Childhood Obesity: Chubby Cheeks are No Longer Cute

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Objectives

- At the end of this presentation, the participant will be able to:
  - Describe the statistics and possible causes of childhood obesity
  - Understand the pathophysiology of obesity and its associated anesthetic implications
  - Describe the anesthetic management of the pediatric obese patient
  - Delineate common surgical procedures that obese pediatric patient's may undergo

Childhood obesity

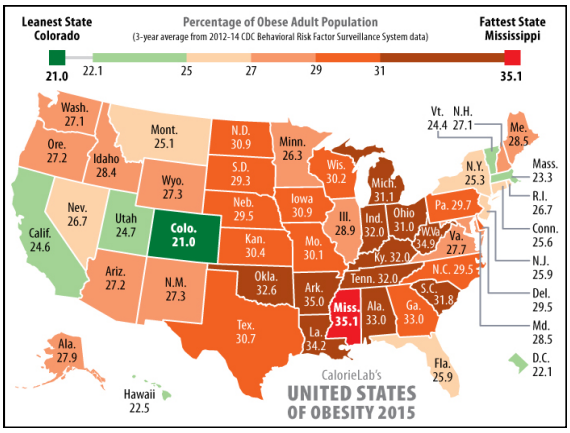
- Major threat to children's health today
- Leads to myriad of co-morbid conditions
- Shown to decrease life expectancy and increase healthcare costs
- Prevalence of childhood obesity increasing at alarming rate
  - Has doubled in past 2 decades in the United States
  - Children and adolescents at or above 95th percentile (obesity) for BMI
    - 15.3% of 6 -11-year-olds
    - 15.5% of 12 – 19-year-olds

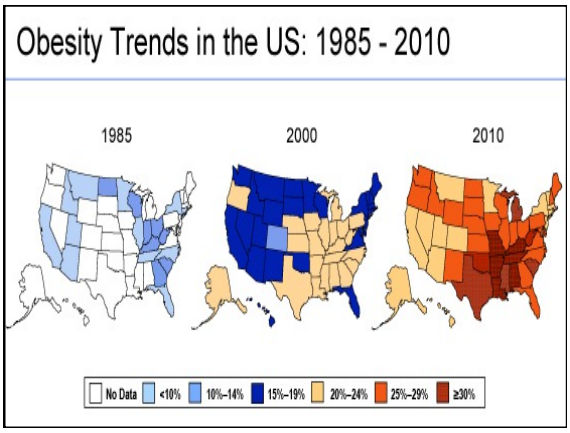
Definitions of overweight and obesity

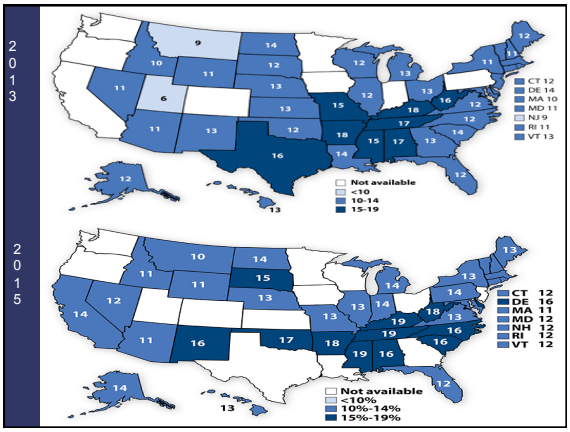
- Overweight and obesity in children and adolescents cannot be measured or defined in the same terms used with adults
- Since children grow at different rates, some think it is not accurate to utilize BMI (body mass index) as a weight indicator
  - Controversy between adiposity and the ratio of weight to height may be looser than adults
- CDC states that the BMI can be utilized effectively for children 2 – 20 years by plotting it on growth charts specific for age and gender

