Section 01: 
Health-Related Physical Fitness Defined 
Risks and Benefits Associated with 
Physical Activity 

ACSM Guidelines: Chapter 1 - Benefits and Risks 
Associated with Physical Activity 

ACSM Manual: Chapter 1 – Introduction (pp. 1-6) 

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HPHE 4450 
Dr. Cheatham 

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Definitions 

• Physical Activity (PA): 
  – Bodily movement that is produced by the 
    contraction of skeletal muscle and that substantially 
    increases energy expenditure 

• Exercise: 
  – A type of physical activity that is defined as planned, 
    structured, and repetitive bodily movement done to 
    improve or maintain on or more components of 
    physical fitness
**Definitions (cont’d)**

- **Physical Fitness (PF):**
  - A multidimensional concept that has been defined as a set of attributes that people possess or achieve that relates to the ability to perform physical activity
  - Comprised of health-related, skill related, and physiologic components

<table>
<thead>
<tr>
<th>Source</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Getchell (3)</td>
<td>Physical fitness is the capability of the heart, blood vessels, lungs, and muscles to perform at optimal efficiency.</td>
</tr>
<tr>
<td>Miller et al. (6)</td>
<td>General physical fitness is a state of ability to perform sustained physical work characterized by an effective integration of cardiorespiratory endurance, strength, flexibility, coordination, and body composition.</td>
</tr>
<tr>
<td>President’s Council on Physical Fitness and Sports Research Digests (8)</td>
<td>Physical fitness is the ability to carry out daily tasks with vigor and alertness without undue fatigue and with ample energy to enjoy leisure-time pursuits and respond to emergencies.</td>
</tr>
</tbody>
</table>

**Physical Activity vs. Physical Fitness**

Table showing the differences between physical activity and physical fitness.

Graph illustrating the relative risk over percentage, with a difference of P ≤ 0.04.
**Health-Related PF**

- **Cardiorespiratory Fitness/CV Endurance**
  - The ability of the circulatory and respiratory systems to supply oxygen during sustained physical activity
  - Primarily Assessed Variable: Maximal Oxygen Consumption ($VO_{2max}$)
  - Major Physiological Systems:
    - Respiratory/Pulmonary (Oxygenate Blood)
    - Cardiovascular (Deliver $O_2$ rich blood)
    - Skeletal Muscle (Utilize $O_2$)
Health-Related PF

- **Body Composition**
  - The relative amounts of muscle, fat, bone, and other vital parts of the body
  - Also includes general variables to assess level of obesity
  - Primarily Assessed Variables:
    - % body fat, body mass index, waist-to-hip ratio

- **Flexibility**
  - The range of motion available at a joint
  - Joint specific

Health-Related PF

- **Muscular Strength**
  - The ability of muscle to exert force
  - Primarily Assessed Variable: 1-RM

- **Muscular Endurance**
  - The ability of muscle to continue to perform without fatigue.
Health-Related vs. Skill-Related PF

**Box 1.1 Health-Related and Skill-Related Physical Fitness Components**

**Health-Related Physical Fitness Components**
- Cardiovascular endurance: The ability of the circulatory and respiratory system to supply oxygen during sustained physical activity.
- Body composition: The relative amounts of muscle, fat, bone, and other vital parts of the body.
- Muscular strength: The ability of muscle to exert force.
- Muscular endurance: The ability of muscle to continue to perform without fatigue.
- Flexibility: The range of motion available at a joint.


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Box 1.1, ACSM Guidelines 9th Edition, P. 3

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**Skill-Related Physical Fitness Components**
- Agility: The ability to change the position of the body in space with speed and accuracy.
- Coordination: The ability to use the senses, such as sight and hearing, together with body parts in performing tasks smoothly and accurately.
- Balance: The maintenance of equilibrium while stationary or moving.
- Power: The ability or rate at which one can perform work.
- Reaction time: The time elapsed between stimulation and the beginning of the reaction to it.
- Speed: The ability to perform a movement within a short period of time.


