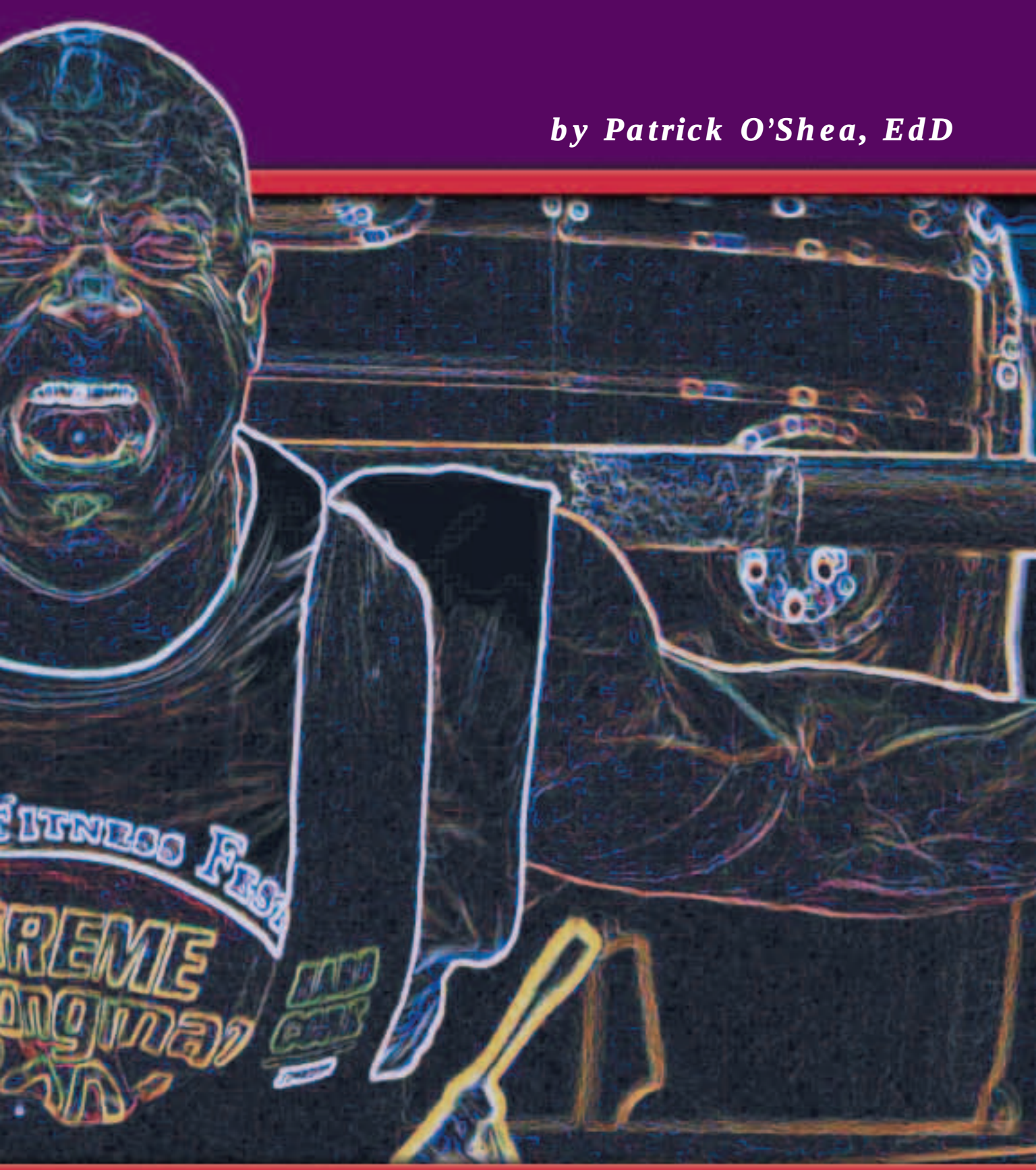
Iron Heart

A review of heart dyna

by Patrick O'Shea, EdD



mics in weight training

It's no secret: heart disease is the number one killer. It's also no secret that being physically fit decreases your risk of heart disease. But what *is* a secret, until now, is that the way you lift weights and the strength sport that you compete in can constitute long-term dangers to your heart health. If you're a powerlifter, weightlifter, bodybuilder, strongman competitor, or even football player, this article is a must-read—unless you want to die before you have to.

