Growth and Maturation

Chapter 6
Growth and Maturation

Parents, childcare givers, and clients want to know if they are growing normally?

Effects of maturation on motor development.
Concept 6.0: Measuring Growth in Length and Stature

- *Recumbent length* is measured from birth until a child is able to stand
  - Measured from the vertex (highest point on skull) to the soles of the feet
Measuring Growth in Length and Stature

- **Stature** or standing height is measured between the vertex and the floor
- Preferred measurement of body length
Measuring Growth in Length and Stature

- Stature can be estimated in the elderly and/or disabled populations from *recumbent knee height*
Calculation of Stature from Knee Height

<table>
<thead>
<tr>
<th>Stature Men</th>
<th>Stature Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>65.19 – (0.04 x age) + (2.02 x knee height)</td>
<td>84.88 – (0.24 x age) + (1.83 x knee height)</td>
</tr>
</tbody>
</table>
Growth in Length and Stature

At Birth
  – Boys ~ 20 in
  – Girls ~ 19.75 in

At one Year 1
  – Boys ~ 30 in
  – Girls ~ 29.25 in
Growth in Length and Stature

• Adolescence
  – 20% of adult stature is attained during this 2 ½ to 3 year period

• Median age in females (17-18 years old) and in males (21-22 years old) when growth in stature ceases

• Stature is stable between ages of 30-45

• Above 45 years of age stature decreases
Growth in Length and Stature

- Plots accumulative growth over time

Typical distance curve for stature
National Center for Health Statistics growth velocity charts for girls on variable stature

- Plots increments of change per unit of time
- Can determine periods of fast and slow growth
Boys: 2 to 20 years

Girls: 2 to 20 years

Stature-for-Age

Use these charts to determine if an individual is growing normally.
Measuring Body Weight

- Electronic digital scales, calibrated in metric units are recommended
- Chair scales are available for those who are not capable of standing
Growth in Body Weight

- **Median Birth Weight**
  - Boys ~ 7.5 lb
  - Girls ~ 7.0 lb
  - Day 1-3 postnatal, infant may lose up to 10% of body weight

- **Year 1**
  - Boys ~ 22.5 lb
  - Girls ~ 21 lb
Growth in Body Weight

- Year 2 ~ gain of 5.5 lb
- Years 3-5 ~ gain of 4.5 lb
- Year 6 – Adolescence
  - Slight increase in rate of weight gain of 6.5/ year
- Adolescence
  - Males add about 45 lb of body weight
  - Females add about 35 lb of body weight
Growth in Body Weight

• *Peak weight velocity* = maximum rate of growth in body weight
  – Occurs after peak height velocity

• Mature body weight is approximately 20x that of birth weight
Growth in Body Weight

• Above 19 years
  – Weight is a matter of nutritional and exercise status

• Pregnancy
  – Some weight gain during pregnancy is permanent
  – Women who have children weigh more than childless women
Growth in Body Weight

Typical distance curve for body weight

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Body weight across one’s lifespan

Bodyweight peaks at the age of 45
Age 45-60, body weight declines or remain stable.
64% of US adults are either overweight.
Over the last 20 year, the number of overweight children between 6-11 years has doubled; 12-19 years of age has tripled.
National Center for Health Statistics growth velocity charts for boys and girls on variable body weight
Concept 6.1: Body Mass Index (BMI)

- Calculating BMI
- Healthy adult = 18.5-24.9
- Underweight = <18.5
- Overweight = 25-29.9
- Obese = ≥30

\[ BMI = \frac{wt\ (kg)}{ht\ (m^2)} \]
BMI (body mass index) is used to determine overweight.

Ideal BMI ranges between 18.5-24.9 kg/m²

Overweight is 25-29.9 kg/m²

Any individual over 30 kg/m² is obese
Mary is a 46-year-old woman who weighs 132 pounds and is 65 in. tall. Calculate Mary’s BMI. Is Mary overweight?
Solution

Convert weight

\[
\frac{132 \text{ lb}}{2.2} = 60 \text{ kg}
\]

Convert height

\[
65 \text{ in} \times 0.0254 = 1.65 \text{ m}
\]

\[
BMI = \frac{60}{1.65^2}
\]

\[
BMI = 22.1 \text{ kg/m}^2
\]
BMI Chart

• Is Mary overweight?
• NO, her BMI is normal

• <18.5 = underweight
• 18.5-24.9 = normal weight
• 25-29.9 = overweight
• >30 = obese
BMI-for-Age

- **Adiposity rebound**: upward trend occurring after the low point on the BMI percentile curve
  - The earlier the adiposity rebound occurs in a child, the more likely BMI will be high in adulthood
BMI-for-Age

• In children and adolescents, BMI-for-age is best used as a guide to determine individual nutritional status
• BMI-for-age between 85th percentile and 95th percentile is classified as risk for becoming overweight
• BMI-for-age greater than 95th percentile, overweight is a concern
BMI-for-Age