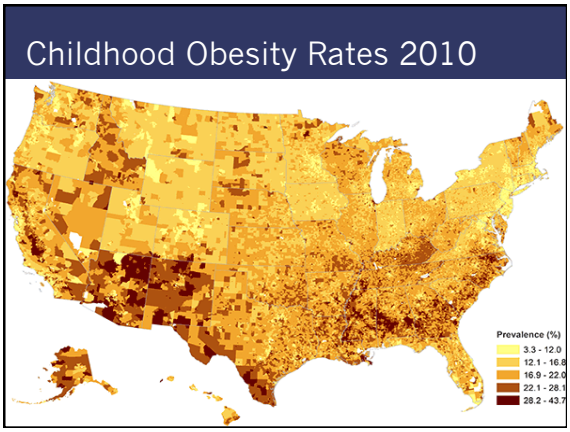
Body Mass Index

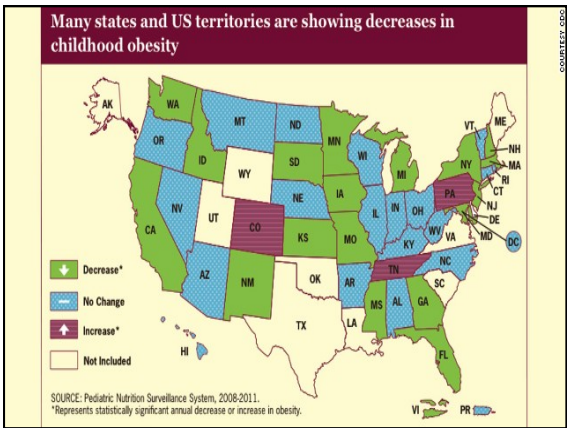
- In correlation with growth charts:
  - BMI > 85th percentile = overweight
    - 21% – 24 % of children and adolescents
  - BMI > 95th percentile = obese
    - 10% – 11% of children and adolescents
      - Consistent with the AMA and NCHS 2010 consensus
- In a retrospective study of charts, the number of overweight children has increased an estimated 50% – 60% in one generation

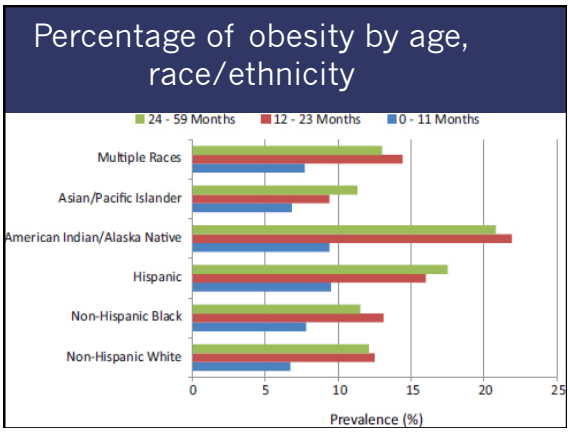

Leanest State
Colorado
Percentage of Obese Adult Population
(3-year average from 2012-14 CDC Behavioral Risk Factor Surveillance System data)
Fattest State
Mississippi
21.0
22.1
25
27
29
31
35.1
Wash. 27.1
Ore. 27.2
Calif. 24.6
Idaho 28.4
Nev. 26.7
Mont. 25.1
Wyo. 27.3
Utah 24.7
Colo. 21.0
Ariz. 27.2
N.M. 27.3
N.D. 30.9
S.D. 29.3
Neb. 29.5
Kan. 30.4
Okla. 32.6
Tex. 30.7
Minn. 26.3
Iowa 30.9
Mo. 30.1
Ark. 35.0
La. 34.2
Wis. 30.2
Ill. 28.9
Mich. 31.1
Ind. 32.0
Ohio 31.0
Ky. 32.0
Tenn. 32.0
Miss. 35.1
Ala. 33.0
Ga. 33.0
Fla. 25.9
S.C. 31.8
N.C. 29.5
Va. 27.7
W.Va. 34.9
Pa. 29.7
N.Y. 25.3
Vt. 24.4
N.H. 27.1
Me. 28.5
Mass. 23.3
R.I. 26.7
Conn. 25.6
N.J. 25.9
Del. 29.5
Md. 28.5
D.C. 22.1
Ala. 27.9
Hawaii 22.5
CalorieLab's
UNITED STATES
OF OBESITY 2015


Obesity Trends in the US: 1985 - 2010
1985
2000
2010
No Data
<10%
10%–14%
15%–19%
20%–24%
25%–29%
≥30%


