Physical Changes Across one Lifespan

Chapter 7
Physiological changes across one’s lifespan

- Cardiovascular
- Pulmonary
- Strength
- Flexibility
- Body composition
- Body weight (Chapter 6)
- Skeleton System (Chapter 6)
Developmental Exercise Physiology

• This lecture is based on principles and concept found in developmental exercise physiology literature and your text....
Cardiovascular Ability

“A person’s ability to deliver oxygen to the working muscles”

- Depends on heart rate
- Depends on stroke volume
- Depends on cardiac output
- Depends on maximal oxygen consumption
What happens to our heart rate across our lifespan?

Heart Rate and Age
- At birth it ranges from 120-140 bpm
- Then by 1 year of age it drops to 80-100 bpm
- It continues to drop and by late adolescence it is 57-60 (men) and 62-63 (women) bpm
- Then the HR increases but stabilizes in adulthood for both men and women is 75-80 bpm
- But after the age of 60, the HR declines slightly.

Important developmental physiological changes:
- When a newborn babies crying HR can reach 170 bpm
- From adulthood, Max HR declines at a rate of .8 bpm per year.
- Children’s heart rate at the same workload level is 30 to 40 beats per minute faster than a young adult.
Stroke Volume

How much blood is pumped from the heart with each beat.

- Depends on heart size
- Depends on contractile force
- Depends on vascular resistance of blood flow
- Depends on venous return
What happens to our stroke volume across our lifespan?

SV and Age
1. SV is 3 - 4 ml per ventricular contraction in children
2. SV is 40 - 60 ml per ventricular contraction in adolescence
3. SV is 70 – 90 ml in untrained male and 100-120 ml in a trained male
4. SV declines between the ages of 25-85 years of old by as much as 30%.

Physiological Changes associated with Stroke Volume

1. A cardiovascular trained person’s SV is greater than an untrained person’s SV.
2. Women have lower SV than males.
3. Elderly trained individual’s SV is slightly less than a young adult but declines as much as 20% for elderly untrained individual.
4. Children’s stroke volume is smaller therefore require a higher heart rate to work at the same workload level as an adult.
Cardiac Output

Amount of blood pumped out of the heart in one minute.
- Depends on heart rate
- Depends on stroke volume

HR X SV = CO
Cardiac Output Changes Across one’s lifespan!

1. CO is less in children than adults at rest and during exercise.

2. Adult average resting CO is about 5 liters per minute.

3. Maximal CO is dependent on physical condition and age.

4. Trained adults resting CO is 20-25 liters per minute.

5. CO reduces as much as 58% from the age of 25-85.

6. CO declines approximately 1% per year after the age of 25.

7. CO is the most important limiting factor for endurance performance in the aged.
Maximal Oxygen Consumption

- Called Max V0\(^2\)
- Amount of oxygen consumed per minute divided by the person weight in Kg.
Maximal Oxygen Consumption changes across one’s lifespan!

V0₂max & Age
1. Children under 6 V0₂max levels are 22-28 ml/kg/min
2. Children 6-16 in age, V0₂max values are 50-53 ml/kg/min
3. Girl’s V0₂max declines by the age of 16 and is 32% lower than a boy’s V0₂max
4. V0₂max declines .5-1% per year after the age of 20 because it is dependent on amount of fat tissue and lean muscle mass, one’s CO, and one’s level of physical activity.
5. Decreased muscle mass in the elderly contributes significantly to declines in V0₂max.
6. To live an independent lifestyle (not being in a wheelchair), an elderly person requires a minimum VO₂max of 20 ml/kg/min.
Cardiovascular Training

THIN FOR THANKSGIVING, THIN FOR THANKSGIVING...

THIN FOR THANKSGIVING, THIN FOR THANKSGIVING...

DARN RIGHT, DARN RIGHT...
Basic Trends in CV Ability across one’s lifespan!

Pre-adolescents children improvement in CV is related to growth and mechanical efficiency of walking and running, not CV training.

Adolescents CV due to training should show steady improvement in boys from 6-16 and in girls from 6-14.

An adult can improve CV ability as much as 20% with training.

Decline in CV in late adulthood and adulthood is dependent more on intensity of training and disuse than duration of training.
Pulmonary Function

Pulmonary function is dependent on:
- the pulmonary circuit
- the pulmonary respiration
- the pulmonary ventilation

Pulmonary function changes across one’s lifespan can be observed and measured by one’s lung volume.
Reserve capacities are:

- Inspiratory reserve volume = max volume inspired,
- Expiratory reserve volume = max volume expired,
- Tidal volume = volume inspired or expired per breath,
- Residual volume = volume remaining at end of max expired air.

Lung Volumes
Pulmonary Function

Reserve capacities steadily declines between 30 and 60 years of age.

After the age of 60, reserve capacities declines rapidly.

As we age, there is increased dependency

- on breathing frequency rather than tidal volume for ventilation, especially during increased exercise intensity.
Why does pulmonary functions decrease as we age?

– Enlargement of alveoli & decrease of vascularization

– Loss of pulmonary elasticity

– *Weakness of respiratory muscles.
Strength
Strength Changes Across One’s Lifespan

1. Little known in young children under 6 years of age.
2. Strength spurt lags at least a year behind height spurt in boys until puberty.
3. Girls strength spurt generally occur in the same year as growth spurt.
4. Strength changes become apparent during puberty.
   - Boys gain muscle mass where as girls develop body fat.
   - During puberty muscle development increases to about 40% of a boys total body weight.
5. Adult women’s absolute body strength is about 63.5 % of adult men’s strength.
6. Muscle mass begins to decline between ages of 25-50 years of age.
7. After the age of 50, muscle mass loss accelerates and by the time one is 80 years of age, one will have loss half of their muscle mass.
Is strength training effective for prepubescent children?