• NHANES, between 1960 and 2000
  – Children and adults are fatter
• In adults
  – Mean height has increased 1 in
  – Mean body weight has increased 24 lb!
• In children
  – 6-11 yr, both boys and girls are 9 lb heavier
  – 12-17 yr, boys are 15 lb heavier and girls are 12 lb heavier
Concept 6.2: Relationship between stature and weight to Motor Performance

• On average
  – Thin, muscular, and small-boned babies walk earlier
  – Infants who are long for their weight walk earlier

• Motor performance may be delayed in obese infants but catch up to peers within a year
Adolescent Awkwardness

• This refers to a period during the *growth spurt* where motor performance is disrupted
  – *Peak height velocity*
  – Estimated age for boys = 13.7 yr
  – Estimated age for girls = 11.8 yr
  – The phenomenon is not universal
Concept 6.3: Body proportions

- Ratio of head size to overall body length
  - Head contributes 25% to body length
  - Head circumference increase is an indication of brain development
- 55-60% of stature increase due to leg growth
- Ratio between biacromial (shoulder) and bicristal (hip) breadths
Changes in Shoulder and Hip Width %

- Bicristal/biacromial breadth x 100
Changes in the Center of Gravity

- A child’s center of gravity varies greatly because the head, trunk, and legs do not grow proportionally.
- The center of gravity is high in children because a large proportion of their weight is in the upper body.
  - Affects stability.
Changes in the Center of Gravity

• For the adult, the center of gravity to total height is 53-59%
  – Males have a higher center of gravity than females do
  – Center of gravity is associated with the center of mass
    • Men – chest
    • Women – hips
Concept 6.4: Body Proportion and Motor Performance

• Stability (balance) is a problem for young children due to their higher center of gravity and small base of support
• Balance is superior in women and girls due to their shorter legs and wider pelvis
  – Lowers center of gravity
Concept 6.5: Measuring Skeletal Health

• Dual-energy X-ray (DEXA)
  – Can measure differences among lean soft tissue, fat soft tissue, and bone tissue
  – Determines BMD – bone mineral density

• US is an aging society
  – More concern for bone diseases like osteoporosis
DEXA ~ Dual-Energy X-ray Apsorptiometry
DEXA ~ Bone Mineral Density Results

Patient, AP Spine

Facility: Acquired: 12/28/1995
43 years 12/01/1992 4.00
64.8 in 125.0 lbs White Female
66.8 in 128.0 lbs White Female
Physician: Analyzed: 03/20/1996
Printed: 07/01/1997

L2-L4 Comparison to Reference

Region

Young-Adult

Age-Matched

L1 0.988 87 -1.2 89 -1.0
L2 1.009 84 -1.6 86 -1.3
L3 0.979 82 -1.8 84 -1.6
L4 1.150 92 -0.3 94 -0.6
L2-L4 1.030 96 -1.4 93 -1.1

1. See appendices on spinae and summary.
2. QEX AP Spine Reference Population, Ages 20-65. See Appendices.
3. Normal for age, weight (BW=118.0 kg).

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• (a) Normal Bone

• (b) Osteoporotic Bone
Skeletal Development

- Bone growth (length and size)

- Bone maturity (amount of ossification)
Skeletal Development

• **Bone remodeling**
  – Occurs throughout the lifespan
  – Osteoblasts (building)
  – Osteoclasts (chewing)
Skeletal Development

• From birth to 35 yr – osteoblast activity > osteoclast activity
  – Gaining bone

• After 35 yr, osteoclast activity > osteoblast activity
  – Exercise and stress on the bones becomes important
Skeletal System

1. Women begin to lose bone minerals at about 30 and men at about 50.
2. Bone lose is called osteoporosis, results in bone with less density and tensile strength.
3. Calcium insufficiency during pre- and post-pubertal years in girls seem related to developing osteoporosis.
4. Estrogen deficiency in post menopausal women is major factor related to bone loss.
5. Chronic amenorrhea is related to decreased bone density.
Exercise & Bone Mineral Loss

1. Exercise is important to prevention and treatment of osteoporosis.
2. Elderly male athletes have greater mineral densities than aged non-athletes.
3. Females active at an early age tend to have higher bone mineral contents.
4. Excessive training in people is associated with less bone density in both men and women.
Concept 6.6: Maturation & Developmental Age

- **Chronological age**
  - Often used to denote maturity, but is a poor indicator

- **Developmental age**
  - Much better indicator of maturity
  - e.g., adolescence
  - Addresses variations in rate of maturation
Measures of Maturity

• Skeletal maturity (x-rays)
• Dental maturity (# of teeth & X-rays)
• Age of menarche (onset and frequency)
• Genitalia Maturity
Skeletal Maturity

3-year-old

5-year-old

14-year-old
Maturation and Motor Performance

• The level of maturation can affect motor performance
• Early maturing boys initially outperform late maturing boys (perceived advantage)
• Early maturing boys reach their motor and sport skill potential earlier.
• Once the late-maturing boys reach adolescence, the advantage is no longer evident & reach their full potential later.
Maturation and Motor Performance

• Early maturation in not associated with superior motor performance in girls, except in swimming
• Late-maturing girls have superior motor performance
  – Longer arms and legs
  – Narrower hips
The End