2013
CT 12
DE 14
MA 10
MD 11
NJ 9
RI 11
VT 13
Not available
<10
10-14
15-19
2015
CT 12
DE 16
MA 11
MD 12
NH 12
RI 12
VT 12
Not available
<10%
10%-14%
15%-19%


Childhood Obesity Rates 2010
Prevalence (%)
3.3 - 12.0
12.1 - 16.8
16.9 - 22.0
22.1 - 28.1
28.2 - 43.7


Many states and US territories are showing decreases in childhood obesity
COURTESY: CDC
Decrease*
No Change
Increase*
Not Included
SOURCE: Pediatric Nutrition Surveillance System, 2008-2011.
*Represents statistically significant annual decrease or increase in obesity.


Percentage of obesity by age, race/ethnicity
24 - 59 Months
12 - 23 Months
0 - 11 Months
Multiple Races
Asian/Pacific Islander
American Indian/Alaska Native
Hispanic
Non-Hispanic Black
Non-Hispanic White
0
5
10
15
20
25
Prevalence (%)

Childhood to adulthood obesity

- Probability of obesity persisting into adulthood estimated to increase from 20% at 4 years of age to 80% by adolescence
- Co-morbidities will also start earlier and become more serious in early adulthood
- Energy intake versus energy expenditure = energy balance
- Complex interplay among genetic, physiologic, metabolic, social, behavioral, and cultural factors

Genetic, physiologic, and metabolic causes

- Recent studies show 25% – 40% of obesity is inherited
- Family history of obesity
  - Just recently focus has changed from environmental to genetic
  - Twin studies show being overweight is a 65-75% inherited trait
- Basal metabolic rate
- Feeding behavior
- Alterations in energy expenditure in response to overfeeding
- Lipoprotein lipase activity
- Basal rate of lipolysis

Genetic, physiologic, and metabolic causes

- Hormones and neurotransmitters regulate satiety, hunger, lipogenesis, and lipolysis
  - Anterior pituitary hormones
    - Growth hormone: 2011 MGH study looked at GH effects on visceral fat and CV markers in obese teenage girls
  - Leptin: satiety hormone
  - Neuropeptide Y: amino acid neuropeptide acts as neurotransmitter in brain; contributes to fat cell growth
  - Melanocortin: G coupled protein receptor; defect responsible for 6% of childhood obesity

Phthalates and Bisphenol A

- Laboratory studies (rats and mice) demonstrated certain chemicals, phthalates and bisphenol A (BPA), found in some plastic toys, and household and personal care products, can interfere with hormone function (endocrine disruption)
- BPA has been shown to increase glucose uptake in mice fat cells, which could be related to development of insulin resistance

Genetic and endocrine causes

- May play a role in dysregulation of energy expenditure versus intake, resulting in weight gain
  - Prader-Willi syndrome
    - Pituitary abnormalities associated with early onset morbid obesity (EMO)
    - Studies: growth hormone may help
  - Bardert-Biedl syndrome
  - Alstrom syndrome
  - Hypothyroidism
  - Cushing's syndrome
  - Mitochondrial dysfunction
    - 2011 MGH study: evaluate the effects of intensive exercise on metabolism

Environmental factors

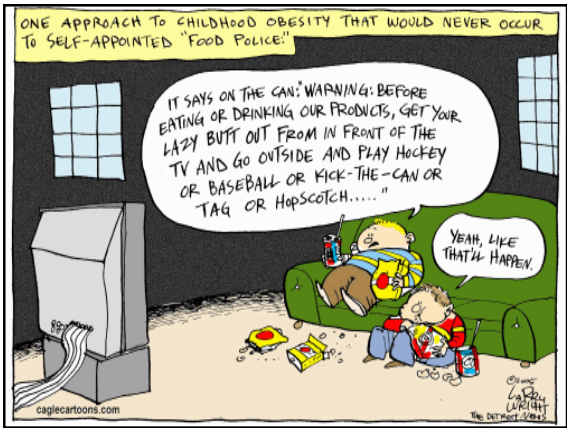
- Home environments with both parents working decreases families eating meals together possibly fostering bad eating habits
- Families that do not provide adequate cognitive stimulation have more than two-fold risk of developing obesity
- Breast feeding has been shown to decrease the propensity towards obesity
- Other dietary factors remain inconclusive
  - Introduction of complementary foods or high protein

