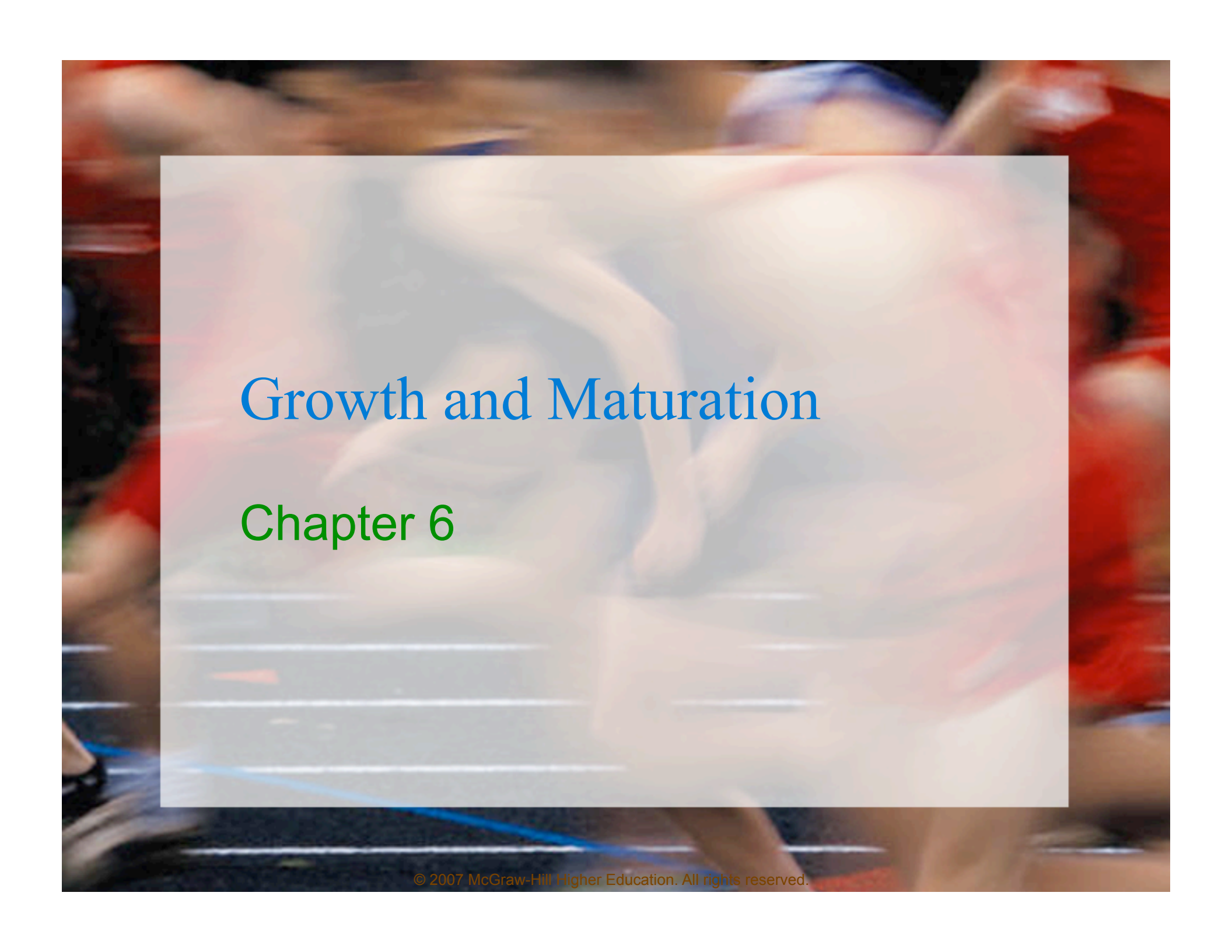




Growth and Maturation

Chapter 6



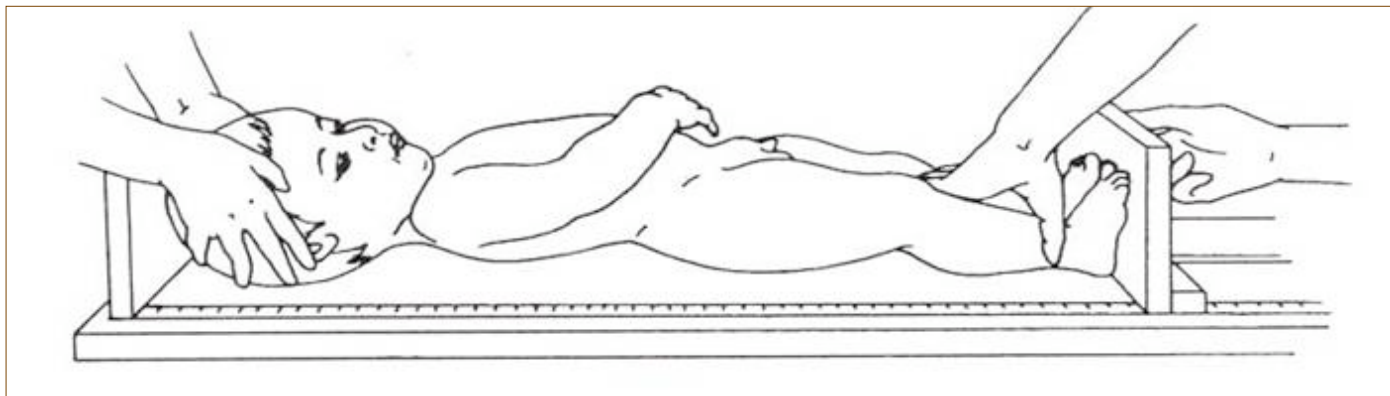
Growth and Maturation

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

Stature Men

$$65.19 - (0.04 \times \text{age}) + (2.02 \times \text{knee height})$$

Stature Women

$$84.88 - (0.24 \times \text{age}) + (1.83 \times \text{knee height})$$