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Box 1.1, ACSM Guidelines 9th Edition, P. 3
Physiologic Fitness

- **Physiologic fitness** differs from health-related fitness in that it includes non-performance components that relate to biological systems influenced by habitual activity
  - **Metabolic fitness**: The status of metabolic systems and variables predictive of the risk for diabetes and cardiovascular disease
  - **Morphologic fitness**: The status of body compositional factors such as body circumference, body fat content, and regional body fat distribution
  - **Bone integrity**: The status of bone mineral density

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Benefits of PA and/or Exercise

Box 1.4 in ACSM Guidelines 9th Edition (p. 10)

**BOX 1.2 Benefits of Regular Physical Activity and/or Exercise**

**IMPROVEMENT IN CARDIOVASCULAR AND RESPIRATORY FUNCTION**

- Increased maximal oxygen uptake resulting from both central and peripheral adaptations
- Decreased minute ventilation at a given absolute submaximal intensity
- Decreased myocardial oxygen cost for a given absolute submaximal intensity
- Decreased heart rate and blood pressure at a given submaximal intensity
- Increased capillary density in skeletal muscle
- Increased exercise threshold for the accumulation of lactate in the blood
- Increased exercise threshold for the onset of disease signs or symptoms (e.g., angina pectoris, ischemic ST-segment depression, claudication)


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## Benefits of PA and/or Exercise

**Box 1.4 in ACSM Guidelines 9th Edition (p. 10)**

### BOX 1.2 Benefits of Regular Physical Activity and/or Exercise

**REDUCTION IN CORONARY ARTERY DISEASE RISK FACTORS**
- Reduced resting systolic/diastolic pressures
- Increased serum high-density lipoprotein cholesterol and decreased serum triglycerides
- Reduced total body fat, reduced intra-abdominal fat
- Reduced insulin needs, improved glucose tolerance
- Reduced blood platelet adhesiveness and aggregation


**DECREASED MORBIDITY AND MORTALITY**
- Primary prevention (i.e., interventions to prevent the initial occurrence)
- Higher activity and/or fitness levels are associated with lower death rates from coronary artery disease
- Higher activity and/or fitness levels are associated with lower incidence rates for combined cardiovascular diseases, coronary artery disease, stroke, type 2 diabetes, osteoporotic fractures, cancer of the colon and breast, and gallbladder disease
- Secondary prevention (i.e., interventions after a cardiac event [to prevent another])
- Based on meta-analyses (pooled data across studies), cardiovascular and all-cause mortality are reduced in postmyocardial infarction patients who participate in cardiac rehabilitation exercise training, especially as a component of multifactorial risk factor reduction
- Randomized controlled trials of cardiac rehabilitation exercise training involving postmyocardial infarction patients do not support a reduction in the rate of nonfatal reinfarction


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Benefits of PA and/or Exercise

BOX 1.2 Benefits of Regular Physical Activity and/or Exercise

OTHER BENEFITS
• Decreased anxiety and depression
• Enhanced physical function and independent living in older persons
• Enhanced feelings of well-being
• Enhanced performance of work, recreational, and sport activities
• Reduced risk of falls and injuries from falls in older persons
• Prevention or mitigation of functional limitations in older adults
• Effective therapy for many chronic diseases in older adults


Benefits of PA and/or Exercise

TABLE 1.3. Evidence for Dose-Response Relationship between Physical Activity and Health Outcome

<table>
<thead>
<tr>
<th>Variable</th>
<th>Evidence for Inverse Dose-Response Relationship</th>
<th>Strength of Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>All-cause mortality</td>
<td>Yes</td>
<td>Strong</td>
</tr>
<tr>
<td>Cardiorespiratory health</td>
<td>Yes</td>
<td>Strong</td>
</tr>
<tr>
<td>Metabolic health</td>
<td>Yes</td>
<td>Moderate</td>
</tr>
<tr>
<td>Energy balance:</td>
<td>Weight maintenance: Insufficient data</td>
<td>Weak</td>
</tr>
<tr>
<td>Weight loss</td>
<td>Yes</td>
<td>Strong</td>
</tr>
<tr>
<td>Weight maintenance</td>
<td>Yes</td>
<td>Moderate</td>
</tr>
<tr>
<td>Abdominal obesity</td>
<td>Yes</td>
<td>Moderate</td>
</tr>
<tr>
<td>Musculoskeletal health:</td>
<td>Bone: Yes</td>
<td>Moderate</td>
</tr>
<tr>
<td>Joint</td>
<td>Yes</td>
<td>Strong</td>
</tr>
<tr>
<td>Muscular</td>
<td>Yes</td>
<td>Strong</td>
</tr>
<tr>
<td>Functional health</td>
<td>Yes</td>
<td>Moderate</td>
</tr>
<tr>
<td>Colon and breast cancers</td>
<td>Yes</td>
<td>Moderate</td>
</tr>
<tr>
<td>Mental health</td>
<td>Depression and distress: Yes</td>
<td>Moderate</td>
</tr>
<tr>
<td>Web-being</td>
<td>Anorexia, cognitive health, and sleep: Insufficient data</td>
<td>Weak</td>
</tr>
</tbody>
</table>