Social and behavioral factors

- Lifestyle trends
  - Empty calories at home and school
    - High fructose soft drinks and juices
      - Consumption increased 65% over last decades
    - "Junk" food (sugar and carbohydrate laden snacks); may not contribute as much as previously thought
    - Fast food: accounts for ~30% variance in body weight
  - Larger portions
  - Urbanization of America
    - Children walking and biking to school reduced 40% over past 3 decades
    - Reductions in mandatory school physical education classes further lowers physical activity; only 29% of schools currently have programs

Social and behavioral trends

- Sedentary activities
  - Watching television and playing video games has increased over past decade and correlates with rise in childhood obesity
  - According to American Academy of Pediatrics, children who view TV or play video games for more than 4 hours daily have a significantly increased risk of being overweight
    - Studies show urban areas lack a safe outdoor area to play so children stay inside
    - If they do go outside, urban areas wrought with fast food restaurants

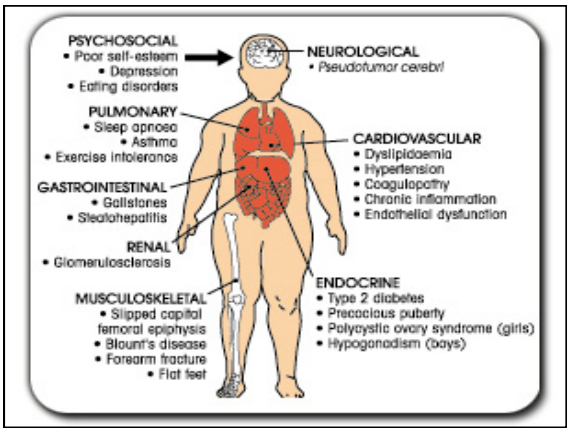


Ethnic and cultural factors

- Rate increasing 47% to 73% faster among African-Americans and Hispanics than among the white population
- American Indian/Native Alaskan twice as obese as white children: 31.2% prevalence
  - Hispanics 22% prevalence
  - African-Americans 20.8% prevalence
  - Whites 15.9% prevalence
  - Asians 12.8% prevalence
- Children < 5 years old across all ethnic groups have the highest percentage increases of obesity

Ethnic and cultural factors

- Low income families have higher percentage of overweight children
  - Poverty rate among African-Americans and Hispanics ~ 3 times higher than the white population
  - Price of fresh fruits and vegetables has increased 54% but soft drinks and high calorie snacks has decreased 22% in last decade



Anesthesia considerations of the pathophysiology of obesity

- Cardiovascular
  - Fatty infiltration of heart may interfere with normal conduction, producing dysrhythmias and conduction blockade
  - Cardiac output doubled to compensate for additional blood vessels required to sustain fatty tissue
    - Must increase 2·3 ml/100g tissue/min and each 13.5 kg (29.7 #) of fat gained requires 25 miles of neovascularization to provide blood flow to fatty tissue→ co increases 0.1 liter/ min/kg of body fat

Cardiovascular considerations

- Increase in total circulating volume, increased pulmonary blood volume, pulmonary hypertension, and ultimately, right ventricular dysfunction
- Hypertension incidence is 10 times higher in obese patient, which also leads to left ventricular dysfunction and hypertrophy
- CHF more common
- Aortocaval compression may occur

Cardiovascular considerations

- Hyperlipidemia
- Dyslipidemia (abnormal levels of fat in blood)
- Vascular disorders
  - Deep vein thrombosis
  - Pulmonary embolism
    - Abnormal arterial function and structure, with an increased intimal-medial thickness
      - Markers for early atherosclerotic changes

Pulmonary considerations

- RESTRICTVE LUNG DISEASE d/t compressive effect of adipose tissue on abdomen, diaphragm and thoracic structures
- VC, ERV, FRC reduced
- Chest wall and lung compliance reduced
- O2 consumption and carbon dioxide production increased (increased work of breathing)
- Collapse of small airways→ V/Q mismatch
- CO2 retention→ Pickwickian syndrome

