Moderate- or Vigorous-Intensity Exercise: What Should We Prescribe?

by David P. Swain, Ph.D., FACSM

Learning Objectives
To understand the potential value of vigorous-intensity exercise in the prevention of coronary heart disease.

Key words: Exercise, Heart Disease, Prevention, Blood Pressure, Physical Activity.

The U.S. Surgeon General recommended in 1996 that adults obtain at least 30 minutes of moderate-intensity physical activity on most days of the week (1). This physical activity will reduce one’s risk for coronary heart disease (CHD), as well as other health problems such as type 2 diabetes, obesity, and certain forms of cancer (1). The U.S. Surgeon General’s Report went on to state that exercise of longer duration or “of more vigorous intensity” would provide more benefit (1). Despite this endorsement by the Surgeon General, acting in concert with the U.S. Centers for Disease Control and Prevention, little emphasis has been placed on vigorous-intensity exercise in public health promotion.

Several recent scientific articles suggest that vigorous aerobic exercise may result in substantially more benefits than moderate-intensity exercise, including greater improvements in aerobic fitness and greater reductions in CHD risk. This is true even when the duration of the moderate effort is prolonged so that the same total amount of work is performed. For example, if one person walks an hour a day at 4 mph, he or she would cover 28 miles per week and expend about 1,400 Kcal above rest (based on a net energy expenditure of 50 Kcal per mile for a 136-lb person; a heavier person would expend proportionally more). Running burns twice as many calories per mile as walking, so a runner would only need to cover 14 miles to burn the same 1,400 Kcal, for example, by jogging at 7 mph for only 30 minutes, 4 days per week. Although the walker and runner would burn the same number of calories, by doing so at a vigorous intensity, the runner could expect a greater increase in aerobic fitness and greater benefits regarding cardiovascular health.

Effect of Exercise Intensity on Aerobic Fitness
The minimum intensity of aerobic exercise needed to increase aerobic fitness or maximal oxygen consumption (V̇O₂max) varies with the client’s starting level of fitness. For those who are of low initial fitness, intensities as low as 30% of V̇O₂ reserve (V̇O₂R) may be effective, whereas...
moderately fit clients need 45% or more of VO₂R to experience any further increase in VO₂max. VO₂R is the difference between resting and maximum VO₂ and can be translated to an exercise intensity by using the same percentages of heart rate reserve (HRR) (3).

While these are minimum intensities for improving aerobic fitness, what is the optimum intensity? As seen in Figure 1, a vigorous intensity of exercise, defined as 60% or more of VO₂R, results in greater increases in VO₂max than do moderate (40% to 59% VO₂R) or light intensities (<40% VO₂R), even when the total amount of work is held constant (2, 4). Other studies suggest that the most effective training for increasing VO₂max is to perform intervals at an intensity approaching VO₂max (5, 6). Typically, aerobic interval training is done by athletes who alternate 3 to 5 minutes at near-maximal effort with 3 to 5 minutes of light intensity for a total of four to six repetitions. However, even cardiac patients have effectively and safely used such training (7).

Effect of Exercise Intensity on Coronary Heart Disease Risk

Greater levels of aerobic fitness are associated with reduced risk for CHD. An important analysis by P.T. Williams, Ph.D., compared the risk reduction attributed to various amounts of weekly caloric expenditure through any type of physical activity with the reduction in risk attributed to different levels of aerobic fitness (8). As seen in Figure 2, individuals in our society who engage in the most physical activity can expect about a 30% reduction in the risk for CHD, but individuals with the highest levels of aerobic fitness enjoy more than double that reduction in risk. How can that be? Aren’t these the same people? Not necessarily. A person could do enormous amounts of moderate-intensity walking, swimming, bicycling, and so on, and might not develop a high VO₂max. Dr. Williams’ study suggests that developing a high VO₂max is more important than merely engaging in moderate-intensity physical activity.