The trouble with heart disease is that the first symptom is often hard to deal with: sudden death.

Michael Phelps, MD

PUMPING HEART

First, the good news. In February 2000 the American Heart Association (AHA) revealed in a major scientific panel report, which reviewed 30 years of research, that weight training does in fact improve cardiovascular health and is strongly recommended for disease prevention programs. The report recommends weight training for individuals who have had heart disease or heart attack—as long as they haven't suffered major heart damage. The AHA panel concluded that the biggest benefit of weight lifting may be the creation of greater lean body mass, which burns calories more efficiently and keeps body fat in check. Strength training also improves the efficiency with which the body uses sugar, decreasing the odds of developing diabetes, a major risk for heart disease. The report also confirms that moderate-intensity weight lifting can reduce blood pressure in normal and borderline hypertensive individuals, which lowers the risk of stroke and coronary heart disease.

This is great news, but heart disease is nothing new. Examination of Egyptian mummies showed that heart disease existed during the time of the pharaohs 3,000 years ago. Greek and Roman literature contains many references to what sounds like fatal heart attacks. And during the 16th and 17th centuries, after a ban against autopsies was lifted because physicians recognized them as a sound method of determining the cause of death, more and more deaths were attributed to what we recognize today as coronary heart disease (CHD).

Your Heart and Weights

During weight lifting, cardiac output (Q) responds to the amount of blood that enters your heart. The amount of blood ejected by the ventricles of your heart is modified and controlled by the amount of blood in your heart before contraction begins (end diastolic volume), resistance to the ejection (impedance), the intensity or force of contraction, and your heart rate. The amount of blood that your heart pumps per minute, the cardiac output or minute volume, depends on the number of cardiac cycles or heartbeats per minute, plus the amount of blood pumped with each heartbeat (stroke volume). Hence, the formula Cardiac Output = Stroke Volume.

What you need to realize is that Q is greatly

IN POWERLIFTERS, EXERCISE-INDUCED HYPERTENSION CAN BE HUGE.

increased during lifting. This increased output ensures adequate blood flow to your working muscles. Since resting heart rates are lower in trained athletes, it follows that stroke volume must be an important compensating factor in maintaining an adequate Q in trained athletes. In the early stages of exercise, heart rate frequency is a major factor to enhance Q; however, as the exercise intensity increases, stroke volume plays a more important role.

Your stroke volume is a function of the amount of blood in the ventricles at the end of diastole, the period when your heart is relaxing and filling with blood, which is a direct result of the amount of venous blood returning to the heart. Furthermore, the amount of blood that's pumped with each stroke is determined by the strength of the heart's contraction and by the amount of pressure that must be overcome to push blood into the vascular system. The force of contraction of your heart also depends on its pre-loading and its after-load. The pre-load is the degree to which the myocardium (the middle muscular layer of the heart wall) is stretched before it contracts; the after-load is the resistance against which the blood is pumped. When the pressure against which your heart is pumping is raised, as when you're lifting heavy weights, your heart puts out less blood than it receives for several beats. Several seconds are required for the heart to respond to any sudden increase in intra-myocardial tension, creating a temporary reduction in oxygen supply to the heart, which is tolerable for most aerobically fit lifters.

