Growth
Lecture for Sydney University Nutrition & Dietetics Students 2008

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Session Goals

- Assess and measure growth accurately
- Plot & interpret growth charts
- Define and identify ‘Failure to Thrive’
- Calculate nutrition requirements based on growth assessment.
Why Measure Growth?

- Valuable tool in the assessment of health and nutritional status
- Common tool used by health professionals (common language)
- Objective measure of food intake
- Can detect growth abnormalities
- Evaluation of nutrition intervention
- Evaluation of medical treatment of a disease
What factors affect growth?
What factors affect growth?

- Genetics
- Psycho-social stress
- Environment
- Ethnicity
- Nutrition
- Health
Growth References

- NH&MRC have advised that U.S National Center for Health Statistics (NCHS) reference data be used in Australia

- **What growth charts do we use at CHW?**
  The new improved NCHS growth references, revised addition from the 1977 charts:
  CDC 2000
Weight and Height
Types of growth charts - CDC 2000
(www.cdc.gov/growthcharts)

Boys and girls:
0-36 months

- Weight-for-age
- Length-for-age
- Weight-for-length
- Head circumference-for-age
Types of growth charts
CDC 2000

Boys and girls:
2-20 years
- Weight-for-age
- Stature-for-age
- BMI-for-age

5-10 years
- Weight for stature (optional)
New features of the CDC 2000 growth charts

- BMI-for-age charts (2–20 years)
- 85th percentile (“at risk of overweight”)
- 3rd and 97th percentiles available
- Lower limits of length (45 vs. 49 cm) and height (77 vs. 90 cm) extended
- Smoothed percentile curves – no disjunction between length and stature for 2-3yr age group
Reference population for CDC 2000 Growth Charts

- Racially and ethnically diverse:
  Representative of US population at time of survey
  1 set of charts for all races/ethnicities

- Infants: Birth to 36 months
  Nationally representative, combined growth pattern
  of breast and formula fed infants

- Children and Adolescents: 2 to 20 years
  Constructed from 5 national survey data sets
  1963 – 1994
Breast vs Formula fed Infants

- Mode of infant feeding can influence growth
- New charts represent the combined growth patterns of breast- and formula-fed infants

- WHO has developed growth charts for 0-5 yr olds using data collected on infants following WHO feeding recommendations (breast-fed at least 12 months and complementary food introduced sometime between 4 and 6 months)
- [http://www.who.int/childgrowth/standards](http://www.who.int/childgrowth/standards)
New growth reference charts
WHO growth reference charts
WHO Growth Charts

- Intensive study in 1997 to develop a new international standard for assessing the physical growth, nutritional status and motor development in all children from birth to age five
- Multicentre Growth Reference Study (MGRS) involving more than eight thousand children from Brazil, Ghana, India, Norway, Oman, and the United States of America
Other Growth Charts

- Premature
- Cerebral Palsy
- Down’s syndrome
- Turner’s Syndrome
Measuring Growth

- Accurate – accurate scales and length/height measuring equipment (stadiometer, length board)
- Performed appropriately for age:
  - supine length for <24 months
  - either lying or standing 24-36 months
  - standing height >36 months
- Child is bare until about 1 year and then in minimal clothing
- Average of 3 measurements
Equipment
Growth Measurement - Common Problems

- Weight of clothes, nappy
- Measuring length-2 people needed
- Not using appropriate chart
- Age errors
- Incorrect zeroing of scales
- Length vs stature
- Children/babies wriggling and moving

Plot before child leaves the office in case you need to re-measure!
Interpreting Growth

- Need serial measurements
  - To establish a growth pattern
  - For correct assessments
- Blue Book/Well Baby Health Record
What is FTT?

The term ‘failure to thrive’ is applied to infants and children who do not grow at the normal or expected rate.
Identifying FTT

- Maximum percentile for infants is the weight achieved at 4-8 weeks of age
- When weight falls by 2 or more percentile bands from the maximum percentile, for a period of one month or more
- When weight is more than 2 percentile bands below height
- Severe FTT is when height also crosses downwards across percentile bands
Why Does a Child FTT?