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

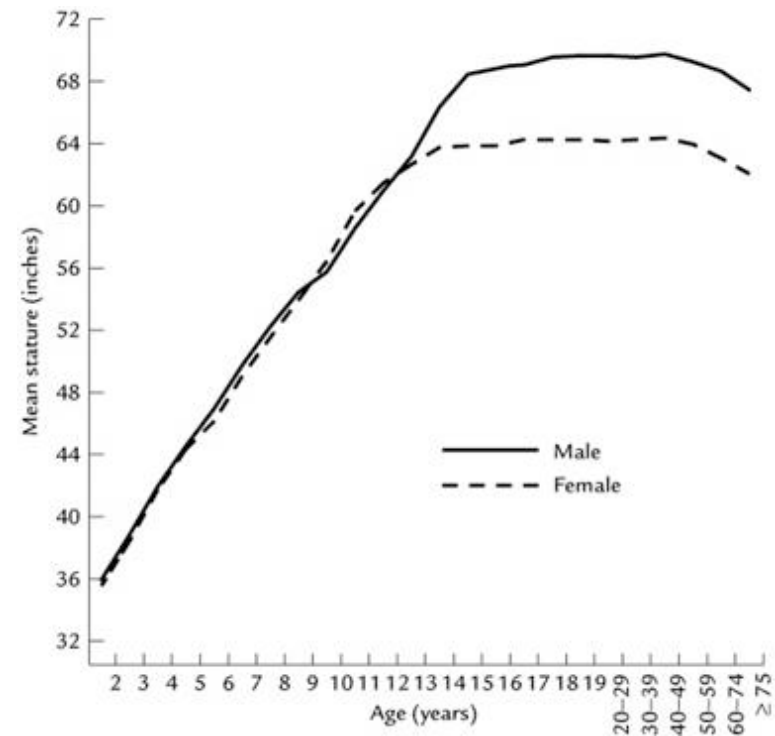


Growth in Length and Stature

- 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

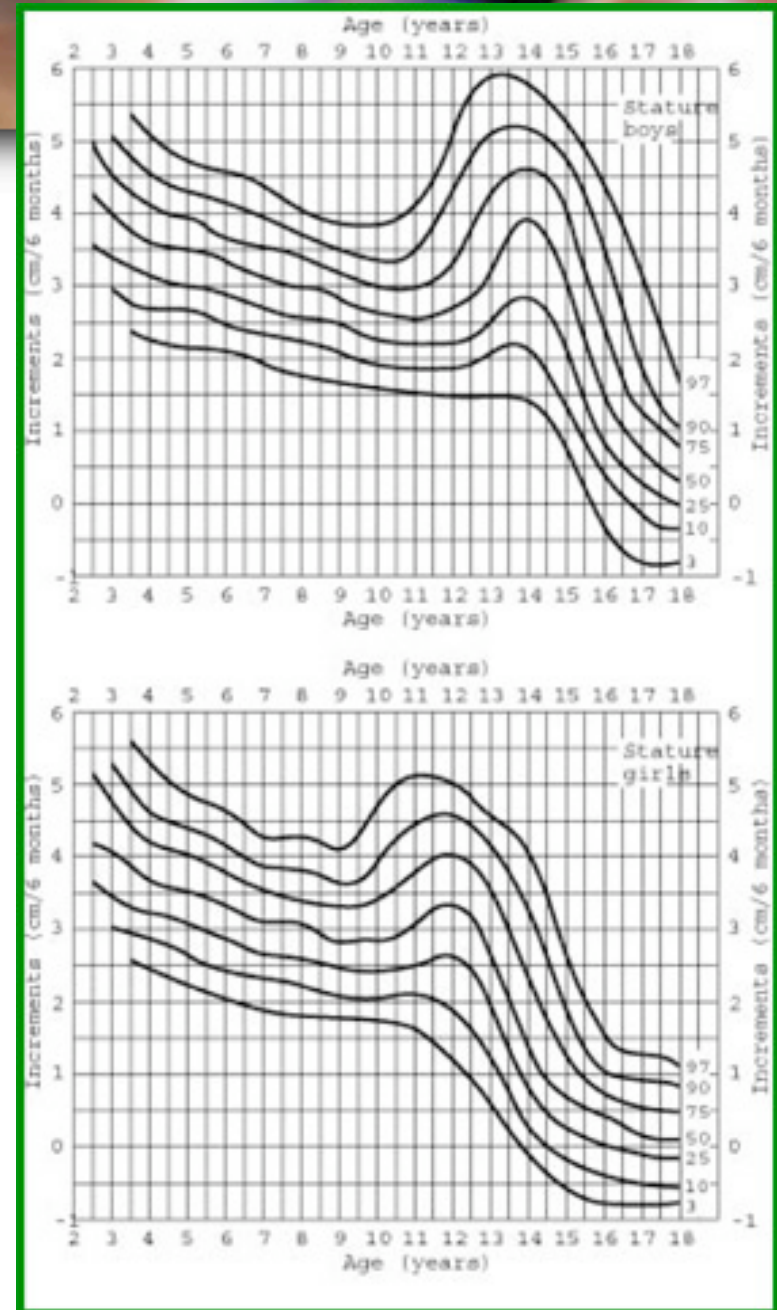
- Plots accumulative growth over time

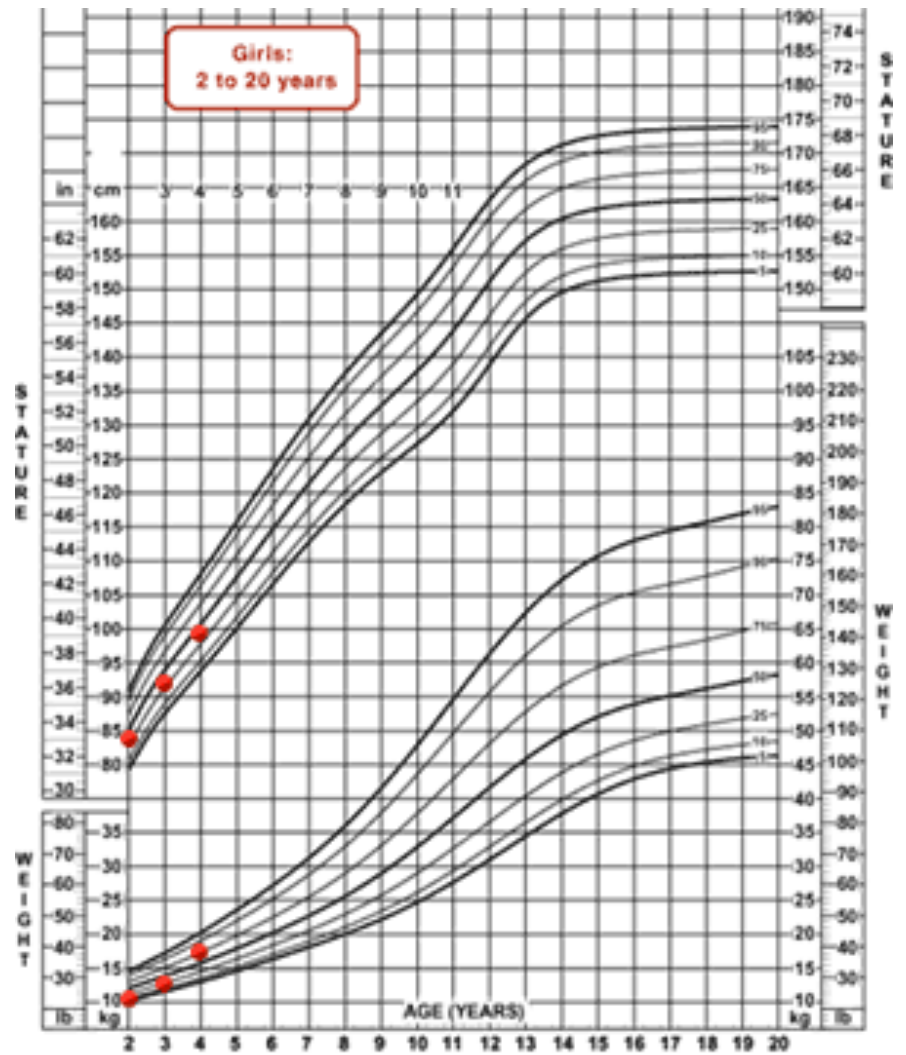
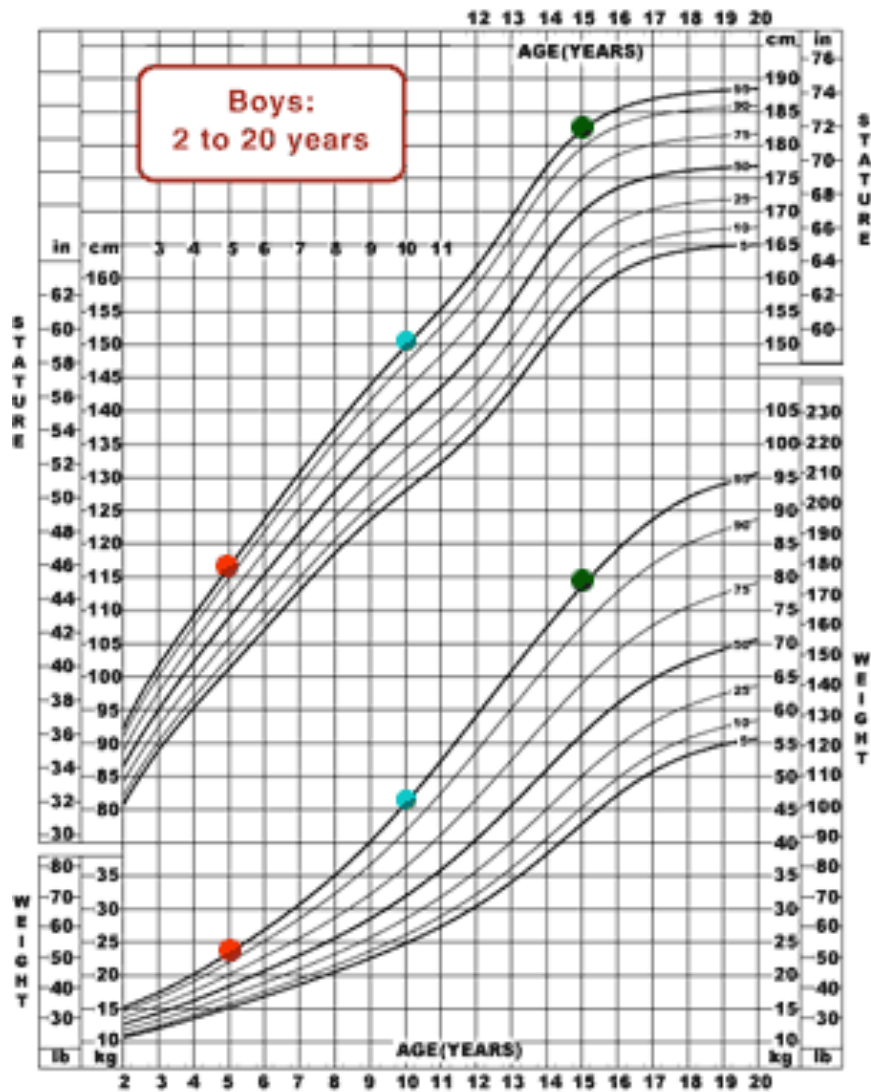


