Chapter 7:
Cardiorespiratory Fitness

ACE Personal Trainer Manual
Third Edition
Introduction

• Cardiorespiratory fitness is an essential component of physical fitness; it improves cardiovascular health in both primary and secondary prevention.

• Cardiorespiratory fitness best describes the health and function of the heart, lungs, and circulatory system and is related to cardiorespiratory endurance.
Introduction

- Cardiorespiratory fitness also describes the capacity of the lungs to exchange $O_2$ and $CO_2$ with the blood and the circulatory system’s ability to transport blood and nutrients to metabolically active tissues for sustained periods without undue fatigue.
Cardiorespiratory Fitness

Health Benefits of Cardiorespiratory Exercise Training

- Reduction in blood pressure
- Increased HDL cholesterol
- Decreased total cholesterol
- Decreased body fat stores
- Increased aerobic work capacity
- Decreased clinical symptoms of anxiety, tension & depression
- Reduction in glucose-stimulated insulin secretion
- Increased heart function
- Reduction in mortality in post myocardial infarction patients
- Prevention of Type 2 Diabetes
Cardiorespiratory Fitness

Adaptive Physiologic Responses to Cardiorespiratory Exercise Training

- Increased lactate threshold
- Decreased resting heart rate
- Increased heart volume
- Increased resting and maximum stroke volume
- Increased maximum cardiac output
- Increased maximum O₂ consumption
- Increased capillary density and blood flow to active muscles
- Increased total blood volume
- Increased maximal ventilation
Cardiorespiratory Fitness

Adaptive Physiologic Responses to Cardiorespiratory Exercise Training (continued)

- Increased lung diffusion capacity
- Increased mobilization and utilization of fat
- Reduced all-cause mortality
- Decreased anxiety and depression
- Decreased incidence of some cancers
- Improved arterial endothelial function
- Increased insulin sensitivity
Components of an Aerobic Exercise Program

The essential components of an aerobic exercise program are:

1. Warm-up & cool-down
2. Primary cardiorespiratory activity criteria:
   A. Mode of exercise
   B. Frequency of exercise session
   C. Duration of exercise session
   D. Intensity of exercise session
3. Supportive conditioning exercise (e.g., strength & flexibility)
4. Progression plan
5. Safety & cautions
Components of an Aerobic Exercise Program

• The warm-up should gradually increase the heart rate, blood pressure, $O_2$ consumption, dilation of the blood vessels, elasticity of the active muscles, and the heat produced by the active muscle groups.

• The warm-up should consist of two (2) distinct components:
  1. Graduated aerobic warm-up activity (e.g., walking or slow-tempo rhythmic calisthenic movements)
  2. Flexibility exercise specific to the biomechanical nature of the primary conditioning activity (e.g., calf, quadriceps, and Achilles stretching prior to running or hiking)
Components of an Aerobic Exercise Program

• The purpose of the cool-down is to slowly decrease the heart rate and overall metabolism, both of which have been elevated during the conditioning phase.
Components of an Aerobic Exercise Program

The American College of Sports Medicine (ACSM) classifies cardiorespiratory endurance activities into three (3) groups:

1. **Group 1**: physical activities in which exercise intensity is easily maintained at a constant level (walking & cycling)

2. **Group 2**: physical activities in which energy expenditure is related to skill (aerobic dance, aerobic step exercise, swimming, skating, & cross-country skiing)

3. **Group 3**: physical activities that are quite variable in both skill and intensity (soccer, basketball, & racquetball)
Components of an Aerobic Exercise Program

• Exercise Mode - selection of the exercise mode is made on the basis of the client’s functional capacity, interests, time availability, equipment & facilities, and personal goals.

• Exercise Frequency - frequency refers to the number of exercise sessions per week included in the program.

• Exercise Duration - duration refers to the number of minutes of exercise during the conditioning period.
Components of an Aerobic Exercise Program

- The following are the primary methods of monitoring exercise intensity:
  - Heart Rate
    - Percentage of maximal heart rate
    - Percentage of heart-rate reserve
  - Rating of perceived exertion
  - The “talk test” method
  - METs
Components of an Aerobic Exercise Program

• Maximum Heart Rate (MHR) - the highest heart rate a person can attain.

• Heart Rate Maximum Reserve - the result of subtracting the resting heart rate from the maximal heart rate; represents the working heart-rate range between rest and maximal heart rate within which all activity occurs.