- Inadequate nutrition compared to requirements
  - inadequate intake
  - decreased absorption
  - excessive losses
  - abnormal utilisation
  - increased needs

- Resulting from
  - organic causes
  - functional problems
  - inadequate intake
  - behavioural/psychosocial factors
  - Combinations of the above
Organic Causes

- Gastrointestinal Disorders e.g. coeliac disease, gastro-oesophageal reflux, Crohn’s Disease, short-gut
- Metabolic Disorders e.g. PKU
- Congenital Cardiac or Respiratory Disorder
- Neurological Dysfunction (may affect oro-motor development)
- Cystic Fibrosis
Non-Organic Problems

- Accounts for 95% of cases
- Functional Problems
  - Suck and swallow co-ordination
  - Oral hypersensitivity
- Behavioural
- Psychosocial
- Neglect
- Abuse
Who Manages FTT?

- Team Approach
- Team Members:
  - Paediatrician
    + Gastroenterologist
    + Neurologist
    + Cardiologist
  - Dietitian, Nurse, Clinical Psychologist, Social Worker, Speech Therapist, Occupational Therapist, Physiotherapist, Community Nurse, GP
How is FTT Managed?

- If organic treat the underlying condition
- Dietitian to assess nutritional adequacy
- Psychology/social work if behavioural problems suspected
- Regular, accurate measures of height and weight
Role of the Dietitian

- **Assessment**
  - Anthropometry and assessment of growth
  - Diet history
  - Nutritional requirements - determine requirements for catch up growth

- **Nutrition care plan**
  - Advice for parents/carer
Assessment - Anthropometry

- Height and Weight History
- Plot on Growth Chart
- Adjust for prematurity ≤37/40
  - HC 18 months
  - Weight 21 months
  - Height 36 months
- Consider parental stature & pubertal development
- Skinfolds & MUAC
Patterns of Growth
Patterns of Growth

- Children double their birth weight by age of 6 months and treble it by 1 year. From then on growth rates slow to about 2 kg/year in the second year of life and on until puberty.
- From birth to 18 years weight increases to about 20 times the birth weight.
- After birth there is a normal drop in weight which is usually regained by 10-14 days.
How Much Growth to Expect?

Growth Charts are the best reference standard

<table>
<thead>
<tr>
<th>Age (months)</th>
<th>Weight Gain (g/week)</th>
<th>Length Gain (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-3</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>4-6</td>
<td>150</td>
<td>25cm</td>
</tr>
<tr>
<td>7-9</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>10-12</td>
<td>50-75</td>
<td></td>
</tr>
<tr>
<td>12-24</td>
<td>2.5kg/year</td>
<td>12cm</td>
</tr>
</tbody>
</table>
Patterns of Growth

- Normal growth - the lines connecting serial measurements will proceed along or parallel to one of the percentile lines on the charts, except during puberty.
- Prior to the growth spurt of puberty growth will fall below the percentile, then increase to above percentile for the next year, then back to the pre-pubertal percentile.
Patterns of Growth- puberty

- If child is less mature than expected for age growth will probably be retarded
- If child more mature than expected for age than growth will be accelerated
- Usual period of puberty
  - boys 10.5-15.5 years
  - girls 9-14 years
Patterns of Growth

- Obese Children tend to be tall as well as heavy and mature early
- Low birth weight infants catch up rapidly after birth
- Overweight infants (often from mothers with diabetes) gain weight slowly after birth
Mid-Parental Height

- Can use as a crude predictor of final height
- Girl’s mid parental height
  \[ \left( \frac{\text{Mo’s ht} + \text{Fa’s ht}}{2} \right) - 7 \]
- Boy’s mid parental height
  \[ \left( \frac{\text{Mo’s ht} + \text{Fa’s ht}}{2} \right) + 7 \]
Ideal Weight for Height

- Used if the height percentile is OK (between the 3rd and 97th percentiles) but weight is more or less than expected
- Calculate weight corresponding to the same percentile as height
- Some problems with this method (particularly at extremes of percentiles)
- Expected weight for height - weight percentile is within 2 percentile bands of height percentile
Height Age & Height Age Weight