Typical distance
curve for stature

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

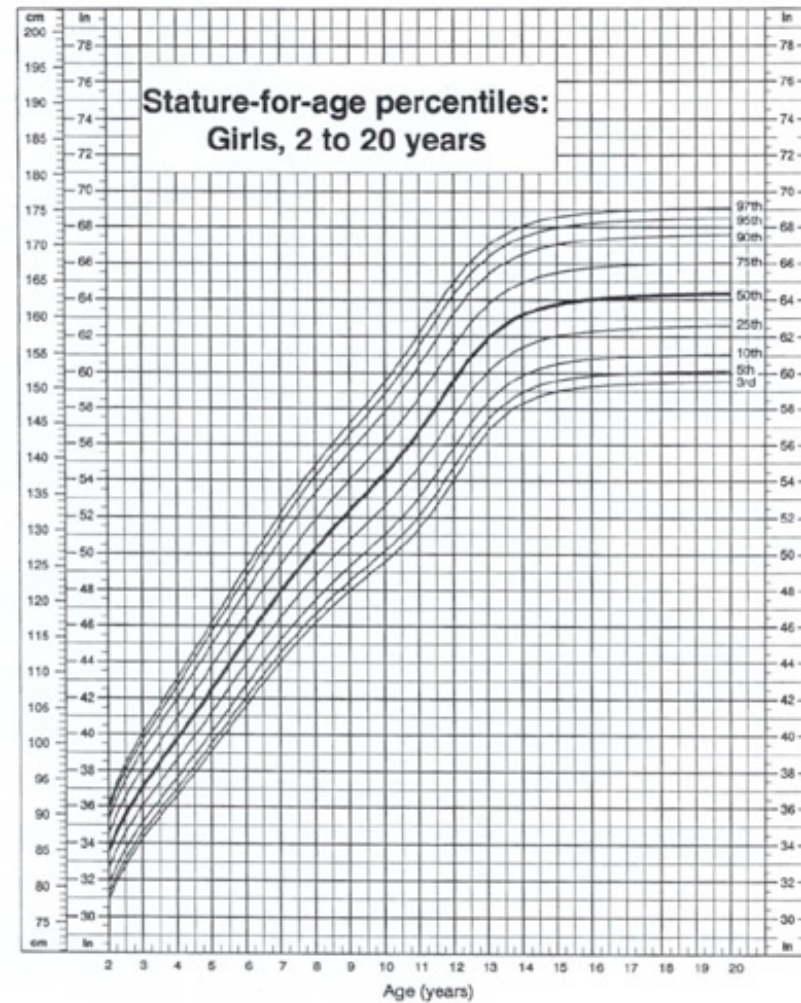
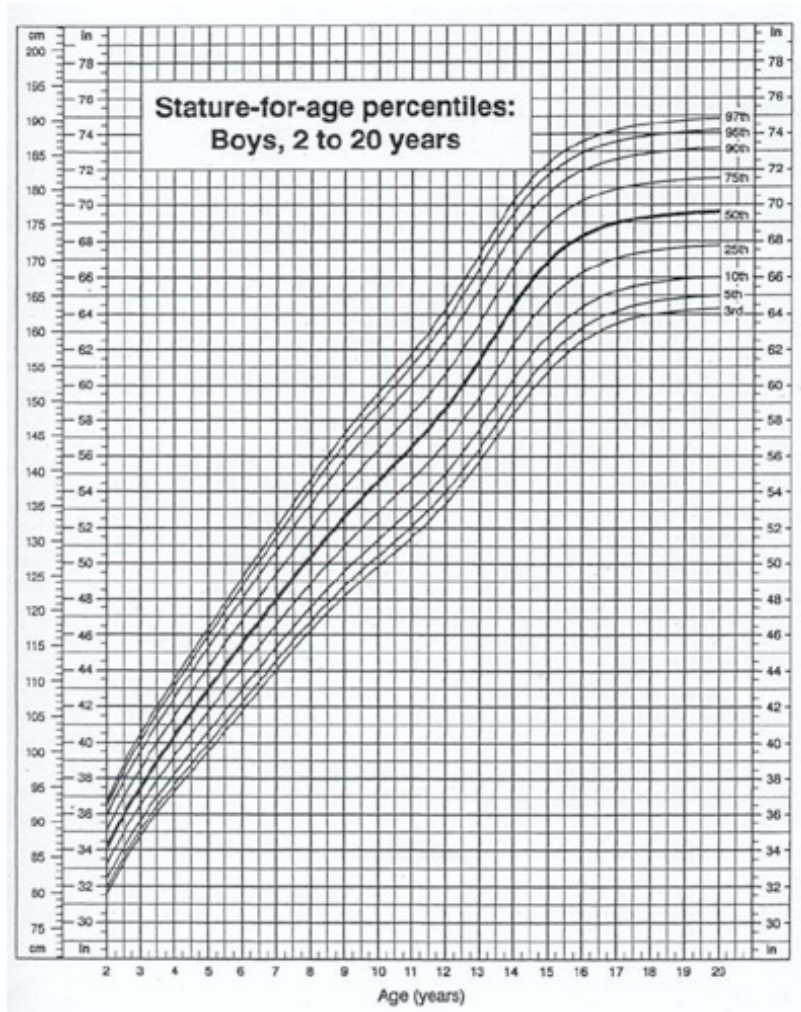




Stature-for-Age

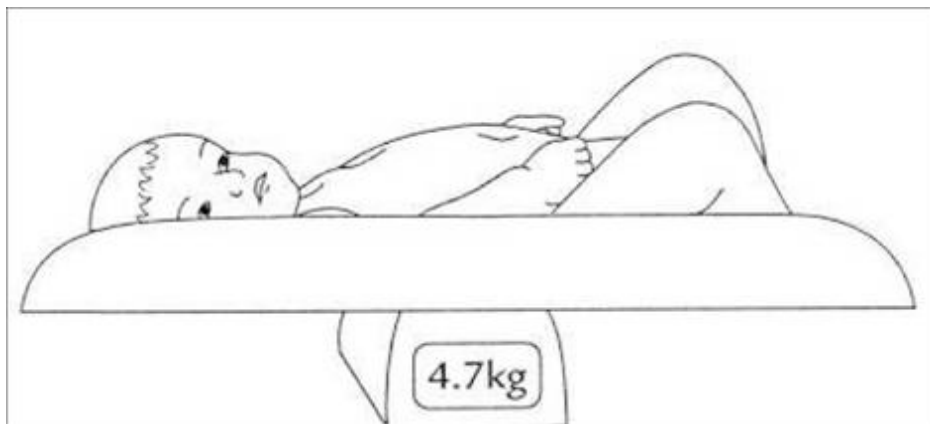
<http://www.cdc.gov/nccdphp/dnpa/growthcharts/training/modules/module3/text/page3d.htm>

