**OBESITY IN CHILDLHOOD**

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**Definition**

- Simple definition is excess body fat (adiposity)
- Adiposity expressed as total fat mass or percentage of total body mass
- In infancy ↑ fat mass mainly due to adipose cell enlargement while later due to cell proliferation; thus fat cell mass ↑ steeply during infancy and then falls with a 2nd rise in later childhood

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**Measurement of body fat**

- Method should be accurate, precise & accessible
- CT scan
- Magnetic resonance imaging
- Dual energy X-ray absorptiometry (DEXA): (X-ray energy travels faster through fat than muscle) as good as CT scan & less expensive
- Bioelectrical impedance (fat has no H2O & thus is of high electric resistance/impedance)
- Underwater weighing (Lean tissue, like bone & muscle, are more dense than water, but fat tissue is less dense than water)

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**DEXA & Underwater weighing**

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**Anthropometry**

- Weight-for-age; 120% of median, 97th percentile & + 2 Z-scores.
- Weight correlated with body fat, but highly correlated with height; height weakly correlated with body fat. Adjusting weight for height ↑ weight-body fat relation
- Weight-for-height useful for adiposity up to 10 yrs in girls & 11.5 yrs in boys, past this it’s age related, thus weight/height² further adjusts (BMI)

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**Body Mass Index**

- BMI has similar natural history to body fat; steep rise in infancy (peak at 9 months), falls until age 6 years, then second rise which lasts till adulthood
- BMI percentile & BMI Z-scores more useful
- BMI ≥ 95th centile for age & gender or > 30 kg/m² whichever is smaller = obese
- BMI ≥ 85th centile but < 95th centile overweight
Skin fold thickness & waist circumference

- Skinfolds: thickness of subcut fat & skin at selected sites (triceps, subscapular & suprailiac) not recommended for routine clinical use
- Waist circumference: better estimate of visceral adipose tissue (but BMI better estimate of subcut adipose tissue); WC good predictor of insulin resistance, BP, cholesterol & triglyceride

Epidemiology

- Obesity ↑ worldwide, estimated that in 2010 11.7% overweight & obese in developed countries & 6.1% in developing countries (from 1990 – 2010 ↑ of 48% & 65% in developed countries & developing countries respectively) (de Onis, Blösner & Borghi, 2010)
- USA: recent estimates, 25% of children overweight & 11% obese

Studies from SA schools show ↑ percentage of overweight in 8-11 yr boys from 1.1% (1994) – 9.5% (2001-2004) & in girls of same age 1.4% - 16.5%. Obesity ↑ from 0.2% - 2.2% in boys & 4.4% in girls (Armstrong et al. 2011)

Cross-sectional survey of rural children in Mpumalanga – overweight & obesity was 18% in 14 yr girls (4% in boys same age) & up to 25% in 18 yr girls (4% in boys) (Kurani-Muranje et al. 2010)

Control of body weight

- Balance between energy intake & expenditure short and long-term control of body weight
- Short-term control related to control of energy intake; meal initiation - environment stimuli e.g. food, emotions & peers
- When meal begins hormones exert influence: oxyntomodulin (↓ appetite), pancreatic polypeptide (↓ appetite), peptide YY (↓ gastric emptying), glucagonlike peptide (↓ appetite)
- Ghrelin: potent appetite stimulant, also ↑ adiposity & GH & ACTH release

Long-term
- Leptin – secreted by adipose tissue, binds to receptors in arcuate nucleus of hypothalamus, secreted in proportion to fat content of adipocytes & reduces energy intake
- Insulin: reduces energy intake
- α-melanocyte stimulating hormone (α-MSH): reduces energy intake
- Pro-opiomelanocortin: stimulates α-MSH
- Neuropeptide Y & orexin: increase appetite

Signals of energy intake & expenditure

- Leptin: reduces energy intake
- α-MSH: reduces energy intake
- Ghrelin: appetite stimulant, also adiposity & GH & ACTH release
**Causes of obesity**

- Genetic: Leptin def, mutations in POMC
- Infections: association with adenovirus (AD36) link unclear, colonic bacteria (↑ firmicutes) - inflammation
- Stress: dysregulation of HPA axis → altered cortisol metabolism
- Drugs: e.g. steroids, antipsychotics
- Endocrine abN: hypothyroidism, GH deficiency, Cushing’s syndrome, pseudohypoparathyroidism 1A (lack of response to PTH), (all short stature), insulinoma, hypothalamic obesity (damage to hypothalamus) e.g. post op

**Causes of obesity (2)**

- Maternal malnutrition & placental insufficiency (Barker hypothesis)
- Breastfeeding: ↓ risk
- Early introduction of solids: ↑ risk of obesity
- Parenting style: authoritarian style associated with obesity, but authoritative style ↓ risk
- Eating patterns: families eating together ↓ risk
- Reduced physical activity
- Sleep duration: less sleep ↑ risk of obesity

**Clinical Assessment**

History:
- Identify modifiable lifestyle behaviour (dietary & physical activity practices)
- Current & future risks of medical comorbidities
- Child & family’s readiness to make behaviour changes

Success more likely if work with child & family than “top-down” approach. Assess which activities that child enjoys & think can achieve

**Dietary assessment**

Assessment of energy intake
- 24 hour recall
- Food records
- Food frequency questionnaires
Above 3 are time consuming & difficult for consultation office (more useful for research)

The weight, activity, variety (in diet) & excess (WAVE) has been shown in studies to be feasible, acceptable, reliable & valid

**WAVE ASSESSMENT**

- Weight: assess BMI
- Activity: physical activity in past week walking briskly, jogging, swimming, biking, dancing
- Variety: is patient eating a variety of foods from NB sections of food pyramid?
- Excess: is patient eating too much of certain nutrients? Too much fat (esp. saturated fat), too much sugar, too much salt
- Assess willingness to make changes.