Pulmonary considerations

- Asthma
  - Higher incidence among overweight children
    - Boys > girls
    - Studies show they used increased medicine, wheezed more, and made more visits to the ER
    - Decreased exercise tolerance
  - May be genetic link between obesity and asthma
    - B2-adrenergic receptor, tumor necrosis factor a (TNF-a), and insulin growth factor 1 (IGF-1)
    - Leptin and pro-inflammatory role

Pulmonary considerations

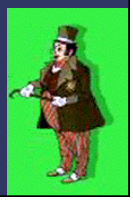
- Obstructive sleep apnea (OSA) has been identified in infants as young as 6 months old
- 59% of obese children with a positive history have OSA
  - Snoring
  - Daytime somnolence (not seen as often in children)
  - Nighttime awakening
  - Orthopnea
  - Difficulty awakening in morning
  - Mouth breathing
  - Enuresis
- Causes include greater fat mass, increased muscle relaxation, and enlarged tonsils and adenoids

Obesity syndromes

- Obstructive sleep apnea syndrome (OSAS): 30 apneic periods of > 20 seconds over 7 hours
- Obesity hypoventilation syndrome (OHS): decreased ventilatory response to CO2 and O2, resulting in sleep apnea, hypoventilation, hypercapnea, pulmonary hypertension, and hypersomnolence
- Pickwickian syndrome: OHS PLUS hypoxemia, polycythemia, biventricular failure

Pickwickian syndrome

- Also called obesity-hypoventilation syndrome by some but not completely accurate definition
- Occurs in 5% of morbidly obese patients
- Historical origin: from Charles Dickens' The Pickwick Papers
  - Describes a morbidly obese boy who is known to fall asleep at odd times



Pickwickian syndrome

- Characterized by hypercapnea 2* to alveolar hypoventilation
- Hypercapnea suggestive of intrinsic disease of the respiratory center of ventilatory system
  - Inadequate ventilatory response combined with worsening hypoxia, leads to pulmonary hypertension and transudation of fluid in lungs
- Clinical characteristics
  - Somnolence
  - Hypercapnea
  - Alveolar hypoventilation
  - Hypoxemia
  - Pulmonary hypertension
  - Right sided heart failure
  - Secondary polycythemia (cyanosis-induced)

Gastrointestinal/hepatic considerations

- High risk for gastric acid aspiration
  - Increased intra-abdominal pressure and decreased lower esophageal sphincter tone
  - Poor gastric emptying
  - Hyperacidic gastric fluid
- Increased incidence of hiatal hernia
- GERD
- Cholelithiasis
  - Stones form when bile is saturated with cholesterol and crystallize
  - Associated with ingestion of simple sugars and saturated fat

Hepatic considerations

- Nonalcoholic steatohepatitis (fatty liver) disease
  - Most common form of liver disease in children
  - Fatty infiltration of the hepatocytes
  - Hepatocyte rupture results in increased levels of lactic dehydrogenase and aspartate aminotransferase, triglycerides, and cholesterol
  - If not treated, fibrosis occurs leading to cirrhosis
  - 1.5-2.5 times more frequently in children
  - Detected on ultrasound and diagnosed on biopsy

Endocrine/metabolic considerations

- Polycystic ovary syndrome (PCOS)
  - Polycystic ovaries
  - Hyperandrogenism
    - Irregular menses
    - Hirsutism
    - Acne
- Type 2 diabetes
  - May be discovered on routine urinalysis
  - Often presents typically as polyuria, polydipsia, or ketoacidosis
  - Much higher risk of diabetes associated complications, especially kidney failure by middle age and death from a CV event, compared to adult onset diabetes

Endocrine/metabolic considerations

- Metabolic syndrome
  - Recognized as major risk for cardiovascular disease in adults
  - Signs and symptoms
    - Obesity
    - Insulin resistance
    - Hypertension
    - Other metabolic derangements
  - Present in nearly 50% of obese children and worsens with increasing BMI
  - Abnormal glucose tolerance tests, high triglycerides, and low HDL

Musculoskeletal considerations

- Slipped capital femoral epiphysis (SCFE)
  - Limp
  - Limitation of motion of hip
  - Hip and/or knee pain
- Blount disease
  - Tibia vara
  - Knee pain
- Predisposed to fractures due to greater bone density
- Osteoarthritis

