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Measuring Obesity in Children

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Preview

1 Why Measure Obesity in Children?

- Childhood obesity and co-morbidities
- Progression to adult obesity
- Obesity Epidemic

2 Determination of Body Composition

- Laboratory-based methods
- Field-based methods

3 Anthropometry

- BMI
- Waist circumference

1 Why Measure Obesity in Children?

Overweight –moderate degree of excess wt-for-ht

Obesity –excess adiposity accumulated to such an extent health adversely affected

•Overweight – more likely to result from behavioural factors such as poor dietary habits and physical inactivity

•Obesity –stronger behavioural, metabolic and possibly genetic aetiology

(Bouchard, 2000)

•Primary cause of increase related to energy balance

•Varied criteria for defining overweight and obesity

•Inconsistencies in definitions – major obstacle in studying global trends

•Need understanding of global situation to:

(i) provide useful insights on causes of epidemic

(ii) assist planning and development of meaningful collaborations and programmes

•Childhood obesity is a multi-system disease

•Cardiovascular, endocrine, pulmonary, musculoskeletal, psychological, neurological, hepatic, renal……

Specifically linked to:

- hypertension
- dyslipidaemia
- chronic inflammation
- metabolic syndrome
- endothelial dysfunction
- type 2 diabetes
- hyperinsulinemia
- polycystic ovary syndrome

- precocious puberty
- sleep apnoea
- asthma
- poor self esteem
- depression
- eating disorders……

Overweight and obesity in adolescence are associated with:

- an 8.5 fold increase in hypertension
- a 2.4 fold increase in prevalence of elevated TC
- a 3 fold increase in elevated LDL-C
- an 8-fold increase in low HDL-C

in adults aged 27-31 years

(Srinivasan et al. 1996)

- Overweight children now have 50% chance of becoming overweight adults (BMA, 2003)

- ~ 2 million UK children overweight

- ~ 700,000 are obese

- By 2010 number of overweight children across EU:

>26 million (rise by ~ 1.3 million per year)

(~6.4 million – obese ~ rise of 350, 000 per year)

(International Obesity Task Force, 2006)

Obesity prevalence in 11-14 year old in South Wales

- Boys *n* = 230; girls *n* = 229

- Wt/ht/waist circumference (WC)

- IOTF criteria (Cole et al. 2000) (BMI): 32% overweight or obese; 8.3% obese

- McCarthy et al. (2003) (WC) -98th percentile – 19.4% obese

- De Ferranti et al. (2004) (WC) – 75th percentile – 54.5% obese

•Estimates of obesity prevalence highly dependent on method used

2 Measurement of Obesity

Body Composition

Laboratory-based techniques:

- Densiometry
  - Hydrostatic Weighing
  - Air-displacement Plethysmography (BodPod)
- Radiographic Techniques
  - Dual-energy X-ray Absorptiometry (DXA)
  - X-Ray, Magnetic Resonance Imaging, Computed Tomography

Field-based techniques:

- Bioelectrical Impedance Analysis (BIA)
- Near infra-red interactance (NIR)
- Skinfold thickness

Hydrostatic Weighing

Principle:

- Archimedes' Principle (Densiometry)

