Nutrition in Infancy and Childhood

Infant Nourishment
Part 2

Infant Nourishment

Objectives:
• To discuss critical nourishment issues for infants to support appropriate growth and development
• To describe the influence of specific nutrients on growth and development
• To describe typical patterns of infant nourishment

Nutritional Influences on ‘Growth’
• Growth & protein-energy ratio
• Growth & protein quality
• Growth & fluid requirements
• Growth & specific nutrient deficiency

Protein content of milks
• Food Pro (gm/oz)
  • Human milk 0.3
  • Infant formulas 0.5
  • Infant soy formulas 0.5
  • Homogenized milk 1.0

Estimated requirements for energy & protein

<table>
<thead>
<tr>
<th>Age (mo)</th>
<th>Energy kcal/kg/day</th>
<th>Protein gm/kg/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1</td>
<td>115</td>
<td>1.98</td>
</tr>
<tr>
<td>1-2</td>
<td>112</td>
<td>1.71</td>
</tr>
<tr>
<td>2-3</td>
<td>100</td>
<td>1.46</td>
</tr>
<tr>
<td>4-5</td>
<td>94</td>
<td>1.18</td>
</tr>
<tr>
<td>5-6</td>
<td>92</td>
<td>1.18</td>
</tr>
<tr>
<td>9-12</td>
<td>92</td>
<td>1.14</td>
</tr>
</tbody>
</table>
Formula intake varies widely and supports growth

<table>
<thead>
<tr>
<th>Age</th>
<th>Water req (ml/kg/day)</th>
<th>Wt (kg)</th>
<th>Intake (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 mo</td>
<td>125-150</td>
<td>3</td>
<td>375-450</td>
</tr>
<tr>
<td>3 mo</td>
<td>140-160</td>
<td>5</td>
<td>700-800</td>
</tr>
<tr>
<td>6 mo</td>
<td>130-155</td>
<td>8</td>
<td>1040-1240</td>
</tr>
<tr>
<td>1 yr</td>
<td>125-135</td>
<td>10</td>
<td>1200-1350</td>
</tr>
<tr>
<td>2 yr</td>
<td>115-125</td>
<td>15</td>
<td>1725-1875</td>
</tr>
</tbody>
</table>

Fluid needs vary with age, ambient temp, etc
Does not include cola, juice, etc

Water requirements

Water- prudent recommendation

- 1.5 ml/kcal of energy expenditure of infants
- Criteria for recommendation
  - large surface area per unit of body weight
  - Higher %age of body water
  - High rate of water turnover
  - Limited capacity of kidneys to handle solute load from high protein intakes required for growth
  - Susceptibility to dehydration
  - Inability to express thirst

Recommendation corresponds to water-energy ratio in human milk and formulas

‘Growth” and Specific Nutrients

- Energy
- Protein
- Water
- Calcium
- Zinc
- Iron
- Vitamin B12
- Vitamin D
- Vitamin A
- Folate
- Vitamin C
- Biotin
- Chloride
- Thiamine

Calcium, zinc, iron

- Deficiency (in the presence of adequate intake of other nutrients) leads to growth failure

Iron deficiency anemia
### Vitamin B12

- **No reports of overt toxicity**
- **Overt deficiency documented among infants and children who are fed no animal foods & are not supplemented**
  - 15 mo old infant
  - Breastmilk only, 10 x/day
  - Appeared well-nourished
  - Refused solids
  - Demonstrated developmental delay
  - < blood B12, folate, Fe

- **Mother, appeared well-nourished**
  - taking extra Vit A, 100ug B12, 3-4000mg Vit C/day
  - Reluctant to D/C breastfeeding
  - Worried re: intro of solids, allergies

### Infant outcome
- Infant treatment
  - supplemented
  - 1000 ug B12 IM
  - PolyViFlor
- Infant outcome
  - fully recovered

### Vitamin D

- **Most toxic of fat soluble vitamins**
- **Infants susceptible to toxicity**
- **Signs - cerebral, cardiovascular, renal damage**
- **Problems with excess supplementation**
  - 3-4000IU/day = hypercalcemia
  - Excess Vit D = calcium deposits in soft tissue, can \( \Rightarrow \) irreversible kidney damage

### Vitamin D deficiency rickets

- **At risk:**
  - Long term breast feeding, w/o suppl
  - Dark skinned children w limited exposure to sunlight
  - No animal products, no supplementation, no fortified milk
- **Classic symptoms of deficiency**
  - delayed motor function
  - hypotonia
  - bowing of legs
  - abnormal gait
  - saber shins

### Vitamin D deficiency rickets

- **Recommendation**
  - Infants = 200 IU/day minimum beginning in 1st 2 mo of life
- **Toxicity**
  - 3000-4000 IU/day

### Vitamin A

- **Recommendation**
  - 1000 IU/day
- **Deficiency**
  - night blindness
  - skin lesions, hair loss, blurred vision, diarrhea
  - liver, kidney, bone damage
- **Toxicity**
  - 3000 supplemented RE (10,000 IU/day) daily for a year
  - infant who was fed chicken livers daily
  - infants who receive adult supplements
**Vitamin A**

- A. 7 mo old twins with irritability, vomiting, bulging fontanels
  - Intake: 4 oz chicken liver/day for 4 mo

- B. Infant fed 18,500 IU daily for 1 mo
  - Liver = 15,000 IU/oz
  - Vitamins = 3600 IU
  - Formula = 400 IU
  - Carrots, squash = 4000 IU provitamin A

Recommendation: Infants = 1000 IU/day
Toxicity: 3000ugRE (10,000IU)/day for a year

**Ascorbic acid**

- Deficiency
  - scurvy
- Excess
  - nausea, diarrhea

- Recommendation:
  - Infants = 35 mg

- Toxicity
  - 1-2 gm/day
- Chewables
  - dental enamel erosion?