Neurological/psychological considerations

- Children with OSA can have neurocognitive effects
  - Reduction in attention, motor efficiency, graphomotor ability
- Pseudotumor cerebri
  - Idiopathic intracranial hypertension
  - Presents with visual loss and papilledema
- Depression
  - Depressed affect, poor school performance, suicidal ideation
- Anxiety
  - Excessive worry, emotional eating pattern
- Poor self-esteem
  - Decreased participation in social/school activities

Preoperative considerations

- Be careful with benzos and opioids→ do not want to suppress respirations because of marginal O2 reserves
- H/O OSA, snoring, somnolence, HTN, CHF and CAD
- EKG: may show increased voltage, atrial/ventricular enlargement and arrhythmias
  - Peds present with more sinus arrhythmias and bradycardia
- Chest Xray: may show atelectasis, cardiac enlargement, infiltrates, effusions, or pneumothorax
- CBC: elevations in WBC and Hct may suggest infection and chronic hypoxemia respectively
- Bicarbonate levels elevated to buffer chronic respiratory acidosis if CO2 retainer

Evaluation of Sleep study

- Respiratory Distress Index (RDI)
  - Adult values do not correlate to children well
  - Measure the Respiratory disturbance index or apnea/hypopnea index
    - Total number of apneas and hypopneas divided by total sleep time and multiplied by 60
      - Apnea: cessation of airflow > 10 seconds
      - Hypopnea: "little breath"; defined differently by centers
        - » 50% reduction in airflow or respiratory effort; reduction in airflow, effort and decreased oxygen saturation

RDI → PICU bed?????

- In children, must pay attention to clinical symptoms and not just numbers
  - Despite kids with low RDI's, gas exchange has been found to be significantly impaired with frequent desaturations
- 0-2: no OSA
- 2-10: mild OSA
- 10-15: moderate OSA
- >15: severe OSA

Induction considerations

- Mask induction most common
- Usually requires at least 50% O2 with mask induction
- Positive pressure ventilation may be necessary b/c spontaneous ventilation may predispose patient to atelectasis and hypoxemia
- Laryngospasm is always a possibility

Intraoperative considerations

- Lipophilic (fat soluble) drugs
  - Opioids, benzos, and barbs→ fat stores provide an increased Vd and decreased elimination half-life→lower serum drug concentrations and decreased clearance
    - Fentanyl is lipophilic but has same profile in obese/ nonobese
  - Larger loading dose required for same plasma concentration; some base dose on actual body weight
- Hydrophilic (water soluble) drugs best to use with obese patients
  - More limited Vd; dose should be based on ideal body weight

Intraoperative considerations

- Technical considerations
  - Difficult venous access → excess adipose tissue makes vascular access difficult; central line or venous cutdown may be required
    - Start with blind saphenous
    - PICC if possible
  - Inaccurate blood pressure readings → blood pressure will be artificially elevated if cuff too small for arm; cuff must encircle 75% of upper arm circumference; may require arterial line

Intraoperative considerations

- Positioning may be difficult → increased risk of nerve injury; carefully place padding to prevent peripheral neuropathy and watch brachial plexus; use sleds to protect tucked arms and to prevent patient from falling off table
- Limited range of motion → have reduced range of motion; frequent palpation of pulses, generous padding, correct alignment, and repeated inspection help to reduce neuropathy

Intraoperative considerations

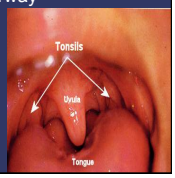
- PEEP may be necessary to maintain arterial oxygenation
- Increase in TV may worsen oxygenation if high PIP impair blood return to chest, decreasing CO and producing V/Q mismatch
- Volatile anesthetics metabolized more extensively in obese patients

Postoperative considerations

- At increased risk for hypoxemia 4-7 days postop
- Supplemental O2 necessary with patient in sitting position (even before extubated)
- Aggressive pulmonary care
- May require ICU for monitoring
- DVT: encourage early ambulation if able;
  - if not, Low molecular weight heparin and SCD's
- PCA/opioids to decrease postop splinting and hypoventilation
- Epidural opioids facilitate earlier ambulation and decrease pulmonary complications