A recent review of epidemiological studies and clinical trials supports this view (9). Several epidemiological studies compared moderate-intensity exercise (usually defined in these studies as 4.0 to 5.9 METS, with 1 MET being resting energy expenditure) with vigorous-intensity exercise (≥6 METS) and consistently found a lower incidence of heart disease in individuals who exercised at the vigorous-intensity rather than the moderate-intensity level. Clinical trials also showed that exercise performed at a vigorous intensity may provide greater improvements than moderate-intensity exercise in some CHD risk factors, such as increased aerobic fitness, decreased resting blood pressure, and improved glucose control. Interestingly, the review found no difference in weight loss for individuals performing moderate-intensity versus vigorous-intensity exercise. When it comes to weight loss, a calorie is a calorie, regardless of how it is burned. But for aerobic fitness and CHD risk, not all calories are created equal. Further research is needed to explore the effect of various exercise intensities on individual CHD risk factors, but the current evidence supports greater improvements with vigorous-intensity compared with moderate-intensity exercise.

Cautions Regarding Vigorous-Intensity Exercise

During exercise, sympathetic drive increases to stimulate increased heart action. The greater the intensity of exercise,
the greater is the increase in sympathetic stimulation. While this stimulation is needed to increase heart rate (HR) and cardiac contractile force, other results include increased blood pressure and an increased tendency for the heart to experience rhythm disturbances. In a person who does not have heart disease, these changes are not considered dangerous. However, a person who already has CHD becomes more susceptible to a heart attack and to serious arrhythmias during exercise, especially if the intensity is vigorous. One study found that when sedentary individuals with CHD suddenly exercised vigorously (≥6 METS), their risk for experiencing a heart attack increased more than 100-fold above rest (10). However, this increased risk was only about twofold for those who normally exercised several times per week. Therefore, although exercise is beneficial to cardiac patients, professionals need to be cautious when first beginning exercise programs for those who have, or may have, CHD.

When prescribing vigorous-intensity exercise, one also must be aware of a higher risk for musculoskeletal complications and overuse injuries, particularly with modes of exercise that involve significant impact, such as running. Increases in intensity should be done gradually and in a periodized manner. For example, when first increasing intensity, decrease the duration or frequency so that total volume remains constant. After the client has adjusted to the higher intensity, volume may increase if desired.

Another concern is the potential effect of exercise intensity on adherence. Some clients may find higher intensities of exercise uncomfortable. In such cases, it is better to maintain a moderate intensity and increase duration, as exercise of a moderate intensity that is actually performed is more beneficial than exercise of a vigorous intensity that the client chooses not to do (11).

Recommendations for Exercise Prescription

Appropriate intensity ranges for aerobic training are presented in the Table. Accumulating sufficient weekly caloric expenditure at a moderate intensity of exercise (40% to 59% VO₂R) is effective for sedentary individuals to achieve weight loss goals, make modest improvements in aerobic fitness, and experience some reduction in CHD risk. For weight loss especially, building up to 1 hour per day of walking or other activities of a moderate intensity is recommended. Individuals who have symptoms of heart disease or who know that they have CHD, other cardiovascular diseases, diabetes, or pulmonary disease need physician clearance before beginning even moderate-intensity exercise (11).

Individuals interested in increasing their fitness and gaining additional cardiovascular benefits should progress to a vigorous level of intensity, provided they can do so safely. Individuals with symptoms or disease should not consider vigorous-intensity exercise until having completed a physician-approved, moderate-intensity exercise program and obtained further clearance to increase intensity. Moreover, individuals who are without symptoms or disease, but who have a high risk for CHD, may begin a moderate-intensity exercise program but should seek physician clearance before beginning vigorous-intensity