Use these charts to determine if an individual is growing normally



Stature-for-Age Percentiles

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

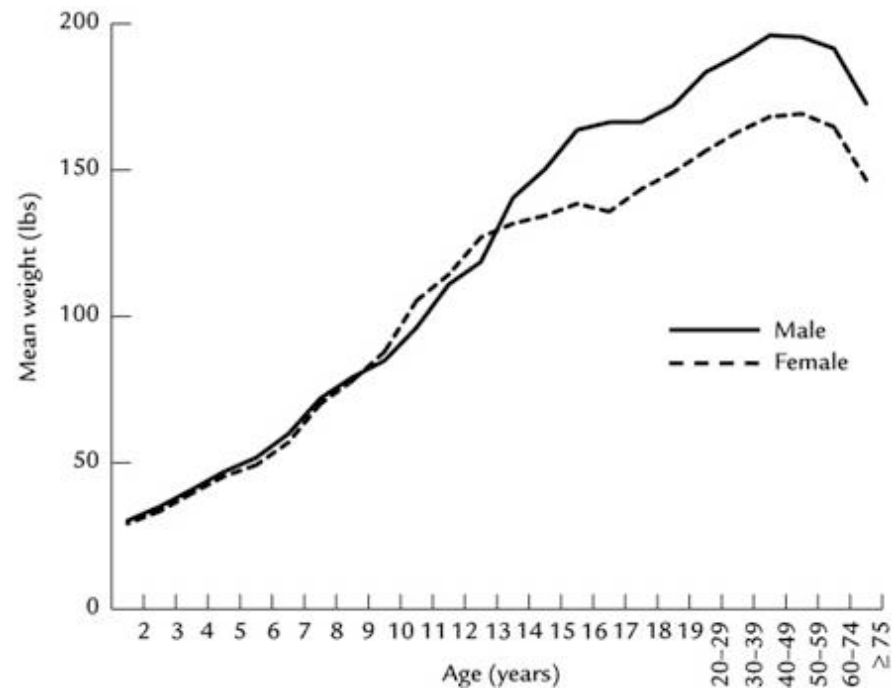


Growth in Body Weight

- 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





Body weight across one's lifespan

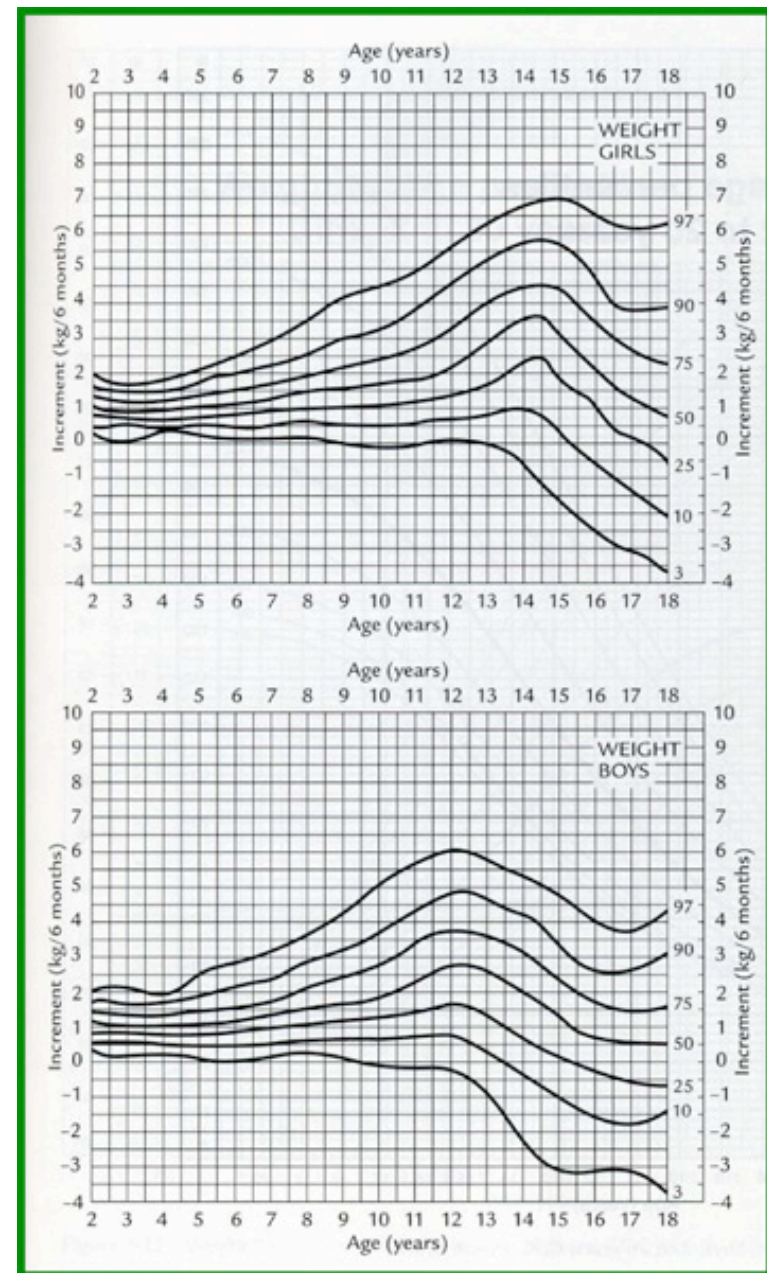
Bodyweight peaks at the age of 45

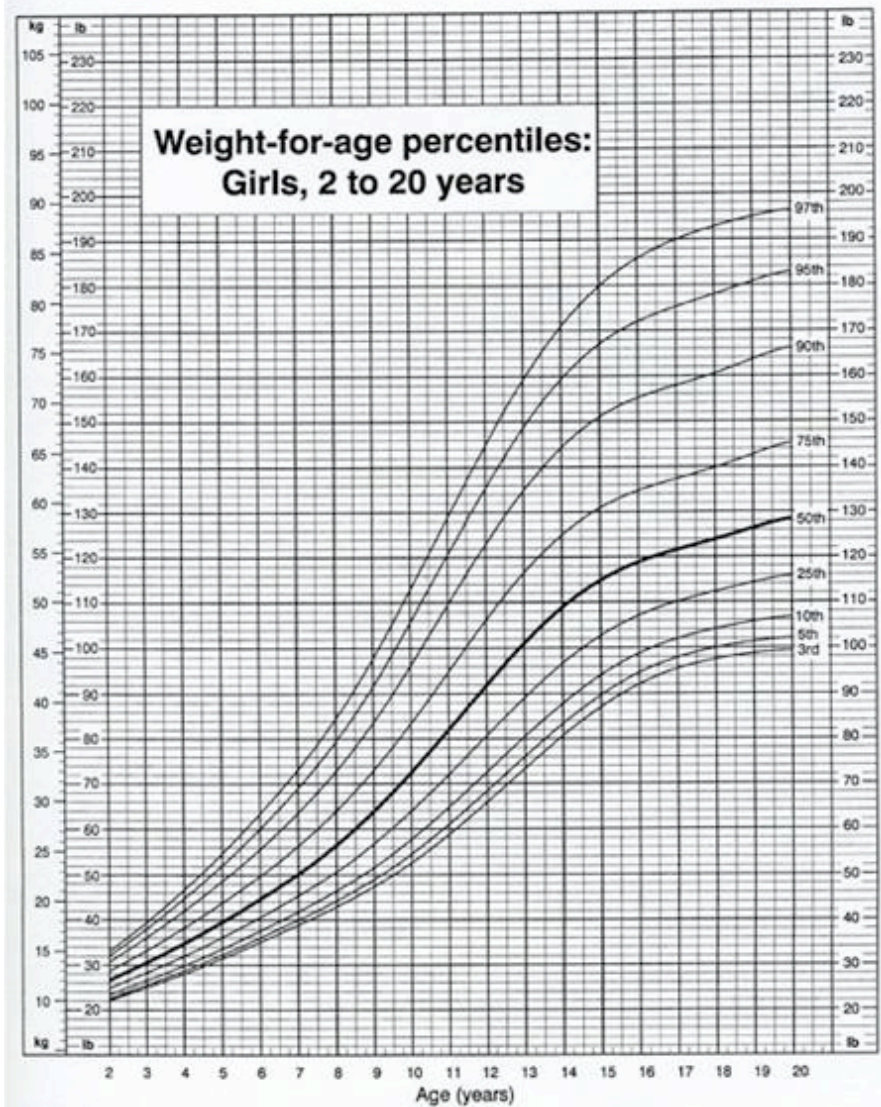
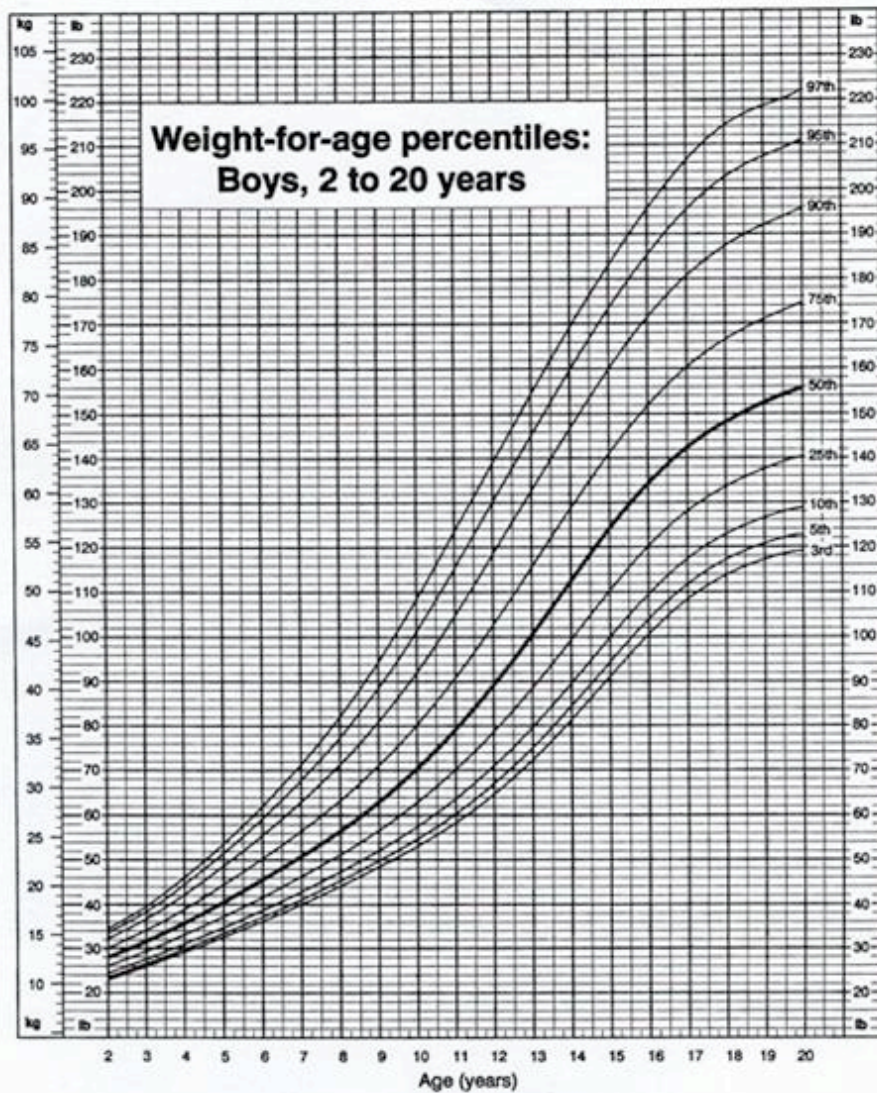
Age 45-60, body weight declines or remain stable.

64% of US adults are either overweight.

Over the last 20 year, the number of overweight children between 6-11years 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

BMI Table				
Height	BMI			
	25	27	30	35
58"	119	129	143	167
59"	124	133	148	173
60"	128	138	153	179