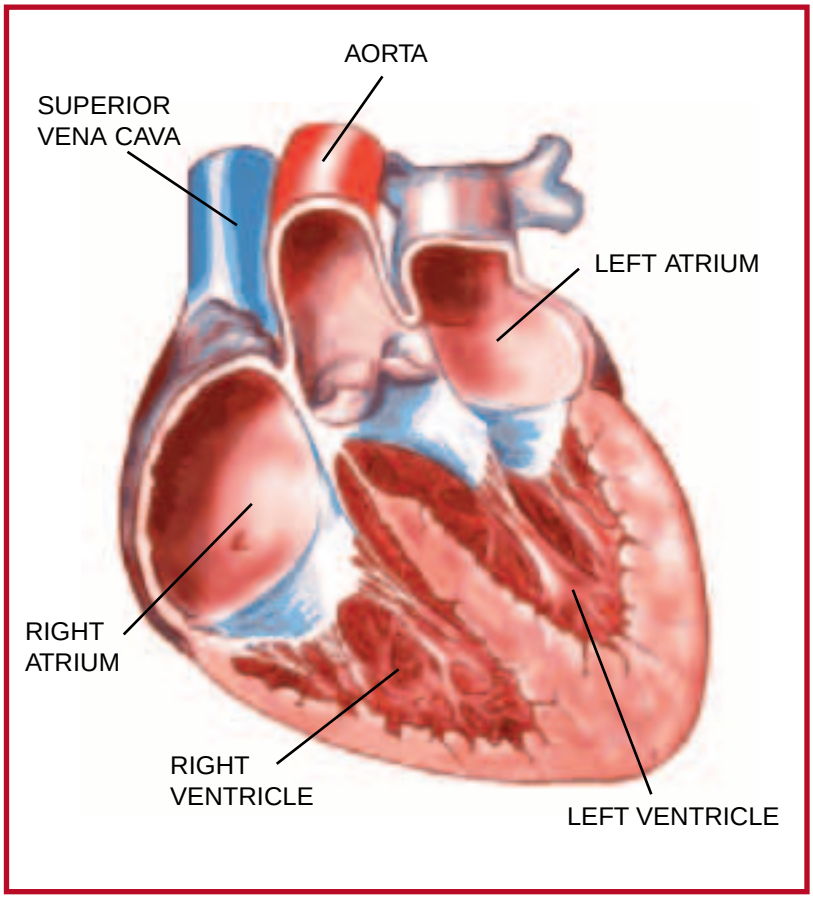
But when you pump iron, the amount of blood that's returning to your heart is increased by the contractions of your muscles with every rep and your increased respiration. In addition, because your blood vessels in the contracting muscles increase in size, resistance to blood flow is decreased, which results in increased cardiac output. Due to greater blood return to the heart, there's an obvious increase in volume and, consequently, cardiac muscle length. The greater stretch causes the heart to contract harder, thereby emptying the heart of additional blood into the cardiac chambers.

Chronic 1-rep max lifting and/or training to failure may have the greatest effect on increased left ventricle wall thickness.

VO_2 FOR YOU

Maximum oxygen uptake capacity, termed VO_2 max, is one of the most important measures of your cardiovascular fitness. Theoretically, VO_2 max is the point at which oxygen consumption by your working muscles fails to rise despite increased exercise intensity. Steady-state training is exercise that produces the condition where cardiac output is equal to oxygen consumption by the working muscles. Your ability to sustain a high steady state by running 30 minutes, or performing interval weight training for 40 to 60 minutes at 75 to 85 percent of your max oxygen uptake, reflects a high level of aerobic fitness.

Anaerobic exercise, such as interval weight training, helps to develop a high VO_2 max, teaches the body to tolerate lactic acid, and pushes back the anaerobic threshold, which is the point during exercise at which lactic acid begins to accumulate in the blood. With a high anaerobic threshold, you can steady-state train at a higher percent of your VO_2 max without accumulating excessive amounts of lactic acid. In other words, you have a higher tolerance for the intensive strength-endurance type of strength training.



BUFFED HEART

Cardiovascular adaptation to long-term weight training has been extensively researched over the past three decades, and the findings show that specific changes occur in your heart.

Heart Wall Thickness

Weightlifters have greater than normal absolute rear left ventricle and intraventricular wall thickness. This increase is due to the increased resistance of pumping of blood during lifting, but the degree to which the heart wall thickness increases depends on the type and intensity of your training. Chronic 1-rep max lifting and/or training to failure may have the greatest effect on increased left ventricle wall thickness; light bodybuilding and circuit training produce only a slight increase.