Strength of the evidence was classified as follows:
• “Strong” — Strong, consistent across studies and populations
• “Moderate” — Moderate or reasonable, reasonably consistent
• “Weak” — Weak or limited, inconsistent across studies and populations

Adapted from 42.
Risks Associated with Exercise

• Habitual PA reduces the incidence of atherosclerotic cardiovascular disease
• Vigorous PA also acutely and transiently increases the risk of sudden cardiac death and acute myocardial infarction.
• Exercise only provokes a CV event in individuals with preexisting heart disease, whether diagnosed or occult.
• Exercise does not provoke CV events in individuals with normal CV systems.

Risks Associated with Exercise

• Sudden Death Among Young Individuals
  – Among younger individuals (<35 yrs), the risk of sudden cardiac death is low because the prevalence of occult disease is low
  – Absolute incidence of death during or within one hour of sports participation among U.S. high school and college athletes:
    • One death per year for every 133,000 men and 769,000 women.
      – These numbers overestimate the incidence of a CV event because only 100 of the 136 deaths were caused by CV disease
### Risks Associated with Exercise

#### Exercise-Related CV Events in Adults

- The risks of exercise in adults are considerably higher than in younger individuals.
- Incidence of sudden cardiac death during vigorous exertion in health adults:
  - One death per year for every 15,000 to 18,000 individuals
- Exercise also acutely increases the risk of acute, nonfatal myocardial infarctions
- Why?
  - Acute coronary plaque rupture leading to coronary thrombosis

#### TABLE 1.4 Cardiovascular Causes of Exercise-Related Sudden Death in Young Athletes

<table>
<thead>
<tr>
<th>Cause</th>
<th>Van Camp (n = 1068)</th>
<th>Mason (n = 134)</th>
<th>Canadian (n = 95)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertrophic CM</td>
<td>51</td>
<td>36</td>
<td>1</td>
</tr>
<tr>
<td>Probable hypertrophic CM</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Coronary aneurysms</td>
<td>18</td>
<td>23</td>
<td>9</td>
</tr>
<tr>
<td>Valvular and subvalvular aortic stenosis</td>
<td>8</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Possible myocarditis</td>
<td>7</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Diabetic and nonhypertrophic CM</td>
<td>7</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Atherosclerotic CAD</td>
<td>3</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Aortic dissection/rupture</td>
<td>2</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Arhythmogenic right ventricular CM</td>
<td>1</td>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td>Myocardial scarring</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Mitral valve prolapse</td>
<td>1</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Other congenital abnormalities</td>
<td>0</td>
<td>1.5</td>
<td>0</td>
</tr>
<tr>
<td>Long QT syndrome</td>
<td>0</td>
<td>0.5</td>
<td>0</td>
</tr>
<tr>
<td>Wolff-Parkinson-White syndrome</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Cardiac conduction disease</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Cardiac tachycardia</td>
<td>0</td>
<td>0.5</td>
<td>0</td>
</tr>
<tr>
<td>Coronary artery aneurysm</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Normal heart at necropsy</td>
<td>7</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Pulmonary thromboembolism</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

**Notes:**
- Ages ranged from 12 to 24 yr (67), 12 to 40 yr (33), and 12 to 26 yr (12). References (67) and (33) used the same database and include many of the same athletes. All (67), 90% (33), and 89% (12) had symptoms onset during or within an hour of training or competition.
- Total exceeds 100% because several athletes had multiple abnormalities.
- Includes some athletes whose deaths were not associated with recent exercise. Includes aberrant artery origins and courses, tunneled ateries, and other abnormalities.