61"	132	143	158	185
62"	136	147	164	191
63"	141	152	169	197
64"	145	157	174	204
65"	150	162	180	210
66"	155	167	186	216
67"	159	172	191	223
68"	164	177	197	230
69"	169	182	203	236
70"	174	188	209	243
71"	179	193	215	250
72"	184	199	221	258
73"	189	204	227	265

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

$$65 \text{ in} \times 0.0254 = 1.65 \text{ m}$$

$$BMI = \frac{\text{weight (kg)}}{\text{height (m}^2\text{)}}$$

$$BMI = \frac{60}{1.65^2}$$

$$BMI = 22.1 \text{ kg} / \text{m}^2$$



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

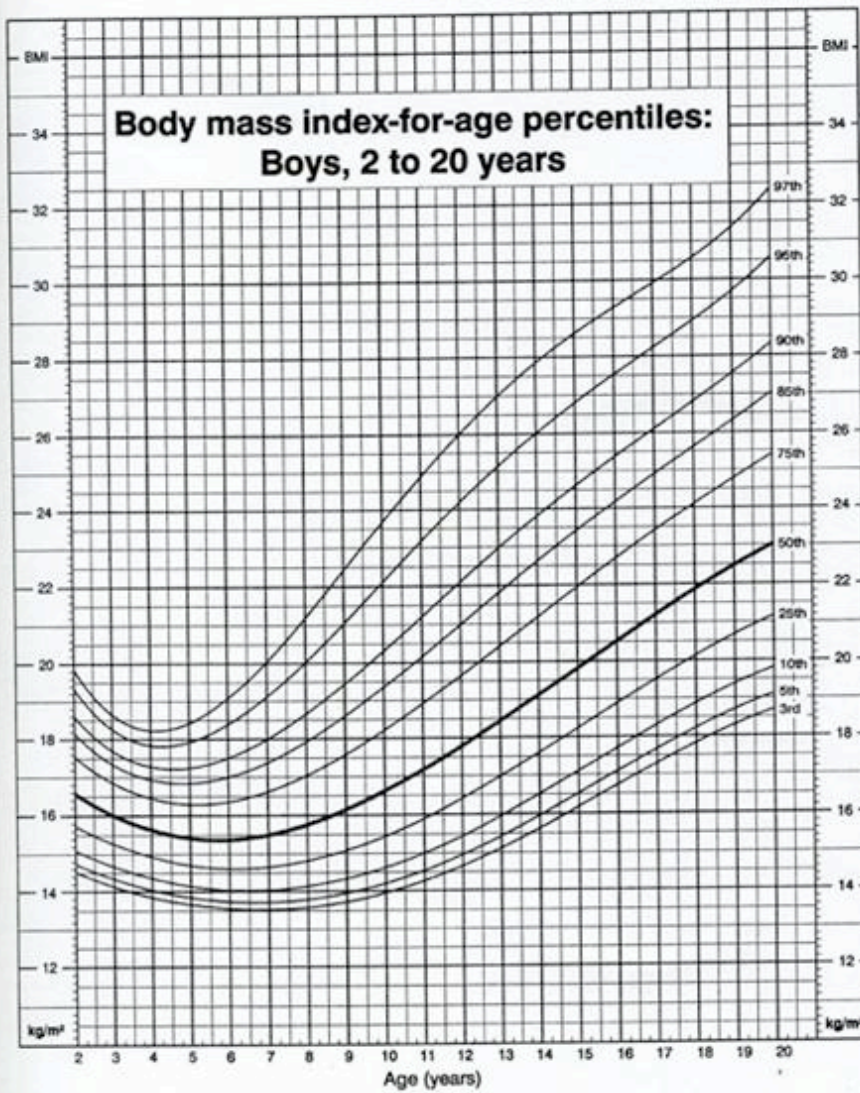
- **Adiposity rebound:** upward trend occurring after the low point on the BMI percentile curve
 - The earlier the adiposity rebound occurs in a child, the more likely BMI will be high in adulthood