**Folate, Vitamin C, Biotin, Chloride, Thiamine**

- Single nutrient deficiency in infant formulas have led to growth failure, neurological damage and death

**What are the nutritional recommendations for infants and toddlers?**

- **Breast milk** or formula provides adequate nutrition up to the age of one year.
  - Breast milk has important immunogenic properties
- Solid food are introduced beginning at 4-6 months- developmental readiness
- ‘Least-allergic’ foods introduced first
  - e.g., rice cereal
  - additional foods added gradually, one at a time.
- Whole cow’s milk can be used after age 1 year.

**Supplements for the first 6 months**

- **Breast milk**
  - Vitamin D = 400 IU
  - Fluoride = 0.01-0.25 mg
- **Commercial infant formula**
  - fluoride= none if in water or 0.25 mg
  - iron+ 5-10 mg at 4 mo..
Children for whom Vitamin and Mineral Supplements are Recommended for Children— particularly at risk for limited nutrient intake—
- with milk allergy or lactose intolerance
  - riboflavin, Vit D, calcium
- exclusively fed goat’s milk
  - folacin
- semi-synthetic diets
- whose families have chosen to be vegetarian or vegan
- with restricted variety - by personal choice

Introducing Solid Foods

- Why introduce solids?
  - Develop oral motor skills, add nutrients
- Foods to support developmental progress—Which foods? When to add?
  - Cereal, fruits, vegetables, juices, crackers
- Foods to provide specific nutrients
  - Calcium, iron, protein, vitamin C, vitamin D
- Oral health concerns

Potential disadvantages of early introduction of solid foods

- Poor oral motor coordination
- Insufficient energy and nutrient replacement for breastmilk or infant formula
- Increased risk of food allergies
- Disturbance of appetite regulation, may encourage overfeeding
- May increase the infant’s desire for sugar and salt intake later in life

Consequences of too early weaning

- Risk of increased morbidity due to diarrhea and food allergies
  - due to intestinal immaturity
- Decreased breastmilk production
  - displaced by weaning foods
- Malnutrition
  - due to diarrheal disease

Consequences of delayed weaning

- Faltering growth
  - breast milk alone provides inadequate energy
- Depressed immunity
  - due to inadequate energy & protein intake
- Increased diarrheal disease
  - due to depressed immunity
- Malnutrition
  - due to inadequate energy, diarrheal disease
- Micronutrient deficiencies
  - due to inadequate dietary intake, increased needs with infection

Food Patterns - Appropriate Energy Intakes

<table>
<thead>
<tr>
<th>Age 2 mo</th>
<th>6 Mo</th>
<th>10 mo</th>
<th>4 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>6 kg</td>
<td>7.5 kg</td>
<td>9 kg</td>
</tr>
<tr>
<td>Energy intakes</td>
<td>650</td>
<td>750</td>
<td>850</td>
</tr>
</tbody>
</table>

Appropriate milks
- 28-32 oz human milk or formula
- 28 oz human milk or formula
- 24 oz human milk or formula
- 24 oz milk

Appropriate foods
- 4 TB dry cereal
- 4 oz fruit
- 5 TB strained fruit
- 8 TB dry cereal
- 4 oz fruit juice
- 14 TB chopped fruit
- 8 TB chopped vegetable
- 6 TB chopped meat
- ½ slice toast
- 2 TB ice cream
- 2 graham crackers
- ½-3/4 c dry cereal
- 6-8 oz fruit juice
- 1 med apple
- 1 small banana
- ¼ c green beans
- 2 oz lean hamburger
- ¼ c macaroni & cheese
- 2 TB peanut butter
- 1 tsp jelly
- 3 slices bread
- 1 graham cracker
- 1/3 c ice cream

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<table>
<thead>
<tr>
<th>Foods as sources of iron</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron-fortified formula</td>
<td>8 oz</td>
</tr>
<tr>
<td>Infant cereal, rice</td>
<td>1 TB</td>
</tr>
<tr>
<td>Strained meats with vegetables</td>
<td>2 TB</td>
</tr>
<tr>
<td>Strained beef</td>
<td>2 TB</td>
</tr>
<tr>
<td>Meats</td>
<td>2 oz</td>
</tr>
<tr>
<td>Egg</td>
<td>1</td>
</tr>
<tr>
<td>Peanut butter</td>
<td>1 TB</td>
</tr>
<tr>
<td>Bread, enriched, white</td>
<td>1 slice</td>
</tr>
<tr>
<td>Macaroni, enriched, cooked</td>
<td>¼ c</td>
</tr>
<tr>
<td>Vegetables</td>
<td>¼ c</td>
</tr>
<tr>
<td>Fruits</td>
<td>¼ c</td>
</tr>
<tr>
<td>CherriOs</td>
<td>½ c</td>
</tr>
<tr>
<td>Rice Chex</td>
<td>½ c</td>
</tr>
</tbody>
</table>