- **Height Age**
  - Use if both height and weight are outside the normal range (below the 3rd)
  - calculate the age at which height would be on the 50th percentile
  - Use to determine nutrient requirements

- **Height Age Weight**
  - Calculate the Height Age and then find the 50th percentile corresponding to the height age.
Body mass index (BMI)

- BMI = weight(kg)/height(m)^2
- Reasonable measure of fatness in population studies and for clinical use - both in adults and in children*

BMI in Children

- Adult BMI ranges not suitable
  - Use BMI for age reference charts
  - Our current ones are based on US children
- Plot on CDC Growth Charts
  - If above the 95th percentile; obese
  - If above the 85th percentile; overweight
  - If on the 50th percentile; healthy
  - If below the 5th percentile; underweight
- New international BMI for age reference - Cole et al
  BMJ 2000; 320: 1240
Nutrient Reference Values for Australia and New Zealand
Including Recommended Dietary Intakes
### Energy Requirements for Infants and Young Children

EER = Total energy expenditure + Energy deposition

<table>
<thead>
<tr>
<th>Age</th>
<th>EER (kcal/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-3mths</td>
<td>$[89 \times \text{wt (kg)} - 100] + 175$</td>
</tr>
<tr>
<td>4-6mths</td>
<td>$[89 \times \text{wt (kg)} - 100] + 56$</td>
</tr>
<tr>
<td>7-12mths</td>
<td>$[89 \times \text{wt (kg)} - 100] + 22$</td>
</tr>
<tr>
<td>13-35mths</td>
<td>$[89 \times \text{wt (kg)} - 100] + 20$</td>
</tr>
</tbody>
</table>


EER x disease factor (DF) if required
Energy Requirements for Children

Estimated Energy Requirements = BMR \times \text{PAL} \times \text{DF}

BMR = \text{basal metabolic rate (in kilojoules)}
    \quad \text{To convert to kilocalories multiply by 1000 and divide by 4.2}
PAL = \text{Physical Activity Level}
DF = \text{disease factor}

\begin{align*}
<3 \text{ yrs} & \quad \text{Male} \quad \text{BMR} = 0.249 \text{wt} - 0.127 \\
& \quad \text{Female} \quad \text{BMR} = 0.244 \text{wt} - 0.130 \\
3-10 \text{ yrs} & \quad \text{Male} \quad \text{BMR} = 0.095 \text{wt} + 2.110 \\
& \quad \text{Female} \quad \text{BMR} = 0.085 \text{wt} + 2.033 \\
10-18 \text{ yr} & \quad \text{Male} \quad \text{BMR} = 0.074 \text{wt} + 2.754 \\
& \quad \text{Female} \quad \text{BMR} = 0.056 \text{wt} + 2.898
\end{align*}

(Reference: Schofield et al 1985)
Energy Requirements for Children

**Activity Factors**

<table>
<thead>
<tr>
<th>Activity Level</th>
<th>Male &amp; Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bed Rest</td>
<td>1.2</td>
</tr>
<tr>
<td>Very Sedentary</td>
<td>1.4</td>
</tr>
<tr>
<td>Light</td>
<td>1.6</td>
</tr>
<tr>
<td>Moderate</td>
<td>1.8</td>
</tr>
<tr>
<td>Heavy</td>
<td>2.0</td>
</tr>
<tr>
<td>Vigorous</td>
<td>2.2</td>
</tr>
</tbody>
</table>

If ventilated: use activity factor of 1.0
Disease Factors

- Burns 1.5 -2.0
- Cardiac 1.2
- Cystic Fibrosis 1.2-1.5
- Liver Disease 1.3
- Malabsorption 1.2-1.5
- Minor surgery 1.2
- (acute influence only)
- Neurology 1.1-1.3
- Oncology 1.3
- Respiratory - acute 1.5 , chronic 1.2 -1.5
- Sepsis ≤ 1.5
- Skeletal Trauma 1.35

CHW Dept Nutrition & Dietetics consensus
**Protein Requirements**

- Use current weight
- Be cautious when advising on high protein intakes
- As a guide: it is best not to exceed 4g protein/kg body weight

