CHILDHOOD OBESITY

Impact on Metabolic Health

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DISCLOSURES

None of the planners or presenters of this session have disclosed any conflict or commercial interest
Childhood Obesity

• OBJECTIVES:
  1. Review the assessment of obesity in children and adolescents
  2. Discuss appropriate diagnostic testing for obesity and other risk factors
  3. Discuss management strategies for obese children and adolescents including lifestyle and pharmacologic interventions.
Aims

- Aware of the metabolic diseases associated with childhood obesity
- Initial therapeutic lifestyle changes
  - Nutritional interventions
  - Exercise expectations
- Medications available
DEFINITION

• Obesity is defined as the abnormal or excessive fat accumulation in the body that may impair health.

• Many professional societies and organizations have accepted obesity as a disease and have adopted algorithms and guidelines for clinicians.

• ASBP algorithm defines obesity as “…a chronic, relapsing, multi-factorial, neurobehavioral disease, wherein an increase in body fat promotes adipose tissue dysfunction and abnormal fat mass physical forces, resulting in adverse metabolic, biomechanical, and psychosocial health consequences.”

• American Association of Clinical Endocrinologists recognize “…obesity is a primary disease, … the prevention and treatment of obesity as a primary disease entity.”
WHY OBESITY IS A DISEASE

• It is associated with impaired body function

• Like other diseases, it results from physiological dysfunction (precipitated by numerous forces in modern society)

• It causes, exacerbates or accelerates more than 150 significant comorbid diseases

• It is associated with a substantial burden of morbidity and premature death
According to the most recent data released September 2015, rates of obesity now exceed 35 percent in three states:

- Arkansas (has the highest adult obesity rate at 35.9 percent)
- West Virginia
- Mississippi

22 states have rates above 30 percent

45 states are above 25 percent

Every state is above 20 percent (Colorado has the lowest at 21.3 percent)
LATEST AVAILABLE STATISTICS

• Approximately 17 percent of children and teenagers (ages 2 to 19) were obese from 2011 to 2012, and 31.8 percent were either overweight or obese.
LATEST STATISTICS

• West Virginia has the highest rate of diabetes at 14.1 percent.

• Nine of the 10 states with the highest type 2 diabetes rates are in the South.

• The CDC projects that one-in-three adults could have diabetes by 2050.

• Diabetes rates have nearly doubled in the past twenty years — from 5.5 percent in 1988 to 1994 to 9.3 percent in 2005 to 2010.¹

• More than 29 million American adults have diabetes and another 86 million have prediabetes.
MAKING SOME PROGRESS

• The 2011 National Survey of Children's Health (NSCH) found obesity rates for children ages 10 to 17 ranged from a low of 9.9 percent in Oregon to a high of 21.7 percent in Mississippi.

• The prevalence of obesity among 2- to 4-year-old children from low-income families increased from 12.7 percent in 1999 to 14.4 percent in 2011.

• However, during 2008 to 2011, 18 states and the U.S. Virgin Islands had a statistically-significant decrease and only three states increased during this time.

- Non-Hispanic white
- Non-Hispanic black
- Mexican American

NOTE: Obesity is defined as body mass index (BMI) greater than or equal to sex- and age-specific 95th percentile from the 2000 CDC Growth Charts.


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2011 State Prevalence Among Low-Income Children Aged 2 to 4 Years
Obesity is a Worldwide epidemic
Obesity is a Worldwide epidemic
DEFINITION IN PEDIATRICS

Overweight: \( \text{BMI} \geq 85^{\text{th}} \) percentile for age and sex

Obesity: \( \text{BMI} \geq 95^{\text{th}} \) percentile for age and sex

Severe obesity (morbid obesity): \( \text{BMI} \geq 99^{\text{th}} \) percentile for age and sex
DEFINITION IN PEDIATRICS

Proposed Obesity Classes based on the percentile of the 95th percentile BMI.