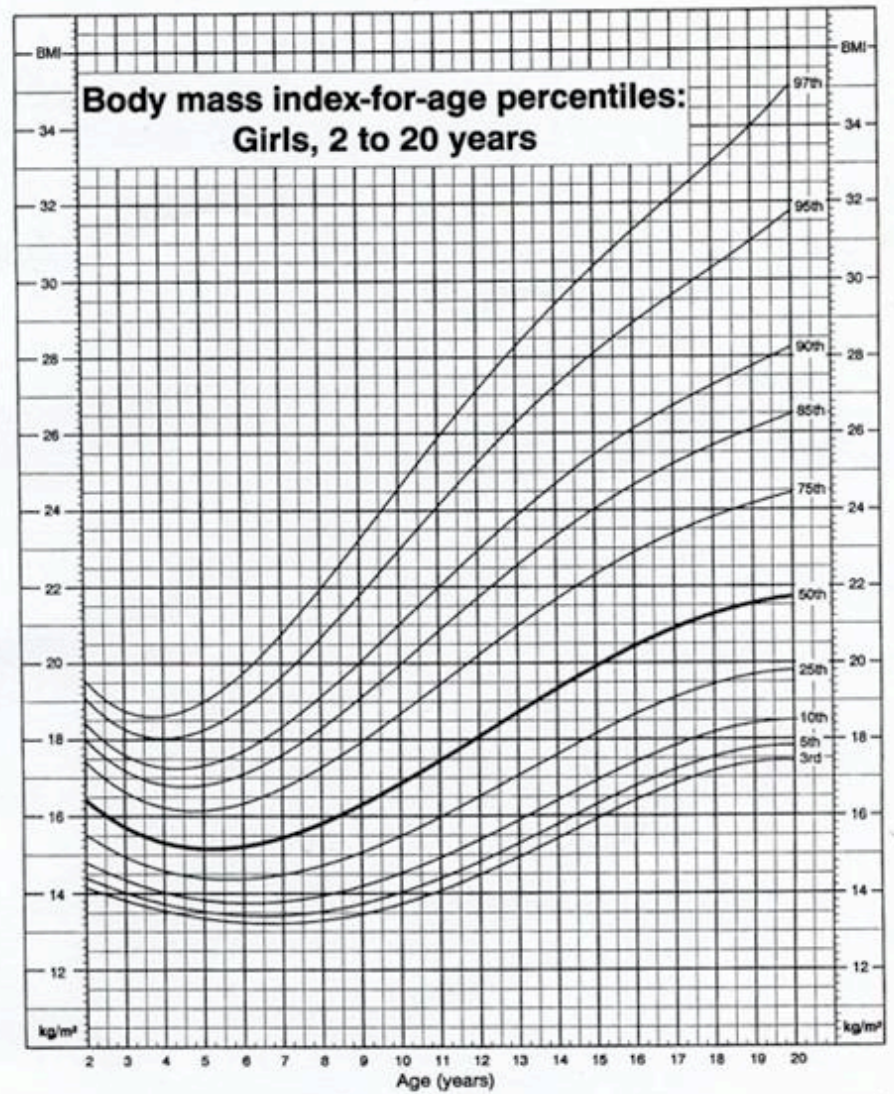
BMI-for-Age

- 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

**Body mass index-for-age percentiles:
Boys, 2 to 20 years**



**Body mass index-for-age percentiles:
Girls, 2 to 20 years**





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

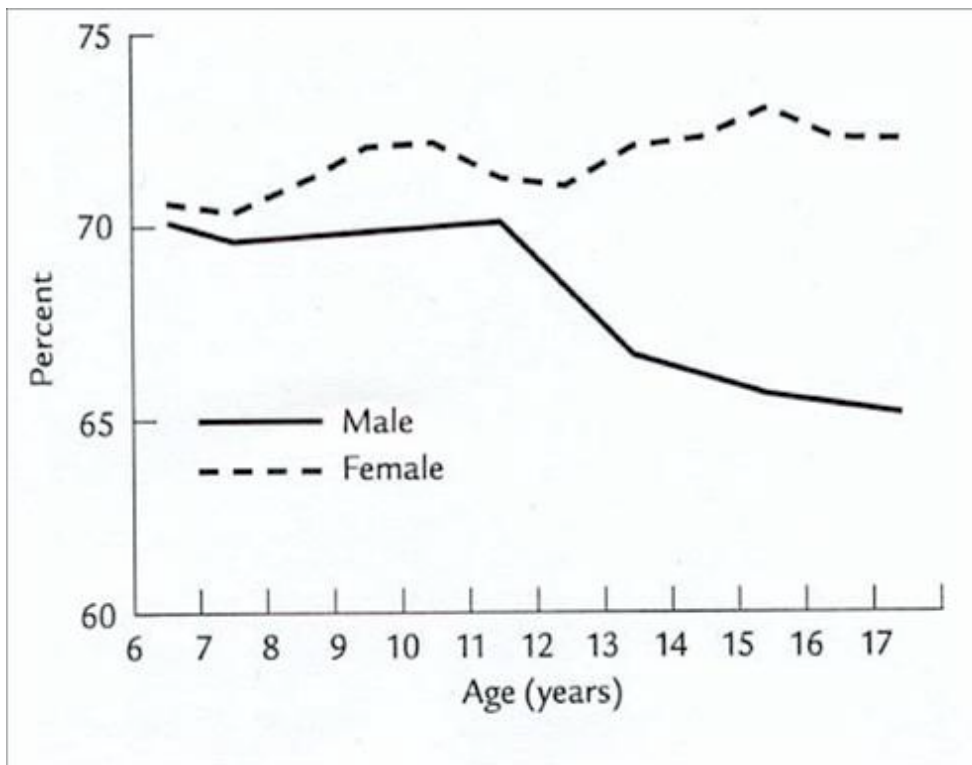


Concept 6.3: Body proportions

- Ratio of head size to overall body length
 - Head contributes 25% to body length
 - Head circumference increase is a 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





