Lecture 20: Fitness

Nutrition 150
Shallin Busch, Ph.D.

Physical Fitness
The ability to carry out daily tasks with vigor and alertness, without undue fatigue, and with ample energy to enjoy leisure-time pursuits and meet unforeseen emergencies (Thompson and Manore)

To Achieve Fitness...

Physical activity: Any movement produced by muscles that increases energy expenditure; includes occupational, household, leisure-time, and transportation activities (Thompson and Manore)

What is exercise?
Leisure-time physical activity that is purposeful, planned and structured.
Physical Fitness Reduces Risks of:
- Heart disease
- Stroke
- High blood pressure
- Obesity
- Type 2 diabetes
- Osteoporosis
- Colon cancer (potentially)
- Anxiety and mental stress

Physical Fitness Improves
- Longevity and health in later years
- Self image and confidence
- Sleep patterns
- Immune function
  - though in excess can reduce immune function

Physical Fitness Includes
- Cardiorespiratory fitness
- Musculoskeletal fitness
  - Muscular strength
  - Muscular endurance
- Flexibility
- Body composition

Physical Fitness Includes
- Aerobic Exercise
  - Cardiorespiratory fitness
- Resistance Training
  - Musculoskeletal fitness
- Stretching
  - Flexibility
To Achieve Fitness Benefits

- Surgeon General: 30 min of physical activity a day
- Institute of Medicine: 60 min of physical activity a day

Remember: Physical activity does not always equal exercise

What Type of Activities?

- General activity
  - Daily
  - Stairs, cleaning house, walking to bus, caring for children
- Aerobic Activity
  - 3-5 times a week for at least 20-30 min
- Strength and Flexibility Activities
  - 2-3 times a week
- Sedentary Activities
  - Keep to a minimum
  - Watching TV, working on computer etc

Physical Activity In America

- 55% of population does not meet recommendation of physical activity
- 26% of population does not engage in leisure-time activity
- Less than 30% of high school students participate in daily physical education
Goals for Fitness

• Personal decision
• For example:
  - Prevent osteoporosis
  - Prevent type 2 diabetes
  - Increase feeling of having energy
  - Compete in athletic events
  - Manage weight

<table>
<thead>
<tr>
<th>TABLE 14.1</th>
<th>Guideline for Physical Fitness</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type of Activity</strong></td>
<td><strong>Cardiorespiratory</strong></td>
</tr>
<tr>
<td>Frequency</td>
<td>3 to 5 days per week</td>
</tr>
<tr>
<td>Intensity</td>
<td>55 to 99% of maximum heart rate</td>
</tr>
<tr>
<td>Duration</td>
<td>20 to 60 minutes</td>
</tr>
</tbody>
</table>


Health vs. Physical Fitness

<table>
<thead>
<tr>
<th>Goal</th>
<th>Health</th>
<th>Physical Fitness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>Daily</td>
<td>2-5 days/week</td>
</tr>
<tr>
<td>Intensity</td>
<td>Any level</td>
<td>50-80% max. heart rate</td>
</tr>
<tr>
<td>Time</td>
<td>Accumulation of at least 30 min/day</td>
<td>20-60 min continuous or intermittent activity</td>
</tr>
<tr>
<td>Type</td>
<td>Any activity</td>
<td>Aerobic and resistance training, stretching</td>
</tr>
</tbody>
</table>

Sound Fitness Program

• Tailored to meet personal goals
• Is fun!
• Includes variety
• Is consistent
• Appropriately overloads the body
• Includes warm-up and cool-down
**Overload Principle**

- To improve fitness level, you must place an extra physical demand on the body.
- Must be done without subjecting the body to inappropriately high stress, which leads to injury and exhaustion.

**Intensive**

- Low: Mild increases in breathing, sweating, and heart rate.
- Moderate: Moderate increases in breathing, sweating, and heart rate.
- Vigorous: Significant increases in breathing, sweating, and heart rate.

**Intensive via Heart Rate**

Maximum heart rate = 220 - age

**Overload Principal**

Three ways to achieve overload (FIT)

- **Frequency**: The number of activity sessions per week.
  - Varies with fitness goals.
- **Intensity**: Amount of effort expended during the activity, how difficult activity is.
  - May be based on maximal heart rate.
- **Time of activity**: How long each exercise session lasts.
Warm-up

- Prepares you for exercise bout
- Includes calisthenics, stretching, exercises specific to exercise
- Should increase body temperature and blood flow
- Reduces risk of injury

Cool Down

- After exercise bout
- Gradual activity that allows body to slowly recover from exercise
- Low intensity version of activity during exercise bout
- Stretching
- May reduce muscle soreness and tightness

Extra-Credit!