<table>
<thead>
<tr>
<th>NRV’s 2005</th>
<th>Age (years)</th>
<th>Grams/kg/ day</th>
<th>Grams/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infants</td>
<td>0-0.5</td>
<td>1.43</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>0.5-1.0</td>
<td>1.60</td>
<td>14</td>
</tr>
<tr>
<td>Children</td>
<td>1-3</td>
<td>1.08</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>4-8</td>
<td>0.91</td>
<td>20</td>
</tr>
<tr>
<td>Boys</td>
<td>9-13</td>
<td>0.94</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>14-18</td>
<td>0.99</td>
<td>65</td>
</tr>
<tr>
<td>Girls</td>
<td>9-13</td>
<td>0.87</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>14-18</td>
<td>0.77</td>
<td>45</td>
</tr>
</tbody>
</table>
# Fluid Requirements

<table>
<thead>
<tr>
<th>Age</th>
<th>Millilitre/kg/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Week</td>
<td>80-100</td>
</tr>
<tr>
<td>Second Week</td>
<td>125-150</td>
</tr>
<tr>
<td>Three Months</td>
<td>140-160</td>
</tr>
<tr>
<td>Four to Six Months</td>
<td>130-155</td>
</tr>
<tr>
<td>Seven to Nine Months</td>
<td>125-145</td>
</tr>
<tr>
<td>Nine to Twelve Months</td>
<td>120-135</td>
</tr>
<tr>
<td>One to Two Years</td>
<td>115-125</td>
</tr>
<tr>
<td>Children</td>
<td>1000mL-1500mL/day</td>
</tr>
</tbody>
</table>
Assessment - Diet History

- Breast or bottle fed
- Introduction of solids
- Feeding stage
- Types of food
- Quantities of formula, foods, breast feeds (how often)
- How much food is offered, how much is eaten
- Other fluids
- Restrictions on intake (culture, religion, other beliefs)
- Length of meal times
- General atmosphere at meal times
- Appropriate use of cup or bottle
- Use of supplements
Assessment - Diet History

- From diet history calculate intake
  - energy
  - protein
  - fluid
  - major micronutrients
- Compare to requirements
Dietary Intervention

- If underlying medical condition provide appropriate dietary advice e.g. gluten free diet for coeliac disease
- If behavioural problem offer behavioural advice and refer to psychology /social work
- If inadequate nutrition, provide advice to improve quality of diet
Exclusively Breast Fed Infants

- Growth charts are not designed for BF babies
- Increase number of breast feeds
- Add human milk fortifier (if EHM)
- Add polyjoule/calogen (if expressing)
- Refer to lactation nurse
- Supplement with polyjoule syrup
- Complementary formula feeds (last resort)
- If severe, enteral or parenteral nutrition
Exclusively Formula Fed Infants

- Increase volume
- Increase number of feeds
- Concentrate formula to 24cal/30mL
- Add energy supplements to formula
- Consider high calorie infant formula (Infatrini)
- If severe, enteral or parenteral nutrition
After Six Months of Age

- In addition to previous advice
  - Introduce solids
  - Encourage energy/protein dense solids
  - Add fats and polyjoule to solids
  - if severe, enteral or parenteral nutrition
After Twelve Months of Age

- High energy/protein solids
- Can continue with formula
- Can have cow’s milk with added calories
- Behavioural advice
- If severe; enteral or parenteral nutrition
Behavioural Feeding Problems
Behavioural Feeding Problems

- Refer to the Experts (Psychology/social work)
- Avoid Force Feeding
- Try to create a pleasant atmosphere
- Reinforce Positive Behaviours
- Ignore Unwanted Behaviours
- Eat as a family (allow the child to model his behaviour on parents)
Behavioural Feeding Problems

- Time Limit Meals
- Regular Meal Times and Snacks
- Avoid the clean plate club
- Avoid grazing
- Limit Juice/Cordial Intake
Checklist

- Accurate data
- More than one measurement
- Health of child – pathology?
- Parental height
- Diet history
- Adequacy