• This classification system is important for the personal trainer to learn because it establishes a common exercise intensity language with other trainers and healthcare professionals.
Components of an Aerobic Exercise Program

- It is essential to understand the relationship between exercise heart rate and aerobic capacity (maximal O₂ consumption).

- For nearly all levels of submaximal exercise, the percentage of heart-rate maximum does not equal the same percentage of aerobic capacity unless the heart-rate maximum reserve method (Karvonen Formula) is used.
Components of an Aerobic Exercise Program

The Karvonen formula is a mathematical formula that uses maximum heart-rate reserve to determine target heart rate:

\[ 220 - (\text{AGE}) = \text{MHR} \]
\[ \text{MHR} - \text{RHR} = \text{HRR} \]
\[ \text{HRR} \times (60\% \text{ to } 80\%) = \text{TR}\% \]
\[ \text{TR}\% + \text{RHR} = \text{TTZ} \]

\text{AGE} = \text{Client’s Age}
\text{MHR} = \text{Maximum Heart Rate}
\text{RHR} = \text{Resting Heart Rate}
\text{HRR} = \text{Heart Rate Reserve}
\text{TR} = \text{Training Range}
\text{TTZ} = \text{Target Training Zone}
Components of an Aerobic Exercise Program

Exercise intensity also can be measured by assigning a numerical value (6-20 or 0-10) to subjective feelings of exercise exertion (Borg Scale).

<table>
<thead>
<tr>
<th>RPE</th>
<th>Category Ratio Scale</th>
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<tbody>
<tr>
<td>6</td>
<td>0  Nothing at all</td>
</tr>
<tr>
<td>7</td>
<td>0.5 Very, very weak</td>
</tr>
<tr>
<td>8</td>
<td>1  Very weak</td>
</tr>
<tr>
<td>9</td>
<td>2  Weak</td>
</tr>
<tr>
<td>10</td>
<td>3  Moderate</td>
</tr>
<tr>
<td>11</td>
<td>4  Somewhat strong</td>
</tr>
<tr>
<td>12</td>
<td>5  Strong</td>
</tr>
<tr>
<td>13</td>
<td>6  Somewhat hard</td>
</tr>
<tr>
<td>14</td>
<td>7  Very strong</td>
</tr>
<tr>
<td>15</td>
<td>8  Very, very light</td>
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<td>9  Very, very strong</td>
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<td>18</td>
<td>* Maximal</td>
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<td>19</td>
<td>Very, very hard</td>
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<tr>
<td>20</td>
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Components of an Aerobic Exercise Program

- Another means of evaluating the intensity of exercise is the talk test.

- Clients should be able to breathe comfortably and rhythmically throughout all phases of a workout to ensure a safe & comfortable level of exercise.
Components of an Aerobic Exercise Program

• MET (metabolic equivalent) - a simplified system for classifying physical activities where one MET is equal to the resting O₂ consumption, which is approximately 3.5mL of O₂ per kilogram of body weight per minute.

3.5mL/ kg/ min
Components of an Aerobic Exercise Program

• The goals of cardiorespiratory exercise must be clearly stated in the written exercise plan.

• The plan is used to reinforce compliance and motivation and for assessment during follow-up.

• The client’s implementation and progression plan must reflect these goals and depict means of achieving them safely and realistically.
Components of an Aerobic Exercise Program

- A written progression plan with periodic reevaluation is crucial.

- This plan must provide details for a graduated progression in the frequency, duration, and intensity of exercise.

- There must be sufficient flexibility in the rate of progression so that the plan comfortably adjusts to the client’s cardiorespiratory and musculoskeletal response.
Components of an Aerobic Exercise Program

- The ACSM has identified three (3) stages of a progression plan:
  1. Initial conditioning stage
  2. Improvement conditioning stage
  3. Maintenance conditioning stage
Components of an Aerobic Exercise Program

Initial Conditioning Stage
• Usually lasts 4-6 weeks or longer
• Includes low-level activities, stretching, and light calisthenics
• Exercise frequency should begin with every other day.
Components of an Aerobic Exercise Program

Improvement Conditioning Stage

- Primary conditioning stage for most training programs
- 8-20 weeks
- Rate of progression in intensity is more rapid
Components of an Aerobic Exercise Program

Maintenance Stage

- Used when clients reach their target functional capacity or primary goals
- Usually reached after the first six (6) months of training
- May be delayed as long as twelve (12) months
- Important to reassess goals at the beginning of this stage
Components of an Aerobic Exercise Program

There are several standard cautions for nearly all exercise programs:

- Do not exercise for at least 90 minutes after a meal.
- Avoid continuing exercise with chest discomfort, lightheadedness, or dizziness.
- Reduce exercise intensity in response to very hot or humid environments or to altitudes above 5,000 feet.
- Avoid exercise with tenderness in a joint (e.g., knee or ankle) that tends to worsen with activity.
- Avoid strenuous aerobic exercise during viral infections such as the flu or upper respiratory tract infection.
- If you are receiving care from a physician for a chronic medical condition (e.g., diabetes, cardiovascular disease, hypertension), you should obtain clearance from your doctor before proceeding with an exercise program.
Training Methods

There are five (5) major training methods:

• Continuous training
  – Intermediate slow distance (20-60 minutes)
  – Long slow distance (60+ minutes)

• Interval training
  – Aerobic interval training
  – Anaerobic interval training

• Fartlek training

• Circuit training

• Aerobic cross training
Training Methods

• Interval training involves alternating relatively more intense bouts of cardiovascular exercise with those that are relatively less intense.

• Consider:
  – Intensity of work interval (e.g., speed)
  – Duration of work interval (e.g., distance or time)
  – Duration of rest or recovery interval
  – Number of repetitions or repeat intervals
Training Methods

- Aerobic interval training is best suited for those beginning in the poor- to low-cardiorespiratory fitness classifications because it is less intense.

- Generally, aerobic interval training uses exercise bouts of 2-15 minutes at an intensity between 60-80% of functional capacity.
Training Methods

• Anaerobic interval training is primarily reserved for those in the higher cardiorespiratory fitness classifications who desire to increase speed, lactate threshold, and overall aerobic power.

• Training stimulus is usually between 30 seconds and four (4) minutes at an intensity of 85% to greater than 100% of functional capacity (maximal O2 uptake).
Training Methods

• Fartlek training is similar to interval training; however, the work-rest intervals are not systematically or accurately measured.

• Work-rest intervals and intensity are usually determined by how the participant feels.

• Fartlek training should be reserved for those in the average or above-average cardiorespiratory fitness levels.
Training Methods

• Circuit training takes the client through a series of exercise stations, with relatively brief rest intervals between each station.

• The number of stations may range from 4-10.
Training Methods

- Aerobic cross training is an individualized combination or composite of all aerobic-training methods and is characterized by a variety of intensities and modes.

- It is primarily for exercisers in the maintenance phase of conditioning.
  
  Ex., 50-minute workout: 15-minute jog to pool, 20-minute swim, 15-minute jog home.
Guidelines for Cardiorespiratory Activity

• The easiest and most preferred aerobic-conditioning activity is walking.

• Walking also has the lowest injury rate.
Guidelines for Cardiorespiratory Activity

• The energy cost of walking is relatively low compared to that of jogging because of slower speeds; however, at walking speeds of five (5) miles per hour and faster, the O₂ and caloric cost per minute approaches that of jogging or running.

• The net caloric cost per mile of walking is 50% - 60% of that for running.
Guidelines for Cardiorespiratory Activity

- When walking, three (3) things are important:
  1. Correct footwear is important.
  2. Always warm up and cool down.
  3. Give special emphasis to gradually increasing the duration.
Guidelines for Cardiorespiratory Activity

- Jogging and running are superb cardiorespiratory-endurance activities.

- The essential difference between the two is that jogging is “slower running” or jogging is running slower than eight (8) minutes per mile.
Guidelines for Cardiorespiratory Activity

• When prescribing a jogging or running program, four (4) things are important:
  1. Wear appropriate footwear.
  2. Always accompany jogging or running exercise with appropriate flexibility exercise.
  3. For beginners, jog every other day with a day of rest in between workouts.
  4. Increase jogging pace and add hills gradually.
Guidelines for Cardiorespiratory Activity

• The following are guidelines for outdoor cycling:
  1. Use a bicycle with at least 10 speeds.
  2. For beginners, keep a relatively constant pedal crank speed.
  3. Bicycle seat height should be high enough so that the leg on the downstroke is not completely extended.
  4. Use toe clips.
  5. Wear bicycling apparel. Always wear a helmet.
Guidelines for Cardiorespiratory Activity