Keep a diary of your physical activity for one week. You do not need to change activity patterns to do this assignment.

Record:
1) Activity (cleaning house, jogging etc)
2) Duration
3) Intensity

Due by March 1st.

Chemistry of Energy Use

- How the body produces energy
- What types of compounds are used to fuel different activities
Anabolic reactions require energy and combine simple compounds into complex compounds.

Catabolic reactions release energy and break large molecules into smaller one.

ATP is a high energy compound used to 1) store energy and 2) yield energy.
### Fuel and Exercise Duration

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Duration of Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATP in muscle</td>
<td>1-3 secs</td>
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### Creatine Phosphate as Fuel

- **Creatine phosphate**: A high energy compound that can be broken down for energy and used to regenerate ATP
- **Anaerobic reaction (doesn’t use oxygen)**
- **Used during very intense, short bouts of activity such as lifting, jumping, and sprinting**

**Split-second surges of power as in the heave of a barbell or jump of a basketball player use energy from creatine phosphate in an anaerobic reaction.**
Fuel and Exercise Duration

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Supports activity for</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATP in muscle</td>
<td>1-3 secs</td>
<td></td>
</tr>
<tr>
<td>Creatine phosphate in muscle</td>
<td>3-15 secs</td>
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Glucose as Fuel

- **Glycolysis**: The breakdown of glucose for energy

Glucose as Fuel

- **Aerobic Catabolism of Glucose**: Reaction using oxygen

- **Aerobic**: Reaction using oxygen

- **Glycolysis**: The breakdown of glucose for energy

- **Glucose Yields energy (ATP)**

- **2 Pyruvates**

- **Uses energy (ATP)**

- **To Electron Transport Chain**

- **Makes ATP**

- **2 CoA**

- **2 Acetyl CoA**

- **To TCA Cycle**

- **CO₂ + H₂O**

- **Lactic acid**
Glucose as Fuel

- Glucose in muscle cells is stored as glycogen
- Average man of about 150 lbs has 200-500g of muscle glycogen
- This muscle glycogen equals 800-2000 cal of energy
- Glucose is used to power moderate to high-intensity activity
**Fuel and Exercise Duration**

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<tr>
<td>Creatine phosphate in muscle</td>
<td>3-15 secs</td>
</tr>
<tr>
<td>Anaerobic metabolism of glucose</td>
<td>3 min</td>
</tr>
<tr>
<td>Aerobic metabolism of glucose</td>
<td>4 hours</td>
</tr>
</tbody>
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**Fat as Fuel**

- Triglycerides are the primary form of storage in the cell for fats
- Triglycerides yield a lot of energy per molecule
  - Can create many ATP molecules
- Body store of fat are abundant
  - With just 10% body fat, a 150 lb man has 15 lbs of body fat, which equals 50,000 cal of energy!

**Fat as Fuel**

- Used when the body is at rest, standing, or sitting
- Used to power low to moderate activity
- Used to power activity of long duration
- Fat can only be used aerobically
The TCA Cycle

Acetyl CoA (from carbon dioxide)
Pyruvate (as carbon dioxide)
CoA
Coenzyme
Yields energy (captured in high-energy compound similar to ATP)

To Electron Transport Chain (makes ATP)

Low- to moderate-intensity aerobic exercises that can be sustained for a long time (more than 20 minutes) use some glucose, but more fat for fuel.

Fuel and Exercise Duration

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</tr>
<tr>
<td>Aerobic metabolism of glucose</td>
<td>4 hours</td>
</tr>
<tr>
<td>Fat (Triglycerides)</td>
<td>Almost endless</td>
</tr>
</tbody>
</table>

Protein as Fuel

- Not a major energy source during exercise
- Used to maintain blood glucose if necessary
- Can contribute up to 3-6% of energy
- Used mostly to build new proteins
Catabolism of Amino Acids

The TCA Cycle

Fuel for Physical Activity
**Diet and Physical Activity**

- Do nutrient needs change with physical activity?
- Depends on the type, intensity, and duration of activity
- For most people, diet should not differ from the general guidelines

**Carbohydrates**

- Recommended intake for all people is 45-65% of daily calories
- Suggest that athletes consume about 60% total calories as carbohydrates
- Adequate carbohydrate intake promotes optimal glycogen stores