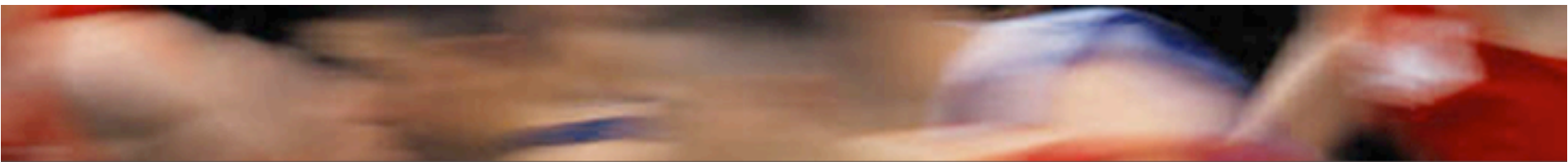
Changes in the Center of Gravity

- 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



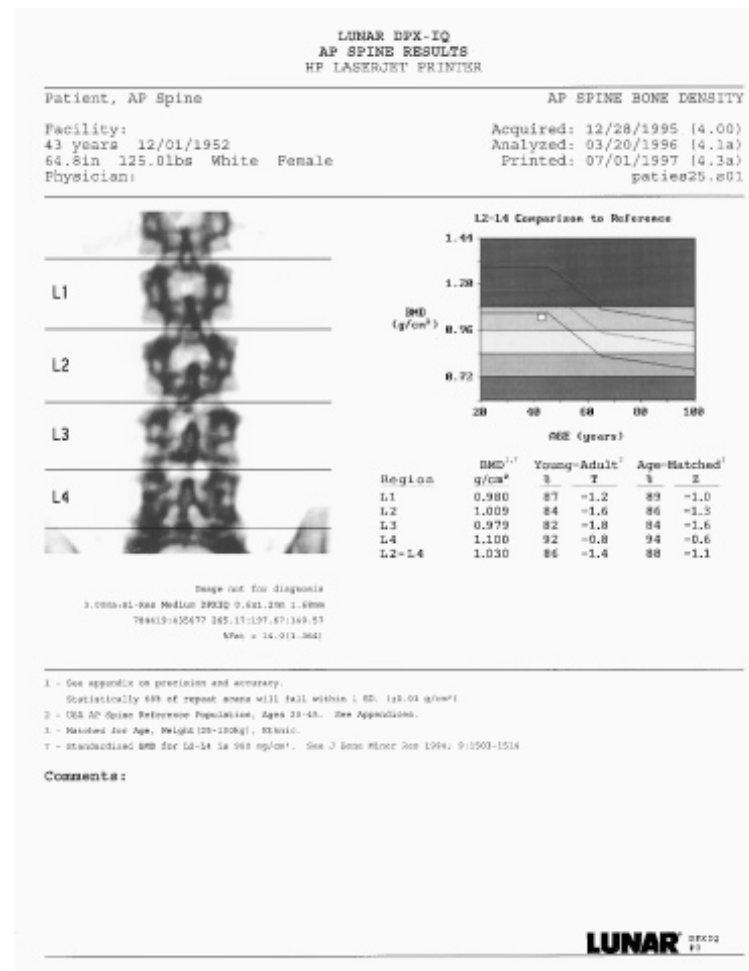
Concept 6.5: Measuring Skeletal Health

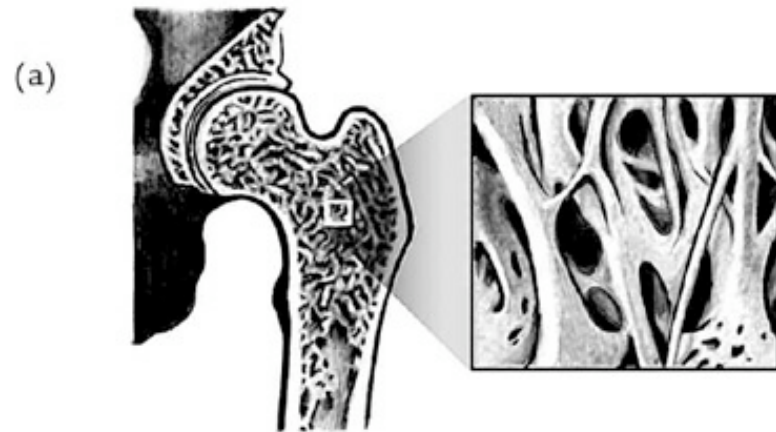
- Dual-energy X-ray (DEXA)
 - Can measure differences among lean soft tissue, fat soft tissue, and bone tissue
 - Determines BMD – bone mineral density
- US is an aging society
 - More concern for bone diseases like osteoporosis

DEXA ~ Dual-Energy X-ray Absorptiometry

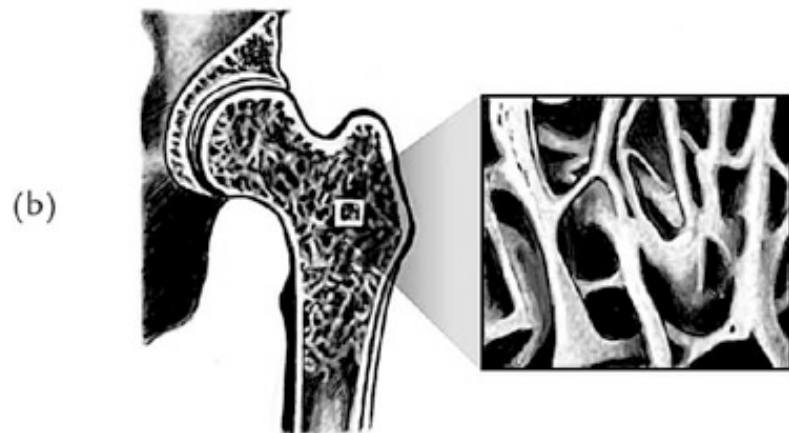


DEXA ~ Bone Mineral Density Results





- (a) Normal Bone



- (b) Osteoporotic Bone



Skeletal Development

- Bone growth (length and size)
- Bone maturity (amount of ossification)



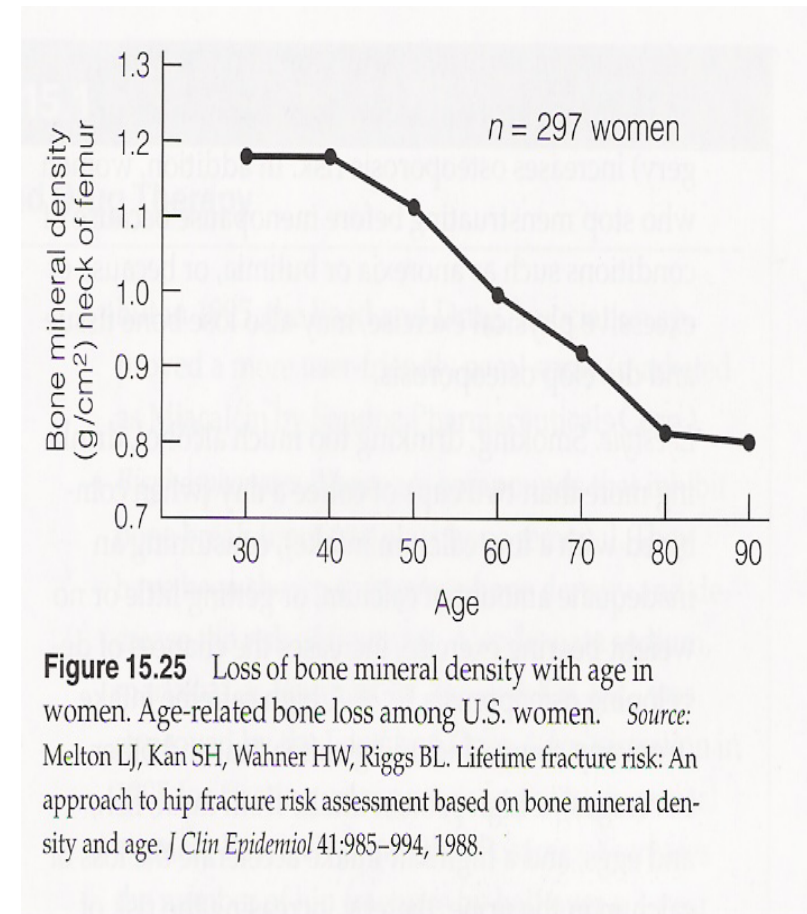
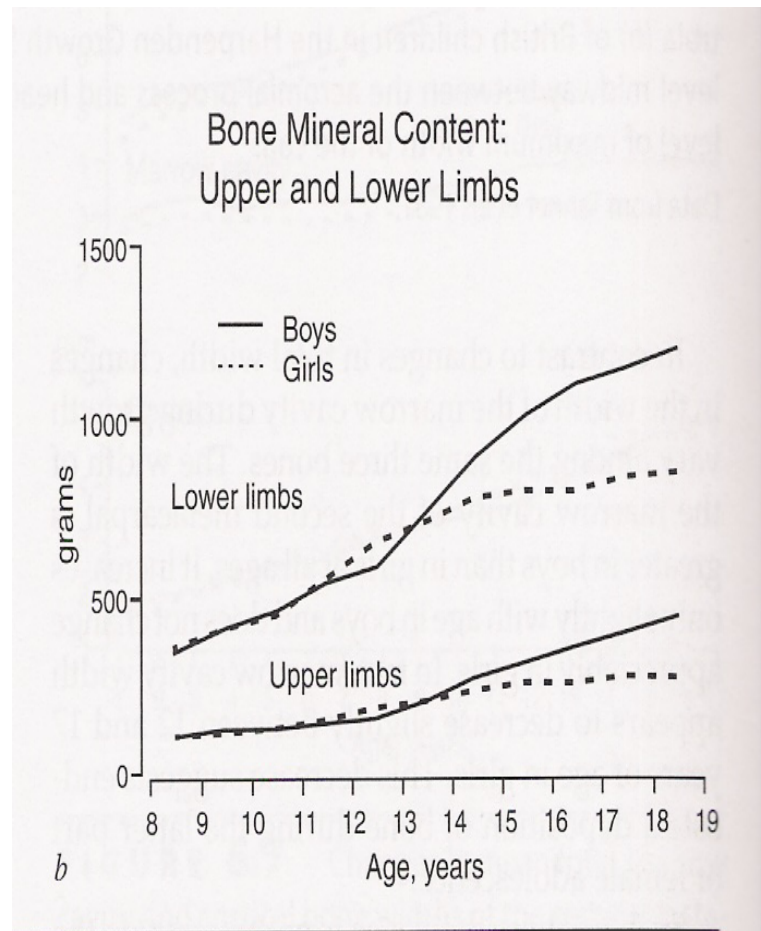
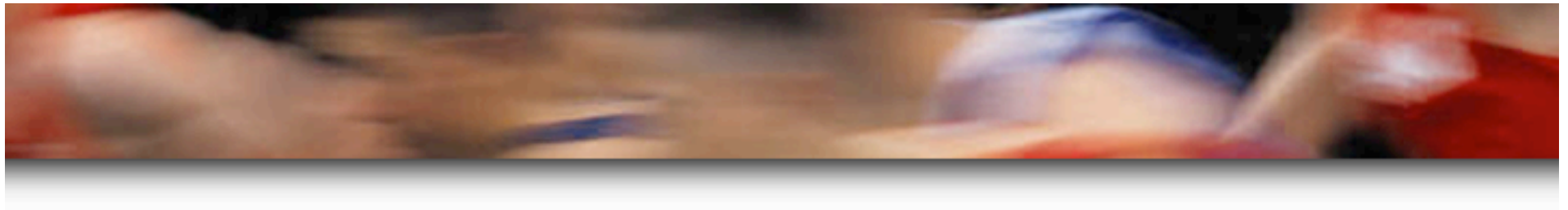
Skeletal Development