- Indoor cycling is convenient and relatively safe.
- The following are guidelines for indoor cycling:
  1. Ensure proper ventilation.
  2. Adjust seat height for a slight bend in the knee at the downstroke position.
  3. Adjust the handlebars so that the client is relaxed and leaning slightly forward.
  4. Hold pedal crank speed relatively constant for beginners in the range of 70-90rpm per leg.
  5. Always warm up and cool down.
  6. Allow longer warm up and cool down for group indoor cycling.
Guidelines for Cardiorespiratory Activity

• The following are guidelines for swimming:
  1. Assess swimming or aquatic exercise skill by evaluating exercise history or by observation.
  2. Keep pool temperature for lap swimming at 76-84°F (24-29°C).
  3. Use a lap pool with approximately 80 lengths per mile.
  4. Use interval training for the beginning swimmer.
  5. For the beginner, include a good warm-up & cool-down exercise.
  6. For those who are not comfortable in the pool or cannot swim, flotation devices can help.
Guidelines for Cardiorespiratory Activity

- The following are guidelines for rowing:
  1. Secure feet in the anchors on the front part of the machine.
  2. Use a smooth rowing action.
  3. Begin with a relatively low intensity (8-10 rows per minute).
  4. Graduate the speed to approximately 15-30 rows per minute.
  5. Gradually increase intensity according to heart rate and perceived exertion.
Guidelines for Cardiorespiratory Activity

• The following are safety precautions for stair climbing:
  1. A fan or other means of convective cooling must be used.
  2. Adequate warm-up & cool-down periods are required due to large energy costs.
  3. Interval-training methods are best when beginning a program with regular stairs or steps in a stadium.
  4. Instruct users to keep their knees aligned with their toes.
Guidelines for Cardiorespiratory Activity

- The following are guidelines for aerobics (dance):
  1. Wear appropriate footwear that adheres to four (4) standards: cushion, support, flexibility, and traction.
  2. Recommend low-impact aerobics for beginners.
  3. Recommend a class that will adapt appropriately to functional capacity and skill level for beginners.
  4. Lower the calculated target heart rate slightly.
Guidelines for Cardiorespiratory Activity

- The following are guidelines for step aerobics:
  1. Step bench height should be from 4-10 inches.
  2. Step at a rate of 120-130 steps per minute.
  3. Advise beginners to use smaller step heights.
  4. Discourage the use of hand-held weights for beginners and those who are coronary-prone.
Monitoring Cardiorespiratory Exercise

• The heart rate can be monitored by palpating (feeling) the pulse or by using a cardiotachometer or electrocardiogram.

• The most practical is to palpate the pulse:
  – Neck (carotid artery)
  – Wrist (radial artery)
  – Head (temporal artery)
  – Chest (apical artery)
Monitoring Cardiorespiratory Exercise

• The resting heart rate will decrease as a person becomes more conditioned.

• For young and middle-aged adults, the usual improvement in aerobic capacity will be 15-20% over 10-20 weeks of training.

• Aerobic capacity may increase up to 45-50% depending on age, initial level of fitness, frequency of training, intensity of training, duration of exercise & training programs, and genetics.
Special Considerations & Safety

• Exercise safety can be maximized by avoiding factors such as post-meal exercise, thermal stress, air pollutants, drugs & other substances, and the presence of unusual symptoms.
Special Considerations & Safety

Thermal stress can be avoided by:

- Allowing 10-14 days to acclimatize to a hot, humid environment
- Defer exercise if the heat index is “high risk” or “severe”
- Avoid training during the hottest part of the day (1000-1400 Hours in the Summer)
- Drink plenty of water
- Wear loose-fitting clothing
- Adjust training intensity by monitoring heart rate
- Incorporate compulsory rest periods of at least 10 minutes every 45-50 minutes
- Closely monitor daily body weight
- Give special consideration to those especially at-risk
Special Considerations & Safety

Air pollutants can be a risk to exercisers:

- Ozone
- Carbon monoxide
- Sulfur dioxide
- Particulate matter (dust & smoke)
Drugs and other substances can increase the risk of cardiovascular complications:

- Certain prescription medications
  - All beta-blocking drugs & some calcium-channel blockers
  - Psychological medications
  - Antianxiety medications
  - Antihypertensives (diuretics, beta- & alpha-blockers, calcium-channel blockers, & ACE inhibitors)
- Alcohol
- Tobacco
- Strong stimulants
  - Nicotine, amphetamines, cocaine
- Over-the-counter medications
  - Decongestants, antihistamines, aspirin
Special Considerations & Safety

Some symptoms warrant a call to a physician:

- Chest discomfort
- Musculoskeletal pain
- Dizziness
- Lightheadedness
- Malaise