance

A. Healthy
- Energy intake
- Adipose storage capacity
- Adipocyte stored triglyceride
- Energy expenditure

B. Obese insulin resistant
- Increased energy intake
- Decreased energy expenditure

C. Non-obese insulin resistant
- Limited adipose storage capacity
Prevalence Metabolic Syndrome: Adolescents (12-19yrs), NHANES III

N=1960

N=2340

**deFerranti SD. et al. Circulation 110:2494-2497, 2004
Body-Mass Index (BMI) z Score (N=477)
Children (4-11ys), RCT x 18 Mos, SSB vs no SSB

- Study in Netherlands
- Primarily normal weight children
- Beverages distributed at school
Results of randomized trials of treatments for pediatric obesity

Interventions

**Pharmacological interventions**
- Sibutramine
- Orlistat
- Metformin

**Dietary interventions**

**Physical activity interventions**
- Effect on BMI
- Effect on fat mass

**Combined lifestyle interventions**
- Targeting family
- Targeting children

Favors intervention

<table>
<thead>
<tr>
<th>Interventions</th>
<th>SMD (95% CI)</th>
</tr>
</thead>
<tbody>
<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>Dietary interventions</td>
<td>-0.22 (-0.56, 0.11)</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>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>

Sibutramine resulted in a relevant increase in both systolic and diastolic pressure and was withdrawn from the US market because of an increased risk of serious cardiovascular events.

Metformin appears to have similar minimal weight loss effects as in adults and should only be used in children aged ≥10 years.

Orlistat remains the only FDA-approved drug for treatment of childhood obesity for those aged ≥12 years.
Bariatric Surgery

Adjustable Gastric Band
Roux-en-Y Gastric Bypass
Sleeve Gastrectomy
Bariatric surgery

- Bariatrics: a branch of medicine that deals with the treatment of obesity.

**Malabsorptive procedures**
- Restriction of absorption in GI tract
- Rarely used due to lifelong management and complications
- Biliopancreatic diversion with Duodenal switch

**Restrictive procedures**
- Restriction of food intake
- **Vertical banded Gastroplasty** (Stomach Stapling)
- Adjustable Gastric Band
- Sleeve Gastrectomy

**Combination procedures**
- Weight loss both through restriction of intake and absorption
- **Roux-en-Y Gastric Bypass**

http://www.homerton.nhs.uk/uploaded_files/Our_services/duodenal_switch_illus.jpg
http://www.overcomingobesity.net/adjustable-gastric-bANDING.cfm
Vertical Sleeve Gastrectomy

http://www.winh.org/bariatric-surgery
# Outcome Adolescent Bariatric Surgery

<table>
<thead>
<tr>
<th>Study</th>
<th>Years follow-up (range)</th>
<th>% in analysis (N/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dillard (2007)</td>
<td>1.0 (1.0-1.0)</td>
<td>58% (14/24)</td>
</tr>
<tr>
<td>Yitzhak (2006)</td>
<td>3.1 (2.1-5.4)</td>
<td>100% (60/60)</td>
</tr>
<tr>
<td>Silberhumer (2006)</td>
<td>2.9 (0.3-7.2)</td>
<td>100% (50/50)</td>
</tr>
<tr>
<td>Angrisani (2005)</td>
<td>3.0 (3.0-3.0)</td>
<td>64% (37/58)</td>
</tr>
<tr>
<td>Fielding (2005)*</td>
<td>1.7 (1.0-2.0)</td>
<td>100% (17/17)</td>
</tr>
<tr>
<td>Abu-Abid (2003)</td>
<td>1.9 (1.0-3.0)</td>
<td>91% (10/11)</td>
</tr>
<tr>
<td><strong>AGB</strong></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Study</th>
<th>Years follow-up (range)</th>
<th>% in analysis (N/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collins (2007)*</td>
<td>1.8 (1.7-1.8)</td>
<td>75% (3/4)</td>
</tr>
<tr>
<td>Lawson (2007)</td>
<td>1.0 (1.0-1.0)</td>
<td>77% (30/39)</td>
</tr>
<tr>
<td>Sugerman (2003)</td>
<td>5.0 (5.0-5.0)</td>
<td>61% (20/33)</td>
</tr>
<tr>
<td>Strauss (2001)</td>
<td>6.3 (1.0-13.0)</td>
<td>90% (9/10)</td>
</tr>
</tbody>
</table>