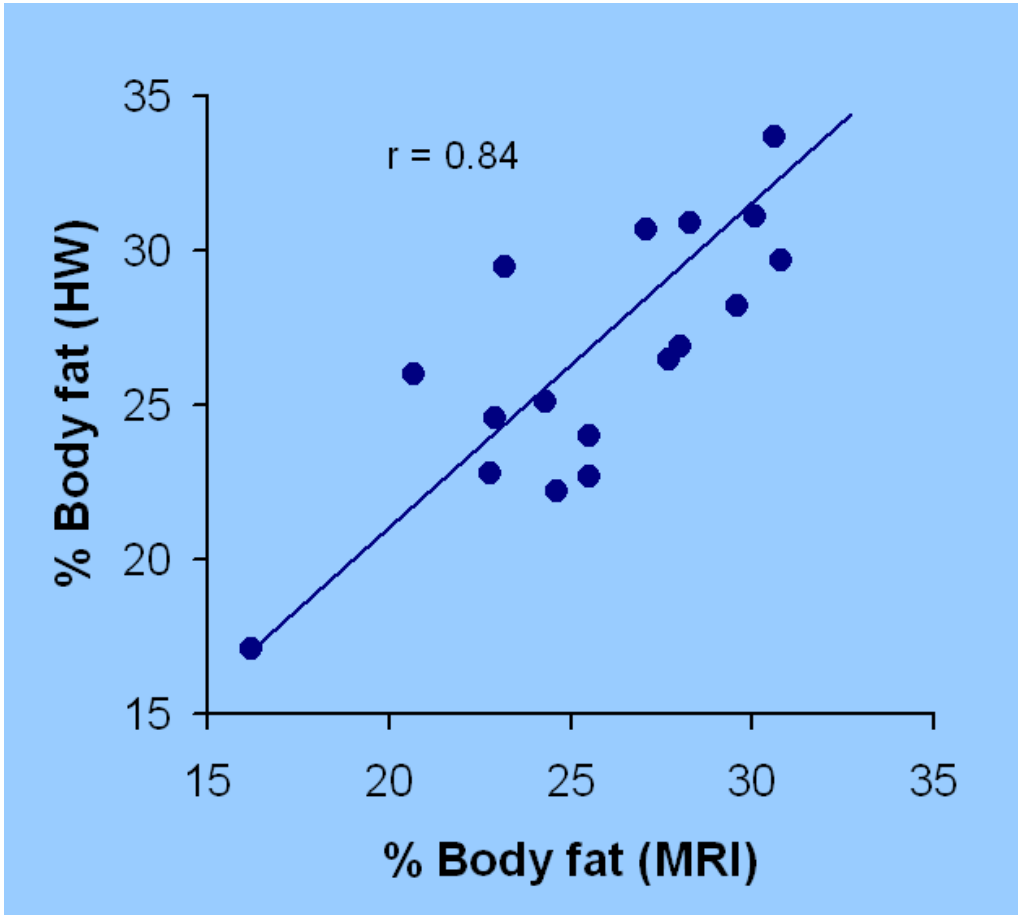
Technique:

- Determine subject mass
- Weigh submerged subject
- (Δ_{weight} proportional to volume)
- Calculate residual air (lungs and GI)
- Calculate density of body
- Calculate %BF using specific equations

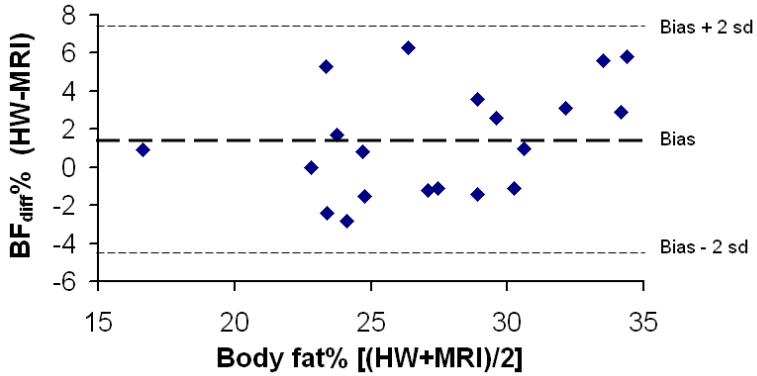
Disadvantages:

- Subject compliance (during test)
- Technical expertise
- High cost – time and resources

Validity: HW v MRI



Source: data from Sohlström et al. (1993) Am J Clin Nutr; 58:830



Dual-energy X-ray Absorptiometry (DXA)

Principle:

• Radiographic Imaging

Technique:

• Subject lies supine as scanner moves over

• Two low-energy X-ray beams penetrate body

• Detector probes quantify absorbance

• Software reconstructs image of tissues & from density values can provide fat mass

Disadvantages:

• Technical expertise

• Radiation dose (short exposure / low dose)

• High cost – time and resources

Air-displacement Plethysmograph (BodPod)

Principle:

- Boyle's Law (Densiometry)

Technique:

- Determine subject mass
- Air pressure of empty BodPod chamber
- Air pressure with subject in chamber
- Δ Air pressure proportional to subject's volume
- Manoeuvre to measure mean air in lungs
- From density calculate %BF

Disadvantages:

- Subject compliance (before & during test)
- Technical expertise
- High cost – time and resources

Bioelectrical Impedance Analysis (BIA)

Principle:

• Impedance to electrical current is related to water content and body composition

Technique:

• Height/mass of subject

• 2 electrodes on R wrist & ankle

• Small current (800 μA) passed at 50 kHz

• Impedance is proportional to fat mass (low water content cf. muscle)