- Class I  \( \leq 95\% \) of the 95th percentile BMI
- Class II \( \geq 95\% \) to \( \leq 120\% \) of the 95th percentile BMI
- Class III \( \geq 120\% \) to \( \leq 140\% \) of the 95th percentile BMI
- Class IV \( \geq 140\% \) of the 95th percentile BMI or BMI \( \geq 40 \)
Girls BMI - Percent of the 95th Percentile (Girls, 2-20 years)

BMI (kg/m²) vs Age (years)

Source: BMI table from CDC. Obese BMI curves are calculated as the percent of the 95th percentile, e.g. 150% is 1.5 x 95th.
Boys BMI - Percent of the 95th Percentile (Boys, 2-20 years)

Source: BMI table from CDC. Obese BMI curves are calculated as the percent of the 95th percentile, e.g. 150% is 1.5 x 95th.
Signs of Progress on Childhood Obesity in New Hampshire

- A report released by the Centers for Disease Control and Prevention (CDC) in August, 2013 showed that 18 states, including New Hampshire, and one U.S. territory experienced a decline in obesity rates among 2- to 4-year-olds from low-income families between 2008 and 2011.

- Over that period, New Hampshire's rate fell from 15.5% to 14.6%, a statistically significant decrease according to the CDC analysis.

- State reports 5.8 percent decline in obesity among preschool children from low-income families.
Childhood Obesity

2- to 4-year-olds from low-income families
Current obesity rate (2011) 14.6%
Rank among states (2011) 12/41

10- to 17-year-olds
Current obesity rate (2011) 15.5%
Rank among states (2011) 19/51

High school students
Current obesity rate (2013) 11.2%
Rank among states (2013) 32/43

Source: stateofobesity.org
STATISTICS IN NH 2010

Current Obesity Risk Factors

Inadequate Physical Activity
- Children, 6-17 years old: 71.0%
- High school students: 53.1%
- Adults: 46.0%

Excessive Television Viewing
- Low income children, 2 to 5 years old: 12.7%
- High school students: 25.1%

Inadequate Fruit and Vegetable Consumption
- High school students: 77.7%
- Adults: 71.5%
Associated Diseases

- Metabolic
- Structural
- Inflammatory
- Degenerative
- Neoplastic
- Psychological
ASSOCIATED DISEASES

Endocrine:
- Type 2 diabetes
- Prediabetes
- Insulin resistance
- PCOS
- Metabolic syndrome

Liver:
- NAFLD
- NASH

Cardiovascular:
- Dyslipidemia – Low HDL-C, High LDL-C
- hypertriglyceridemia
- Hypertension
- Hypertrophy of right ventricle

Pulmonary:
- Reactive airway disease
ASSOCIATED DISEASES

Neurological:
• Obstructive sleep apnea
• Pseudotumor cerebri

Gastrointestinal:
• GERD
• Constipation
• Vitamin D deficiency
• Hepatitis B non-converter

Elevated CRP
• A cardiovascular disease marker

Psychological
• Lower self-esteem
• Less popular with their peers
COMPLICATIONS OF OBESITY

**Mechanical burden:**
- Musculoskeletal issues
  - Osteoarthritis
- Sleep apnea
NORMAL PHYSIOLOGY OF ENERGY BALANCE

• Average adults require approximately 1300 kcal/day*
• Average adults consume 2000-2500 kcal/day
• Average adults thus consume 1.5-2 times as much food as needed
• Excess intake is available for physiological emergencies
• Maintenance of normal fat stores (and body weight) requires precise disposal of 40-50% of ingested calories daily
• Maintaining weight within 20 lbs. between ages 21 and 65 requires matching of intake and expenditure within 0.2%
  • Corresponds to accuracy of 4-5 kcal/day
  • Less than one-half potato chip
• Daily energy balance must be a tightly regulated physiological trait

• The body maintains a stable adipose tissue mass

• Obesity results from a failure of normal weight and energy regulatory mechanisms…leading to an elevated body fat set point
ENERGY REGULATING HORMONES

- Ghrelin
- Leptin
- GLP-1
- PYY
- CCK
COMPLICATIONS OF OBESITY

Insulin Resistance

- Unclear pathophysiology
- Decrease insulin receptor number and response to insulin
- Results in increased insulin secretion to maintain normal glucose and lipid homeostasis – leads to hyperinsulinemia
COMPLICATIONS OF OBESITY