Recent studies indicated resistance training programs produced significant strength gains in prepubescent children (Payne and colleagues, 1997).

Resistance training programs can improve motor fitness skill and sport performance (NSCA, 1996).

American Academy of Pediatrics (2001) maintains the position:
   1. Weight training is safe but not power lifting or body building
   2. One should not train with maximal lifts before the age of 14
   3. If a child does do maximal lifting if should be conducted under knowledgeable adult supervision.
Adolescence to Late Adulthood
Strength Training

Period of time where you see the greatest gains in muscle mass (critical period)

Any type of progressive resistance training will improve muscular strength and endurance during this developmental period.
Strength Training & Aged

Age related decline in strength will occur but the rate of decline is less with training.

There is direct relationship between one’s strength and independent mobility.

Aged individual can improve their strength no matter at any age (McArdle, 2004) but little is know about the specifics (duration, intensity, or mode).

Resistance training is important for management of body fat:lean muscle mass ratio.

Aged lose muscle mass in both size and number of fibers especially type II (fast-twitch) over Type I, (slow-twitch).

Neural system is intact with the aged but the muscles contraction speed is reduced due to loss of Type II fibers.
Changes in flexibility across one’s lifespan?

Flexibility seems to peak in the late teens or early 20s.

Girls are more anatomically more flexible than boys.

Flexibility declines with age due to structural changes of the joint
- tendons become less elastic
- ligaments fray
- synovial fluid become less viscous
- cartilage becomes cracked

Flexibility can be maintained or improved with just being active (Munn’s Study)
Body Composition across one’s the lifespan

The average body fat at birth in boys is 11% and 14% for girls.

Two periods of rapid adipose tissue (fat) growth

1. Number and size of fat cells increase during first year of life to 26% for boys and 28% for girls.
2. During puberty females increase in number and size is greater than boys.

Only time adipose tissue (size & number of cells) in early life decreases is the onset of walking.

Body-fat Norms

1. 10-25% for men; 18-30% for women based on averages
2. Optimal fitness occurs at 12-18% for men; 16-25% for women.
3. 19% for men and 21% for women are IAR obesity standards developed from 60,000 adults.

There is a strong association between fat changes especially around one’s organs to incidence of heart disease.
Changes in Body Composition from Late Childhood to Young Adulthood

- Fat-free mass
- Fat mass
- Percent fat

Age, years

Boys
Girls
Adiposity Trend

• “…the earlier a child is “fat”, the “fatter” the child. The fatter a child will be at a later age.” (Guo et al. 2000)
Common Measures of Body Fat

- Hydrostatic weighting
- Circumference measures
- Skinfold
  1. 2 sites (medial calf & triceps)
  2. 3 sites
  3. 7 sites
Table 11.2
Linear Correlations between Body Density and Anthropometric Variables for Adults (Jackson and Pollock 1978; Jackson, Pollock and Ward 1980).

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>MEN (N = 402)</th>
<th>WOMEN (N = 283)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General Characteristics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height</td>
<td>-0.03</td>
<td>-0.06</td>
</tr>
<tr>
<td>Weight</td>
<td>-0.63</td>
<td>-0.63</td>
</tr>
<tr>
<td>Body mass index*</td>
<td>-0.69</td>
<td>-0.70</td>
</tr>
<tr>
<td><strong>Skinfolds</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chest</td>
<td>-0.85</td>
<td>-0.64</td>
</tr>
<tr>
<td>Axilla</td>
<td>-0.82</td>
<td>-0.73</td>
</tr>
<tr>
<td>Triceps</td>
<td>-0.79</td>
<td>-0.77</td>
</tr>
<tr>
<td>Subscapula</td>
<td>-0.77</td>
<td>-0.67</td>
</tr>
<tr>
<td>Abdomen</td>
<td>-0.83</td>
<td>-0.75</td>
</tr>
<tr>
<td>Suprailium</td>
<td>-0.76</td>
<td>-0.76</td>
</tr>
<tr>
<td>Thigh</td>
<td>-0.78</td>
<td>-0.74</td>
</tr>
<tr>
<td>Sum of Seven</td>
<td>-0.88</td>
<td>-0.83</td>
</tr>
<tr>
<td><strong>Circumferences</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waist</td>
<td>-0.80</td>
<td>-0.71</td>
</tr>
<tr>
<td>Gluteal</td>
<td>-0.69</td>
<td>-0.74</td>
</tr>
<tr>
<td>Thigh</td>
<td>-0.64</td>
<td>-0.68</td>
</tr>
<tr>
<td>Biceps</td>
<td>-0.51</td>
<td>-0.63</td>
</tr>
<tr>
<td>Forearm</td>
<td>-0.35</td>
<td>-0.41</td>
</tr>
</tbody>
</table>
What does it all mean?

<table>
<thead>
<tr>
<th>Gender</th>
<th>3 site</th>
<th>7 site</th>
<th>BMI</th>
<th>Body Cir.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>.80</td>
<td>.88</td>
<td>.69</td>
<td>.60</td>
</tr>
<tr>
<td>Female</td>
<td>.76</td>
<td>.83</td>
<td>.70</td>
<td>.63</td>
</tr>
</tbody>
</table>

1. Skinfold method is more accurate for men than women.
2. Body circumference are the poorest method to determine body fat %.
3. Seven site skinfold measures are more accurate than 3 site.
In Summary

• Gains and losses in our physiological abilities across is age dependent but the rate of change in our physiological abilities across our lifespan is dependent on our lifestyle and physical activity/exercise.

• Great physiological differences are found between a trained versus untrained person at all ages.
The End