**Exercise and Carbs**

- Body stores the most glucose as glycogen in the first few hours after exercise
- Takes a few hours for carbohydrates to make it from the GI system into the glycogen stores
- Training increases muscle glycogen stores
Carbohydrate Loading

• Maximizes muscle glycogen stores
• Useful for athletes in marathons, triathlons, long-distance swims etc.
• Uses both diet and exercise
• Can be difficult on the digestive system

<table>
<thead>
<tr>
<th>Day prior to event</th>
<th>Exercise duration</th>
<th>g carb/kg body weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>90</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>40</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>40</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>1</td>
<td>None</td>
<td>10</td>
</tr>
</tbody>
</table>

Day of Race

Competition
Normal pre-event food

Exercise and Fats

• People who regularly engage in physical activity burn more fat for energy
• Increase in number and activity of enzymes involved in fat metabolism
• Improved ability for muscles to store fat
• Improved ability to extract fat from blood during exercise
• Use of fat for energy spares carbohydrate stores

Fat Intake in Active People

• Fat intake should be 15-25% of total energy intake
  - Acceptable range for non-athletes=20-35%
• Fat in diet is necessary to absorb fat-soluble vitamins
• Inadequate fat intake can be detrimental to training and performance
Protein Intake

• Protein intake for most Americans is already adequate to support increases in activity
  - Most Americans consume too much protein in diet
• Some sources do recommend higher protein intake in active people, some do not
• Athletes of concern: those with low energy intake, vegans or vegetarians, young people

Definitions for Activity

• Competitive endurance athletes: Train 5-7 days/week for at least 1 hr, often 3-6 hrs a day
• Moderate-intensity athletes: Train 4-6 days/week for 45-60 min/day
• Recreational endurance athletes: Train 4-6 days/week for 30 min/day at less than 60% max effort

Protein Requirements

<table>
<thead>
<tr>
<th>Group</th>
<th>g protein/kg body weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competitive athletes</td>
<td>1.4-1.6</td>
</tr>
<tr>
<td>Moderate-intensity athletes</td>
<td>1.2</td>
</tr>
<tr>
<td>Recreational endurance athletes</td>
<td>0.8-1.0</td>
</tr>
<tr>
<td>Football, power sports</td>
<td>1.4-1.7</td>
</tr>
<tr>
<td>Resistance athletes, weight lighters (early training)</td>
<td>1.5-1.7</td>
</tr>
<tr>
<td>Resistance athletes, weight lighters (steady-state training)</td>
<td>1.0-1.2</td>
</tr>
</tbody>
</table>

The Effect of Diet on Physical Endurance

- Fat and protein diet: 57 min
- Normal mixed diet: 114 min
- High-carbohydrate diet: 167 min
**Water**

- Proper hydration is vital to athletic performance
  - Performance impaired with fluid loss of 1% body weight
- Avoid losing 2-3% body weight
- Activity markedly increases water needs

**Electrolytes**

- Minerals that act as electrolytes are lost in sweat
- Training improves electrolyte retention
- Usually, the diet can replace electrolytes

**Fluid Needs**

<table>
<thead>
<tr>
<th>Activity Level</th>
<th>Environment</th>
<th>Liter water/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sedentary</td>
<td>Cool</td>
<td>2-3</td>
</tr>
<tr>
<td>Active</td>
<td>Cool</td>
<td>3-6</td>
</tr>
<tr>
<td>Sedentary</td>
<td>Warm</td>
<td>3-5</td>
</tr>
<tr>
<td>Active</td>
<td>Warm</td>
<td>5-10+</td>
</tr>
</tbody>
</table>

**Vitamins and Minerals?**

- Active people usually do not need more vitamins and minerals than sedentary people
- If they do, they receive the extra vitamins and minerals from their extra food intake
- Increased intake of vitamins and mineral will not enhance performance if well-nourished
Iron

- Active individuals lose more iron in sweat, feces, and urine
- Small amount of bleeding in abdomen during high intensity exercise in some athletes
- Poor iron status can hinder performance
- Physically active females are at highest risk for anemia

Ergogenic Aids

- Substances used to improve exercise and athletic performance

Steroids

- Some are BANNED, all should be
- Extremely dangerous and can cause permanent damage to body
- Testosterone, Androstenedione, Dehydroepiandrosterone (DHEA), Human Growth Hormone

Creatine

- Part of creatine phosphate
- Might enhance sprint performance
- Might increase work performed and strength gained during resistance training
- Very little information on how it impacts health
  - Unsure of its safety