Table. Recommended Exercise Intensities

<table>
<thead>
<tr>
<th>Intensity</th>
<th>%VO₂R or HRR</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light</td>
<td>&lt;40%</td>
<td>initial intensity for deconditioned clients</td>
</tr>
<tr>
<td>Moderate</td>
<td>40%–59%</td>
<td>appropriate for calorie burning and some cardio benefits</td>
</tr>
<tr>
<td>Vigorous</td>
<td>60%–85%</td>
<td>appropriate for calorie burning and provides greater cardio benefits than moderate</td>
</tr>
<tr>
<td>Maximal</td>
<td>90%–100%</td>
<td>aerobic intervals; provides greatest increase in VO₂max</td>
</tr>
</tbody>
</table>

VO₂R indicates oxygen consumption reserve; HRR, heart rate reserve.
exercise (11). Although most clients can eventually enter a vigorous-intensity program, only individuals who are young (men, <45 years; women, <55 years) and have a low risk for CHD (no more than one major risk factor) should do so without first obtaining physician clearance (11).

Once ready to progress to vigorous-intensity exercise, individuals should be prescribed three to five sessions per week of 20 to 60 minutes at 60% to 85% \( \text{VO}_2\text{R} \) (11). As described in the side bar, this intensity can be translated to a target HR using the HRR method. Vigorous exercise sessions may be interspersed with moderate-intensity physical activities and recreational pursuits to provide a well-rounded regimen.

For the greatest increases in aerobic fitness, individuals already engaging in vigorous exercise should consider replacing one or two exercise sessions per week with aerobic intervals. After an extended warm-up (e.g., 20 minutes), choose an intensity of exercise that can be maintained for no more than 5 minutes, and that causes HR to rise to 90% to 100% HRR by the end of the interval. Maintain an even pace throughout the interval, rather than sprinting at the end. Then perform an equivalent period of time at a light intensity to recover for the next interval. The goal is to pace oneself so that subsequent intervals can be performed at the same near-maximal intensity for four to six repetitions. Aerobic interval training is stressful and

### Prescribing Exercise Intensity With Heart Rate Reserve

The HRR method is preferred by the author over the percent of maximum HR method for prescribing exercise intensity, because the HRR method accounts for differences in resting HR between clients. Moreover, \%HRR directly relates to \%\( \text{VO}_2\text{R} \) values (3). Calculate target HR using HRR with the following formula:

\[
\text{Target HR} = \left( \text{intensity fraction} \right) \left( \frac{\text{HRmax} - \text{HRrest}}{\text{HRmax}} \right) + \text{HRrest}
\]

“Intensity fraction” is selected from the Table and expressed as a fraction, not a percentage. HRmax can be estimated as 220 – age, but the client’s actual maximal HR should be used if known. HRrest should
be measured when the client has been resting for several minutes, free of distractions, and not influenced by caffeine or other stimulants, such as early in the morning, preferably in a position similar to that used during the prescribed exercise, for example, sitting for cycling or standing for walking or running.

Example:
A 40-year-old client with a resting HR of 72 BPM is ready to progress to vigorous-intensity exercise. What would be the target HR range at 60% to 85% HRR?

Low target HR = (0.60)(180 − 72) + 72 = (0.60)(108) + 72 = 65 + 72 = 137 BPM
High target HR = (0.85)(108) + 72 = 92 + 72 = 164 BPM.

should not be performed for extended periods of training. Typically, one would perform aerobic intervals for a period of 4 to 6 weeks with a reduced total volume of exercise, as these sessions replace other exercise bouts, as opposed to being added to the current training.

David P. Swain, Ph.D., FACSM, is a professor of exercise physiology at Old Dominion University. He is the author of Exercise Prescription: A Case Study Approach to the ACSM Guidelines and is the originator of the VO2 reserve concept for exercise prescription. Dr. Swain is an associate editor of ACSM’s official research journal, Medicine & Science in Sports & Exercise.

References

Condensed Version and Bottom Line

Moderate-intensity physical activity has clear cardioprotective benefits. However, exercise of a vigorous intensity provides even more benefit, most likely because of a greater increase in aerobic capacity and greater reduction in risk factors for heart disease. Clients who can do so safely should be encouraged to include vigorous exercise in their overall exercise routine.