Used with permission from (2).
**Risks Associated with Exercise**

- **Risks of CV Events During Exercise Testing**
  - The risk of exercise varies with the prevalence of underlying coronary artery disease in the population.
  - Therefore, the risk of exercise stress testing also varies with the populations studied.
  - The overall risk of exercise testing in a mixed subject population is:
    - 6 CV events (MI, VF, other major dysrhythmia, or death) per 10,000 tests.

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### TABLE 1.5. Cardiac Complications during Exercise Testing

<table>
<thead>
<tr>
<th>Reference</th>
<th>Year</th>
<th>Site</th>
<th>No. of Tests</th>
<th>MI</th>
<th>VF</th>
<th>Death</th>
<th>Hospitalization</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rychmos (44)</td>
<td>1971</td>
<td>73 U.S. centers</td>
<td>170,000</td>
<td>NA</td>
<td>NA</td>
<td>1</td>
<td>3</td>
<td>34% of tests were symptom limited; 50% of deaths in 8 h; 50% over the next 4 d</td>
</tr>
<tr>
<td>Irving (29)</td>
<td>1977</td>
<td>15 Seattle facilities</td>
<td>10,700</td>
<td>NA</td>
<td>4.67</td>
<td>0</td>
<td>NR</td>
<td></td>
</tr>
<tr>
<td>McHenry (34)</td>
<td>1977</td>
<td>Hospital</td>
<td>12,000</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Attenho (4)</td>
<td>1979</td>
<td>20 Swedish centers</td>
<td>50,000</td>
<td>0.8</td>
<td>6.4</td>
<td>5.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stuart (49)</td>
<td>1980</td>
<td>1,375 U.S. centers</td>
<td>518,448</td>
<td>3.58</td>
<td>4.78</td>
<td>0.5</td>
<td>NR</td>
<td>VF includes other dysrhythmias requiring treatment</td>
</tr>
<tr>
<td>Gibbons (191)</td>
<td>1980</td>
<td>Cooper Clinic</td>
<td>71,914</td>
<td>0.56</td>
<td>0.29</td>
<td>0</td>
<td>NR</td>
<td>Only 4% of men and 2% of women had CVD</td>
</tr>
<tr>
<td>Knight (27)</td>
<td>1995</td>
<td>Griesinger Cardiology Service</td>
<td>28,133</td>
<td>1.42</td>
<td>1.77</td>
<td>0</td>
<td>NR</td>
<td>25% were inpatient tests supervised by non-MDs</td>
</tr>
</tbody>
</table>

*Events are per 10,000 tests. CVD, cardiovascular disease; MD, medical doctor; MI, myocardial infarction; NA, not applicable; NR, not reported; VF, ventricular fibrillation.*
• **Risks of CV Events During Cardiac Rehabilitation**
  
  – Individuals with diagnosed coronary artery disease are at the highest risk of experiencing a CV event during exercise and it has been estimated that vigorous exercise increases the risk of a CV event 100 times in this population.

  – Nevertheless, studies of CV events during cardiac rehabilitation document that the risk of vigorous exercise in such supervised populations is extremely low.

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### TABLE 1.6. Summary of Contemporary Exercise-Based Cardiac Rehabilitation Program Complication Rates

<table>
<thead>
<tr>
<th>Investigator</th>
<th>Year</th>
<th>Patient Exercise Hours</th>
<th>Cardiac Arrest</th>
<th>Myocardial Infarction</th>
<th>Fatal Events</th>
<th>Major Complications*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Van Camp</td>
<td>1980–1984</td>
<td>2,351,916</td>
<td>1/111,996b</td>
<td>1/293,990</td>
<td>1/733,972</td>
<td>1/81,101</td>
</tr>
<tr>
<td>Digienio</td>
<td>1982–1988</td>
<td>480,000</td>
<td>1/120,000c</td>
<td></td>
<td>1/160,000</td>
<td>1/120,000</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td>1/116,906</td>
<td>1/219,970</td>
<td>1/752,365</td>
<td>1/81,670</td>
<td></td>
</tr>
</tbody>
</table>

*Myocardial infarction and cardiac arrest.

b Fatal 14%.

c Fatal 75%.

d Fatal 0%.

Used with permission from (2).