Hyperinsulinemia

Leads to

- Decrease glycogen production in liver
- Decrease glucose uptake by muscle cells
- Increase lipase active in fat cells
  - Increase free fatty acid circulation ➔ ↑TG

Overall, blood glucose rises.
COMPLICATIONS OF OBESITY

Insulin Resistance

• Progresses to T2DM as compensation fails

• Children with T2DM tend to move rapidly to need insulin replacement therapy
COMPLICATIONS OF OBESITY

Acanthosis Nigricans

- Acanthosis nigricans is a skin disorder in which there is darker, thick, velvety skin in body folds and creases
  - Axilla, back of neck, antecubital fossa

- Useful physical sign of insulin resistance
COMPLICATIONS OF OBESITY

Definitions

• Impaired fasting glucose:
  • Fasting blood glucose 100 mg/dl to 125 mg/dl

• Impaired glucose tolerance:
  • 2-h plasma glucose 140 mg/dl to 199 mg/dl in the OGTT using 1.75 gm/kg of glucose.
COMPLICATIONS OF OBESITY

Definitions

• Prediabetes:
  • Impaired fasting glucose
  • Impaired glucose tolerance
  • A1c 5.7% to 6.4%
COMPLICATIONS OF OBESITY

Definitions

• Type 2 Diabetes Mellitus (T2DM):
  • A1C ≥ 6.5%
  • FPG ≥ 126 mg/dl
  • 2-h plasma glucose ≥ 200 mg/dl
  • Random plasma glucose ≥ 200 mg/dl
COMPLICATIONS OF OBESITY

Polycystic Ovarian Syndrome (PCOS)

- Clinical or biochemical evidence of hyperandrogenism
  - Severe acne
  - Hirsutism
  - Elevated free testosterone
- Amenorrhea or oligoamenorrhea
- Elimination of other diagnoses which can cause the same clinical picture - late onset congenital adrenal hyperplasia, virilizing tumor (rare)
Modified Ferriman-Gallwey scoring system.
Polycystic Ovarian Syndrome (PCOS)

- Complications:
  - Higher incidence of all the above mentions issues
  - Cancer of the uterine lining (endometrial cancer), caused by exposure to continuous high levels of estrogen
  - Gestational diabetes or pregnancy-induced high blood pressure
Non alcoholic fatty liver disease (NAFLD)

• Most common reason for elevated liver transaminases in children

• NAFLD has emerged as the leading cause of chronic liver disease in children and adolescents in the United States

• Prevalence ~3% of all children – much higher in BMI > 95%tile

• NAFLD aggregates in families
COMPLICATIONS OF OBESITY

Non alcoholic fatty liver disease

- Higher in adolescents than younger children
- NAFLD is more common in boys than girls
- NAFLD is more common in Mexican Americans than Caucasian Americans
- More common in young adults from Asian-Indian and Asian-American descent
COMPLICATIONS OF OBESITY

Non alcoholic fatty liver disease

- Progression:

  Fatty liver ➔ Inflammation ➔ Fibrosis ➔ Cirrhosis

  ➔ Hepatocellular Carcinoma in a subset

- Progression maybe rapid in children
COMPLICATIONS OF OBESITY

Non alcoholic fatty liver disease

- Difficult to stage without a liver biopsy
- ALT is not well correlated with level of fibrosis or cirrhosis
- Waist circumference maybe a better marker of disease progress/severity
<table>
<thead>
<tr>
<th></th>
<th>Baseline biopsy JAN 2009</th>
<th>Follow up Biopsy APRIL 2011</th>
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<tbody>
<tr>
<td>Age (years)</td>
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<td>BMI %ile</td>
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<tr>
<td>Waist (cm)</td>
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<td>HDL cholesterol</td>
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<td>AST</td>
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<td>GGT</td>
<td>43</td>
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<td>Hgb A1C (on metformin)</td>
<td>4.7</td>
<td>5.1</td>
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<td>Fasting glucose</td>
<td>100</td>
<td>107</td>
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</table>
COMPLICATIONS OF OBESITY