• Calculation of BF%

Disadvantages:

• Subject compliance (before test)

• High cost – time and resources

Near-infrared interactance (NIR)

Principle:

- Absorptiometry of infrared light

Technique:

- Single site (anterior of bicep)
- Wand delivers low-energy near-infrared light
- Wand has measures intensity of reemitted light
- Uses mass and height to calculate %BF

Disadvantages:

- Questionable validity
- High cost – resources

Skinfold thickness

Principle:

• Skinfold thickness reflects subcutaneous fat and used to estimate %BF

Technique:

• Location of standardised site(s):
  – Tricep, bicep, subscap, suprailiac
• Grasp skinfold (including subcutaneous fat)
• Apply calibrated caliper (e.g., Harpenden)
• Use skinfold values to calculate %BF

Disadvantages:

• Technical expertise
• Subject compliance
• Time consuming

3 Measurement of Obesity

Anthropometry

- **Body Mass Index (BMI)**
  - Body Mass
  - Stature
- **Waist Circumference**

International Society for the Advancement of Kinanthropometry (2001). *International Standards for Anthropometric Assessment.* Australia: The International Society for the Advancement of Kinanthropometry.

Body Mass Index (BMI)

Body Mass Index

- Mass (kg) / Stature^2 (m^2)

Disadvantages:

- Does not estimate adiposity
- Relationship (^2) might not be appropriate for all populations
- Overweight/Obesity BMI cut-offs
  - Age / Ethnicity specific

Advantages:

- Based on simple anthropometry

International cut-off points for BMI

E.g., Cole et al. (2000) BMJ; 320:1240–3.

- Brazil, Netherlands, Singapore, HK, GB, USA

Others:

Chinn and Rona (2002)

- UK data only
- Lower thresholds

Age (years)	BMI 25 kg/m^2		BMI 30 kg/m^2	
	Males	Females	Males	Females
2	18.4	18.0	20.1	20.1
2.5	18.1	17.8	19.8	19.5
3	17.9	17.6	19.6	19.4
3.5	17.7	17.4	19.4	19.2
4	17.6	17.3	19.3	19.1
4.5	17.5	17.2	19.3	19.1
5	17.4	17.1	19.3	19.2
5.5	17.5	17.2	19.5	19.3
6	17.6	17.3	19.8	19.7
6.5	17.7	17.5	20.2	20.1
7	17.9	17.8	20.6	20.5
7.5	18.2	18.0	21.1	21.0
8	18.4	18.3	21.6	21.6
8.5	18.8	18.7	22.2	22.2
9	19.1	19.1	22.8	22.8
9.5	19.5	19.5	23.4	23.5
10	19.8	19.9	24.0	24.1
10.5	20.2	20.3	24.6	24.8
11	20.6	20.7	25.1	25.4
11.5	20.9	21.2	25.6	26.1
12	21.2	21.7	26.0	26.7

BMI: Standing Height (Free-Standing Stature)

- Use appropriate stadiometer (e.g., Holtain stadiometer)
- The individual stands feet together (no shoes)
- Heels and upper part of the back against the stadiometer (not necessarily buttocks)
- The head is placed in the Frankfort plane; with Orbitale (lower edge of the eye socket) in the same horizontal plane as the Traglion (the notch superior to the Traglus of the ear)
- Head board is lowered firmly to the Vertex (the most superior point of the skull) when subject has inspired fully
- Record height to nearest 0.001 m
- Diurnal variation ~1% stature

BMI: Body Mass

•Calibrate and zero scales

- Ideally measure body mass with the individual wearing minimal clothing
- Individual stands unsupported in the middle of the scales
- Record body mass to the nearest 0.05 kg

- Diurnal variations ~ 1 kg in children

Waist Circumference

Location:

- Narrowest point between the lower costal border and the iliac crest
- Use mid-point between the lower costal border and the iliac crest if no obvious narrowing exists

Method:

- Abduct the subject's arms
- Hold tape horizontally at the measurement site
- After the individual has lowered their arms, the measurement is taken at the end of normal expiration
- Record mean of 2 repeat measures <1% difference

Summary: Measuring Obesity in Children

- Primary Outcome
  - Individual (identification of obese children)
  - Population (prevalence of obesity)

- Measurement of an individual's adiposity
  - Hydrostatic weighing, DXA, BodPod (lab)
  - BIA, NIR? (field)
- Measurement of Obesity in a population
  - BMI, Waist Circumference