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David Swain
Old Dominion University, dswain@odu.edu

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Fine-tuning The Exercise Formula

By David Swain

One hundred years ago, our forebears consumed more calories than we do today, yet they were leaner. Labor-saving devices were a rarity, and so in everyday life most people worked very hard physically. Obesity was present, of course, but afflicted only a small fraction of the population. We are not as fortunate today.

The epidemic of obesity continues to grow as technology advances. From cars to computers, there are gadgets aplenty to save us from exertion. In order to survive we no longer need to move about very often. Nor, when we relax, is our leisure time usually devoted to intense physical activity.

Inactivity has its price and can include disease. For example, the most common form of diabetes, known as Type 2, used to be found only in middle-aged or older adults who were sedentary and overweight. In recent years, diabetes has been found in increasing numbers of obese children; research studies have linked childhood obesity to such indicators as the number of hours that children watch television. Other maladies, including high blood pressure, heart disease and perhaps certain forms of cancer, can be tied directly to obesity.

What to do? These days, diets almost universally fail, not because most of us are overeating, but because (unlike previous generations) we do not move often enough. We do not exercise. Exercise is the key.

A wealth of scientific research has firmly established that exercise is essential to good health. Individuals who engage in regular exercise have a lower risk for many chronic diseases. Aerobic exercise — such as walking, running, bicycling and swimming — is best for developing cardiovascular fitness and reducing the disease risk. Resistance training, such as weightlifting, is necessary for developing muscle strength and maintaining the ability to live independently far into the retirement years. And any type of exercise that places stress on the bones — weightlifting as well as certain aerobic exercises, like walking and running — will stimulate bone health and reduce the risk of osteoporosis.

Not all exercisers are at the same level, however. A simple idea, perhaps, but one that led myself and Old Dominion colleagues Brian Leutholtz, an associate professor of exercise physiology, and David Branch, assistant professor of exercise physiology, to conduct studies on the way oxygen is used by the body during exercise. The results of our work have led to the adoption of new national guidelines by the American College of Sports Medicine (ACSM). Anyone who works out, but particularly those in supervised exercised programs, stand to benefit from our findings.

Small Error, Significant Effect

An individualized prescription for aerobic exercise involves several key points that are summarized in the acronym FITT: frequency, intensity, time and type. ACSM guidelines call for an exercise frequency of at least three times per week; an intensity of 40 to 85 percent of one's aerobic capacity; an exercise time of 20 to 60 minutes per session; and a type of exercise that uses a large amount of muscle mass in a rhythmic, continuous activity, such as walking, jogging, jumping rope and the like.

Aerobic capacity is the greatest amount of oxygen that a person can consume during strenuous exercise. This value can be measured in a laboratory and is called maximum oxygen consumption, or VO2max for short. But when you're out for a walk or bike ride, you don't know how much oxygen you are consuming. The intensity range of 40 to 85 percent of VO2max must be translated by a fitness professional into a specific heart rate or a specific workload on a piece of exercise equipment, such as a certain speed and a specific incline setting on a treadmill.

For many years, fitness professionals have used what is known as the heart-rate reserve method to calculate a target heart rate at the desired percentage of maximum oxygen uptake. Heart-rate reserve is the range of heart rates between the resting and maximal value. To use this method, you first need to measure your resting heart rate. This can be done when you have been relaxing for several minutes, preferably in the morning before you've gotten out of bed. Measuring your maximal heart rate is more difficult, and is usually only done in a laboratory or clinical test. It can, however, be estimated as 220 beats per minute (bpm) minus your age in years.

If you are 40 years old, for example, then your maximal heart rate would be calculated at approximately 180 bpm. Thus, if you measure your resting heart rate as 70 bpm, you could increase your heart rate by as much as 110 bpm above your resting value before reaching that 180 bpm level. Say you wanted to exercise at 50 percent of your aerobic capacity. Using the standard heart-rate reserve measure, you would then need to increase your heart rate to 125 bpm — that is, half of 110, or 55, added to your resting pulse of 70.

But we realized there was a flaw in relating heart-rate reserve to maximum oxygen consumption. When a person is resting, heart rate is at zero percent of heart rate-reserve; that is to say, it hasn't yet risen to the beneficial range between resting and maximum. But a resting person is not at zero percent of VO2max. At that level the person would have to be dead, not resting!

Exercise scientists work with athletes who train at high intensities. At rest, these individuals are at only five percent of VO2max (since an elite athlete's maximum oxygen capacity is already very high), so the error between their percent of heart-rate reserve and percent of VO2max is not important. But the less fit a client is, the greater the error, since their maximum aerobic capacity is far less. At rest, such an individual could already have an oxygen consumption as much as 25 percent of VO2max. Therefore, to calculate an effective aerobic training zone for a given individual, we should compare the range of resting to maximal oxygen consumption, just as we do for target heart rates.

A New Formula

To validate our theories, we conducted two studies. The first one, done on a bicycle ergometer, involved 63 subjects (33 male, 30 female), all between the ages of 18 and 40. The second was conducted using a treadmill and included 50 subjects (26 male, 24 female), again between the ages of 18 and 40. We had a representative mix of ethnic and racial groups and also a wide range of fitness levels, from sedentary to highly fit.

We attached electrodes to the chest to measure heart rate. We used face masks or mouthpieces to collect exhaled air and monitor what is known as the respiratory exchange ratio, in order to validate the extent of maximum physical exertion. As we increased exercise intensity, at each stage we calculated heart-rate reserve for each individual. When we compared this to the percentage of VO2max at each stage, we confirmed an error in relating percentage of heart-rate reserve to percentage of maximum oxygen consumption. We thus introduced a new term, VO2Reserve, to indicate the range of oxygen consumption between resting and maximum. It was recommended that this term should be used when designing exercise prescriptions. The American College of Sports Medicine quickly realized the advantages of using VO2Reserve, and has since made it part of its national guidelines.

The use of VO2Reserve has been of benefit for those individuals who cannot use traditional heart-rate guidelines because of, for example, the ways certain medications alter heart rate. For these clients, fitness professionals now calculate a workload on a piece of exercise equipment by using a percentage of VO2Reserve instead of a percentage of VO2max. For the least fit, this will correct errors of up to 40 percent in prescribed exercise intensity.

The adoption of VO2Reserve means that professionals are better able to improve the fitness of clients who need specialized care. In practice, this means that those who are fit can optimize performance, while those who are just beginning a supervised exercise program can progress more productively than would otherwise be the case.

Fit or not, the best imperative for everyone remains “Exercise!” Your body will thank you for it.

David P. Swain is the director of the University’s Wellmess Institute and Research Center and an Old Dominion associate professor of exercise physiology.

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