(2005 Institute for Community Health Promotion, Brown University, Providence, RI)

**Food pyramid**
Physical examination
- Anthropometry
- Pulse & BP
- Neck for goitre
- Fundi-papilloedema, ↓ venous pulsation with pseudotumour cerebri
- Acanthosis nigricans, some association with insulin resistance
- Wheezes, asthma worsened by obesity
- Hepatomegaly-non-alcoholic fatty liver disease

Physical examination (2)
- Secondary sexual development: obesity often associated with premature pubarche, false gynaecomastia & micropenis in boys
- Lower limbs: limitation of movt, hips (slipped capital femoral epiphyses), knees (Blount’s disease)
- Syndromes: Prader-Willi, proopiomelanocortin (POMC) mutations (red hair, pale skin, adrenal insufficiency), Laurence-Moon, Bardet-Biedl, Down’s, Fragile X

Complications of obesity
- Hypertension
- Dyslipidaemia
- GIT: steatohepatitis, gallstones
- Endocrine: diabetes, insulin resistance, polycystic ovarian disease
- Respiratory: asthma, sleep apnoea
- CNS: pseudotumour cerebri
- Orthopaedic: Blount’s disease, slipped epiphyses

Interventions
- Behaviour change mainstay of treatment = multidisciplinary team
- Active lifestyle interventions more effective than education only, ↓ in overweight percentage of 8.9% compared to ↑ of 2.7%
- Predictors of sustainable behaviour change
  - Early weight loss (within 2 months)
  - Parental treatment response
  - Appetite responses (impulsivity, binge eating)
  - Environment (access to open spaces, less access to fast food shops)

Dietary intervention
- Fruit & vegetables: low intake of fruit ass with overweight, but less definite for vegetables
- Fruit juice: no evidence that 100% fruit juice causes obesity, but limit amount
- Soft drinks & sweetened fruit juices definite evidence for causation & maintenance
- Dairy foods & Ca+: possible role in preventing obesity
- Dietary fibre: no conclusive studies, but experts think there’s a role

Dietary intervention (2)
- Breakfast skipping: obese children more likely to skip breakfast. Associated with eating bigger meals later, esp. dinner
- Snacking: not seem to be ass with adiposity unless these have > energy & fat content
- Eating out: definite association if eat in fast food establishments rather than other restaurants. Fast foods ass with > intake of fried foods & trans fats
**Dietary intervention (3)**

- Energy restricted diet: significant weight loss over 3-6 months, but at 12-18 months rarely > 5% of baseline weight
- High protein, low carb diet: useful for rapid weight loss, not for long-term
- Decreasing energy density (energy/mass of food) with volume maintained independent of carb : protein ratio seems more useful (not conclusive). E.g. diet rich in vegetables, fruits, legumes, minimally processed grain & water rich foods & decreasing high-fat foods
- Traffic light diet: green (often) (fruit & vegies), yellow (moderation) (grain), red (sparingly)

**Physical activity**

- Plays a role in obesity as it ↑ energy expenditure; inactivity major role in aetiology
- Largest modifiable component of expenditure (15-30% of energy expenditure)
- Much less impact on weight loss than diet as easier to ↓ energy intake than to ↑ energy expenditure by same amount
- Toddlers-5 yrs: recommend 120 min moderate to vigorous activity (MVPA) (½ as structured); older kids MVPA of 60 min & aerobic should form most of this activity, muscle strengthening at least 3 days per week

**Medical therapies (2)**

Orlistat:
- Especially beneficial in those with difficulty in adhering to a reduced fat diet, have hypertension or hypercholesterolaemia
- Need to supplement fat soluble vitamins 2-3 hrs before or after medication
- Adverse effects include – abdominal cramps, flatulence, oily spotting, liquid stools
- Contraindicated in pts with malabsorption & cholestasis

**Medical therapies (3)**

Metformin:
- Licensed for use in type 2 diabetic children ≥ 10 yrs but has been by paediatricians for obesity
- Recommended as adjunct therapy in obese adolescents with type 2 diabetes
- May be useful in adolescents with polycystic ovarian syndrome & prediabetes
- Improves insulin sensitivity without affecting insulin secretion
- Small in ↓ BMI & ↑ weight gain on stopping

**Physical activity**

- American Academy of Pediatrics (2001), no TV at < 2 yrs & after 2 yrs not > 2 hrs of TV/day, no TV or other screens in child’s primary sleeping place (based on consistent evidence); promotes calorie expenditure
- Physical activity also improves cognitive development & motor skills
- Also ↑ academic & cognitive performance (Lambourne & Donnelly, 2011)

**Medical therapies**

- Medicines have modest efficacy (BMI loss of 1-3 kg/m²) & have adverse effects
- Subitramine was approved by FDA in kids ≥ 16 yrs Orlistat for those ≥ 12 yrs. Subitramine associated with ↑ risk of myocardial ischaemia & stroke in adults (remember Simply slim!)
- Orlistat – inhibitor of GI enzymes including pancreatic lipase; at 120 mg tds prevents 3% of fat absorption (thus ↓ dietary fat & calorie intake); result in BMI loss of about 2-3 kg/m²
- Phentermine: amphetamine derivative; may be useful if used intermittently (alternate months)
- Fluoxetine (Prozac): blocks serotonin reuptake & inhibits neuropeptide Y - ↓ appetite & thus ↓ calorie intake, better than metformin in ↓ weight; not licenced for obesity treatment
- Bupropion (also for depression): blocks reuptake transporters for dopamine & noradrenaline – seems to ↑ energy expenditure without ↑ food intake; not licenced for obesity treatment