**RYGB**

**Pooled estimate (I²=56%):**

**Pooled estimate (I²=0%):**

<table>
<thead>
<tr>
<th>Change in BMI after surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>-35</td>
</tr>
</tbody>
</table>

BMI > 85th percentile

History and physical examination

- Abnormal
  - Additional evaluations based on findings
    - Attenuated growth velocity
    - Neuro-developmental abnormalities

- Normal
  - Evaluate for obesity co-morbidities
    - Present
      - Anti-psychotic drug use
        - Reevaluate drug therapy/choice
          - Initiate lifestyle changes and specific treatment of co-morbidity
            - Continued weight gain > 6 months
              - Consider pharmacotherapy and/or surgery
                - Data supporting use of these interventions are limited to pubertal individuals
            - Weight loss or stabilization
              - Maintain support for lifestyle changes and co-morbidity treatment
        - Initiate lifestyle changes
    - Absent
  - Evaluate for obesity co-morbidities
Childhood obesity is associated with family, community, racial, and SES factors in addition to sugared beverage intake, physical activity level, and sedentary activity.

Obesity and extreme obesity have increased over the past 3 decades particularly among African American and Hispanic Youth.

**Obesity in childhood tracks into adult life.**

Comorbidities include diabetes, hypertension, dyslipidemia, PCOS, and metabolic syndrome.

Prevalences of these comorbidities have increased in children and adolescents.
Summary (2)

*Lifestyle interventions* focused on the family and including both dietary and physical activity changes have therapeutic efficacy in reducing obesity but of small effect (approx. 3 to 4 Kg on average).

There are *limited pharmacological agents* currently available for use in the pediatric population and their efficacy above and beyond lifestyle intervention is marginal at best.

*Surgical interventions* have proven to be most effective for extremely obese pediatric patients.
Prevention (BMI 5th to 85th %ile)

Dietary Intake
- Limit consumption of sugar sweetened beverages
- Encourage 5-a-day fruits and vegetables

Physical Activity
- Limit screen time to 1-2hrs/day starting age 5yrs
- No TV/computer screens in bedroom
- Encourage 60min moderate to vigorous physical activity/day

Eating Behaviors
- Daily breakfast
- Limit restaurant eating
- Encourage family meals
- Limit portion size

Barlow SE. Pediatrics 2007; 120, Suppl #4: S164-S192
Role of Primary Care Physician

✓ Measure height and weight and calculate BMI at least annually

✓ Observe for trends such as rapid weight gain

✓ Offer anticipatory guidance about nutrition and physical activity at every well child check

✓ Help families make better food choices

✓ Advocate for children on local, state, and national levels

Interventions

• Stage 1: Prevention program
  + General recommendations + monthly follow-up
  + Target: **Weight maintenance**

• Stage 2: Structured weight management program (failed prevention+)
  + Balanced macronutrient diet,
  + Supervised **active play** of 60 min/day,
  + Decreased screen time ≤ 1 hr/day
  + Target: **Weight loss** 1 lb/month in 2-11 yr olds,
    maximum 2 lbs/week in older obese children and adolescents

Barlow SE. Pediatrics 2007; 120, Suppl #4: S164-S192
Conclusions (1)

Lifestyle interventions are the cornerstone of all therapeutic interventions for obesity in childhood.

Recognition of comorbidities in children with obesity demands both a therapeutic intervention for the comorbidity as well as targeting the obesity.

Pharmacotherapy and surgical interventions are currently recommended only for those who have failed lifestyle approaches and continue to gain weight at an accelerated rate.
Conclusions (2)

**Given our limited armamentarium for treating obesity, prevention represents the best course to control the epidemic.**

Research into non-surgical interventions to treat those children already obese is an important unmet need.
Conclusions (3)

Successful lifestyle change requires family interventions with community advocacy to support those changes.

- Shared agreements for use of physical activity spaces
- Establishing/maintaining recess and gym classes
- Subsidies for schools to provide healthy foods
- Menu labeling in restaurants
- Laws addressing food advertising to children
- Food and beverage industry incentives

A collective responsibility requiring

individual
family
physician
community
corporate
government

COMMITMENT
THANK YOU

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