Surgical procedures associated with the obese child

- Tonsillectomy and Adenoidectomy
  - Adenotonsillar hypertrophy→most effective treatment for OSA in pediatric population
  - OSA may persist in obese children
    - May be from increased visceral fat having an effect on decreasing airway tone → airway collapse
    - May be from increased fat in the neck decreases caliber of airway
  - Hold off on opioids until extubated



Orthopedic procedures

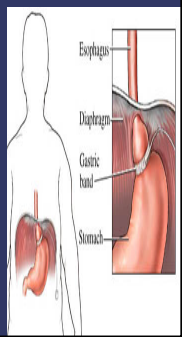
- Slipped capital femoral epiphysis (SCFE)
  - Occurs when proximal femoral epiphysis separates from the femoral neck through growth plate
  - Considered orthopedic emergency (urgency) → risk of avascular necrosis of femoral head
    - Seen in up to 30% of obese children
  - High incidence of premature degenerative joint disease
  - General +/- regional anesthesia:
    - Femoral sciatic block or epidural

Orthopedic procedures

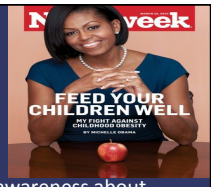
- Blount's disease (tibia vara)
  - Caused by excessive weight on growth plate
  - Knee pain
  - Characterized by bowing of knees medially
  - Tibial osteotomy and lengthening
  - General +/- regional anesthesia
    - Femoral block or epidural

Abdominal procedures

- Cholecystectomy
- Appendectomy
- Inguinal hernia repair
- Bariatric surgery (laparoscopic)
  - Controversial: Lap banding
  - Advocated as only treatment to show achievable lasting weight loss in the obese child



Let's Move Campaign



- Michelle Obama's platform as First Lady
- Launched in 2010 to raise public awareness about childhood obesity and urge kids to be more physically active to decrease associated problems

How's Let's Move doing?

- Raised recognition/awareness of childhood obesity
- > 70 recommendations released with goal to decrease childhood obesity to 5% by 2030
  - Improving quality of food in schools: Healthy, Hunger-Free Kids Act
    - New standards set by USDA: More fruits, vegetables, whole grains; less sugar and sodium and ban on transfats
  - Menu labeling with calories
- Critics feel it was a failure because did not emphasis need to change eating habits overall

http://www.modernhealthcare.com/article/20160823/NEWS/160829986

Future areas of investigation

- Infectobesity (term coined in 2001)
  - Refers to obesity of infectious origin and the emerging field of medical research that studies the relationship between pathogens (disease-causing organisms, such as viruses and bacteria) and weight gain
- Capascin (University of Toronto)
  - Injected in diabetic mice and killed vascularization; Studies shown to prevent fat cells, or adipocytes, from growing into mature cells
  - ?"antiobesity" properties; ?anticancer properties
- Sertraline-1
  - Role in anti-aging and DM with metformin

"Master Switch" gene for obesity

- Recent study published in journal *Nature Genetics (May 2011)*
  - Since fat plays important role in metabolic disease, regulating gene could be target for drugs
  - Found a link between KLF14 gene, which is linked to Type 2 DM and cholesterol, and other genes found in fat tissue
  - Seems to act as master switch in controlling processes that connect changes in SQ fat to disturbances in muscle and liver that contribute to other metabolic conditions
    - *Nature Genetics* Volume: 43, Pages: 561–564 Year published: (2011)

Ethical Issues in the OR

- Does obesity qualify as child abuse?
  - http://www.latimes.com/health/la-he-childhood-obesity-custody-20110829,0,3696579.story
  - http://jama.ama-assn.org/content/306/2/206.short
- How young is too young to perform bariatric surgery?
  - http://onlinelibrary.wiley.com/doi/10.1111/j.1758-8111.2010.00003.x/full
  - http://journals.lww.com/jpgn/pages/articleviewer.aspx?year=2004&issue=07000&article=00002&type=fulltext
- Are anesthesia providers cognizant of the increased risk with the obese pediatric patient?
  - http://journals.lww.com/anesthesiology/pages/articleviewer.aspx?year=2008&issue=03000&article=00009&type=fulltext
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