Non alcoholic fatty liver disease

- Feldstein et al reported a long-term study in 66 children from Mayo Clinic with NAFLD
  - The average age and BMI were 14 years and 31 kg/m², respectively
  - At baseline visit, 40% had no fibrosis and 60% had some fibrosis. 2 children had cirrhosis
  - These children with NAFLD had 13.6 higher odds of mortality or needing a liver transplant as compared to age-sex-matched controls from the general Minnesota population
COMPLICATIONS OF OBESITY

Non Alcoholic Fatty Liver Disease (NAFLD)

- ALT, AST and liver ultrasound are poor indicators of fibrosis
- Liver biopsy is the only accurate method to determine fibrosis/cirrhosis
- No specific therapy other than lowering BMI. Therefore biopsies tend to be limited in cases to exclude other treatable causes
- Vitamin E no longer recommended
COMPLICATIONS OF OBESITY

Metabolic Syndrome

• Adults with metabolic syndrome
  • Two to three times as likely to have a heart attack or stroke
  • Five times as likely to develop type 2 diabetes

Compared with people without the syndrome
COMPLICATIONS OF OBESITY

Metabolic Syndrome

• No clear definition in pediatrics

• Important to develop a definition to be able to study outcome

• The International Diabetic Federation (IDF) has suggested a definition
## Metabolic Syndrome

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>Obesity - Waist Circumference</th>
<th>Triglycerides</th>
<th>HDL-C</th>
<th>Blood Pressure (mm Hg)</th>
<th>Glucose mg/dL or known T2DM</th>
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<tbody>
<tr>
<td>6 ≤ 10</td>
<td>≥ 90th percentile</td>
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<td></td>
<td>or adult cut-off if lower</td>
<td>≥ 150 mg/dL</td>
<td>&lt; 40 mg/dL</td>
<td>Systolic ≥ 130</td>
<td>Diastolic ≥ 85 mm Hg</td>
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<td>10 ≤ 16</td>
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</table>
| >16               | Use existing IDF criteria for adults, ie: Central obesity with any two of the following four factors:  
|                   | • Raised triglycerides: ≥ 150 mg/dL  
|                   | • Reduced HDL-cholesterol: < 40 mg/dL and < 50 mg/dL in females  
|                   | • Raised blood pressure: systolic ≥ 130 or diastolic ≥ 85 mm Hg  
|                   | • Impaired fasting glycemia: fasting plasma glucose ≥ 100 mg/dL or previously diagnosed type 2 diabetes |
# Lipid Panel

<table>
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<th>Lipid Panel</th>
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<th>Borderline</th>
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<td>less than 170</td>
<td>170-190</td>
<td>200 or greater</td>
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<td>LDL cholesterol &quot;bad&quot; (mg/dL)</td>
<td>less than 110</td>
<td>110-129</td>
<td>130 or greater</td>
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<tr>
<td>HDL cholesterol &quot;good&quot; (mg/dL)</td>
<td>45 or greater</td>
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<tr>
<td>Triglycerides (mg/dL)</td>
<td>150 or less</td>
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</table>
Dyslipidemia in Obesity

- Commonly seen with insulin resistance
  - ↑ TG
  - ↓ HDL-C
  - ↑ LDL-C moderately
Research has shown that treatment for overweight and obesity is more likely to be successful in childhood than in adolescence or adulthood (Styne, 2001)
TREATMENT

PREVENTION
TREATMENT

PREVENTION

- Obesity in childhood, particularly in adolescence, is a key predictor for obesity in adulthood
  - Persistence of pediatric obesity into adulthood increases according to the age at which obesity is initially present.  *Goran, M. I. (2001)*

- Morbidity and mortality in the adult population is increased in individuals who were overweight in adolescence, even if they lose the extra weight during adulthood.  *Must, A., Jacques, P. F., Dallal, G. E., Bajema, C. J., Dietz, W. H. (1992).*
TREATMENT

Therapeutic Lifestyle Intervention

- Change in diet, eating habits
  - Less calories, balanced nutrition

- Change in activity level
TREATMENT

Specifics

• **Lower carbohydrates** to ≤ 50% of total calories

  • Achieved by following [www.choosemyplate.gov](http://www.choosemyplate.gov)
  • Healthy diet high in vegetables, fruit and whole grain
  • low fat dairy
  • Limited but required protein portion
New WHO and USDA recommendations:

USDA
• Limit added sugar to < 10% of total calories

WHO
• Limit added sugar to < 5% of total calories
TREATMENT

Added sugar – processed foods

- regular soft drinks, energy drinks, and sports drinks
- candy
- cakes
- cookies
- pies and cobblers
- sweet rolls, pastries, and donuts
- fruit drinks, such as fruitades and fruit punch,
- dairy desserts, such as ice cream, yogurts, smoothies

http://www.choosemyplate.gov/what-are-added-sugars
COMPLICATIONS OF OBESITY

Treatment Specifics

• More specific carbohydrate education
  • Nutrition label reading
  • Following portion sizes

• Carb counting – with dietitian
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<th>Activity level</th>
<th>MALES</th>
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<th>FEMALES</th>
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<td>76 and up</td>
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</table>
Treatment Specifics

• Moderate to vigorous physical exercise

As explained to a patient:

• Feels somewhat hard. Here are clues that your exercise intensity is at a moderate level:
  • Your breathing quickens, but you're not out of breath.
  • You develop a light sweat after about 10 minutes of activity.
  • You can carry on a conversation, but you can't sing.
COMPLICATIONS OF OBESITY

Treatment Specifics

• Smoking avoidance or cessation
  • Offer a smoking cessation program
Treatment Specifics

PCOS

• Induce menstrual period
• Low-dose birth control pills that contain a combination of synthetic estrogen and progesterone.
  • Decrease androgen production
• Reduce excessive hair growth
  • May add spironolactone - blocks the effects of androgens on the skin
COMPLICATIONS OF OBESITY

Treatment Challenges

There are only two things that prevent me from losing weight.

What are they?

Diet and exercise.
COMPLICATIONS OF OBESITY

Treatment Challenges

Misconceptions

“Good cholesterol comes from ice cream, cheeseburgers, and pizza. Bad cholesterol comes from tofu, broccoli, and spinach!”
COMPLICATIONS OF OBESITY

Treatment Challenges

The adolescent
- Not invested or engaged in wanting to make changes to lifestyle
- “immortality”
  - All potential issues are far off in the future
- Depression
  - Prevalence of major depressive disorder has been estimated to be 2% of children and 4-8% of adolescents
COMPLICATIONS OF OBESITY

Treatment Challenges

Family influences
- Parental activity level, eating habits – teaching by example
- Socioeconomic
- Genetics
- Parental obesity
COMPLICATIONS OF OBESITY

Treatment Specifics

• Look and treat other complicating factors
  • Obstructive sleep apnea
    • Difficult to lose weight if not treated
  • Poorly controlled asthma
    • PFTs, controller medication
• Orthopedic issues
  • Physical therapy
COMPLICATIONS OF OBESITY

Treatment Specifics

• Look and treat other complicating factors
  • Depression
  • Being bullied
  • Illiteracy
Treatment Medications:

**Metaformin**

- Consider in:
  - very elevated insulin level
  - Inability to lose weight despite exercise and nutrition modification
  - Prediabetes – A1c > 6.0%
  - NASH
COMPLICATIONS OF OBESITY

Treatment Medications:

Statin:

- FDA ≥ age 8.
- Clinical trials with medium term follow up suggest safety and efficacy of statins in children.
- Consider if LDL-C ≥ 190 mg/dL despite therapeutic lifestyle modifications or if 160 mg/dL with other factors.
- Goal is LDL-C <130 mg/dL.
- More aggressive LDL cholesterol targets should be considered for those with additional CHD risk factors.
TREATMENT

Orlistat

- Only medication FDA approved in the pediatrics population
- Lipase inhibitor reducing calorie absorption
- Modest weight loss
- Shown to slow progression to T2DM
- Decrease blood pressure

- High unpleasant side effect
  - Steatorrhea

- OTC available
TREATMENT

Topiramate

- Anticonvulsant
- Treatment of:
  - epilepsy and migraines
  - alcoholism, cocaine and methamphetamine addiction
  - Smoking cessation
- Used to treat pseudotumor cerebri
- Off label use in pediatric obesity
Topiramate

- Used for weight loss
- Qsymia – combination topiramate and phentermine
  - Not FDA approved in children