- ***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





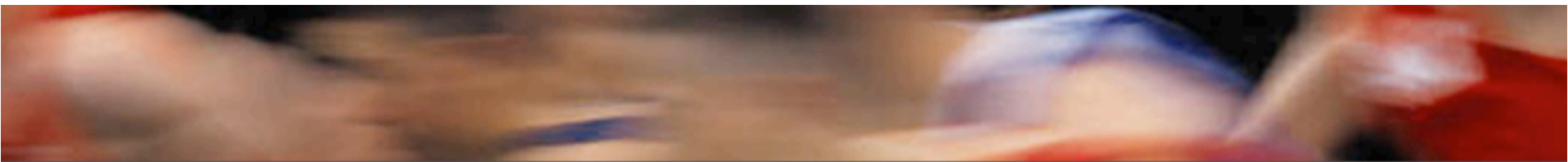
Skeletal System

1. Women begin to lose bone minerals at about 30 and men at about 50.
2. Bone loss 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

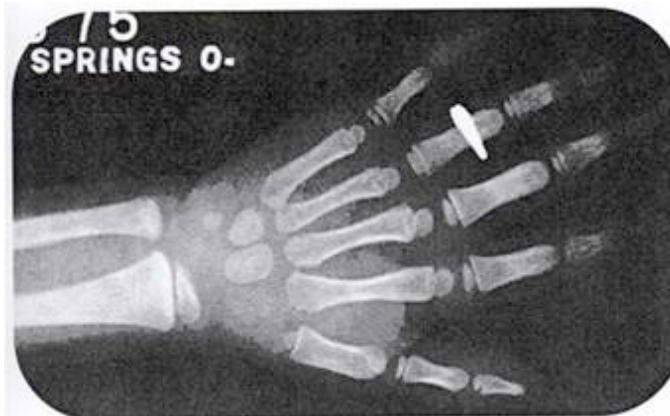


Measures of Maturity

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

Skeletal Maturity

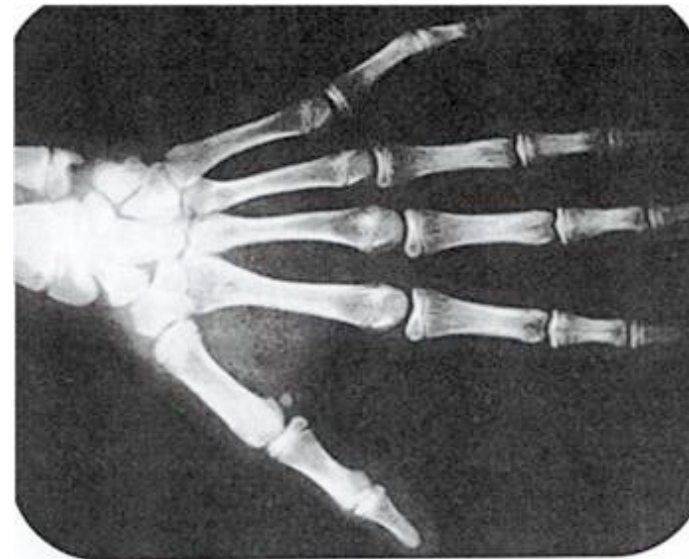
3-year-old

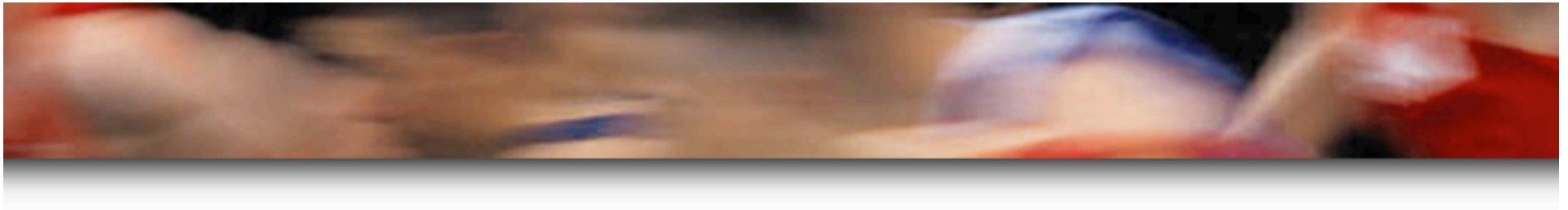


5-year-old



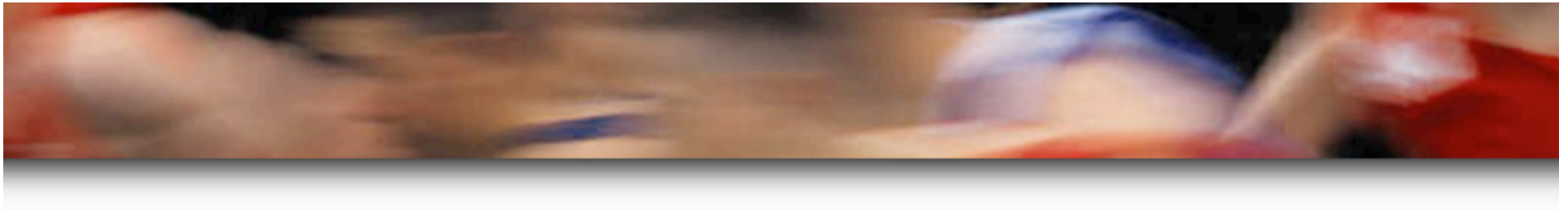
14-year-old





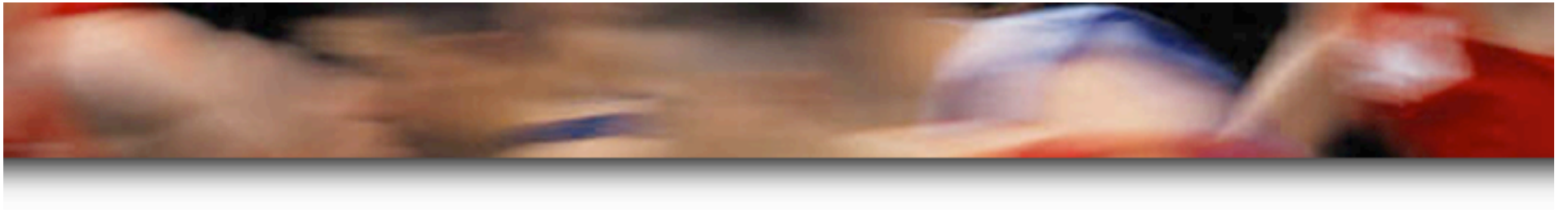
Maturation and Motor Performance

- 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 is 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