Heart Chamber Dimensions

Endurance-type weight training or high-volume bodybuilding will increase right ventricular chamber size. The size of the right ventricle of bodybuilders, but not powerlifters, is greater than normal in absolute and relative terms to body surface area and lean body mass. Low-volume, high-intensity Olympic-style lifting or powerlifting has little to no effect on chamber size.

Left Ventricular Mass

Left ventricular mass is directly related to an increase in either wall thickness or chamber size and is dependent on the type and intensity of training. Most iron sport athletes exhibit greater than normal absolute left ventricular mass. However, only bodybuilders have a significantly greater than normal left ventricular end-diastolic volume, which means their heart has a greater pumping capacity. In bodybuilders, the increased left ventricular mass is caused by both greater left ventricular wall thickness and chamber size, whereas, in powerlifters and Olympic-style lifters, the increase is mainly caused by greater than normal wall thickness.

Blood Pressure

Long-term lifting seems to have limited positive effects on some systolic and diastolic functions. Stroke volume of highly trained

MEASURING YOUR HEART

Electrocardiology

Electrocardiology records your heart's electrical activity as waveforms. By interpreting these waveforms or electrocardiograms (ECG), physicians can identify rhythm disturbances, conduction abnormalities, and electrolyte imbalances. An ECG aids in diagnosing and monitoring such conditions as heart attacks and pericarditis (inflammation of the heart). What's more, an ECG can monitor the immediate and chronic effects of weight training on cardiac function.

Exercise ECG evaluates your heart action during physical stress to test reaction to increased demand for oxygen and thus provides important diagnostic information that can't be obtained from a resting ECG. An ECG and a blood pressure reading are taken while you walk or run on a treadmill or pedal on a stationary bike and your heart's response to an increasing workload is recorded.

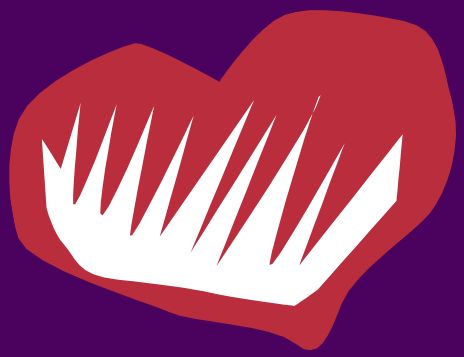
Echocardiography

Echocardiography examines the size, shape, and motion of your heart's structures and is valuable in evaluating the effects of strength training on your heart. Echocardiography uses ultrasound to image the heart. From the reflection of ultrasonic waves from the interface of tissue with differing densities, the ventricular walls as well as the ventricular cavities can be imaged.

An echocardiography is extremely useful but should be correlated with the results of an ECG. For strength athletes, especially powerlifters, an echocardiography provides valuable information about the effects of long-term, intense heavy lifting on heart size and function as well as detecting any myocardial abnormalities.

Pulse pressure

The best predictor of heart disease may not be systolic blood pressure but pulse pressure, which is the difference between your systolic pressure and diastolic pressure. One factor that influences pulse pressure is the stiffness or flexibility of the arteries. Healthy blood vessels are flexible and dilate with each heartbeat. Based on current knowledge, the condition of the arteries seems to be the key factor in high blood pressure. And as we now know, chronic heavy lifting does cause hardening of the arteries.



Olympic-style lifters isn't significantly different from untrained individuals. Yet clinical studies have shown that weight training with a high aerobic component doesn't cause hypertension and may actually lower its occurrence. However, when weight-training-induced hypertension does occur in lifters, it's most likely related to overtraining, use of steroids, large increases in muscle mass, or a significant increase in total body weight.

In 1987, in an unpublished study, this author had an opportunity to personally measure the pre-exercise blood pressure of seven male and two female world-class powerlifters. Two of the men, at body weights of 80 and 90 kilos, had normal systolic pressure readings under 130 mm Hg. Four men, weighing from 75 to 110 kilos, had pressure readings between 165 and 180 mm Hg, while the two women (both world champions), weighing 52 and 65 kilos, and the superheavyweight male (also a world champion), had readings greater than 192 mm Hg. The women also had very poor oxygen uptake numbers, and seven years later one woman had suffered a heart attack and the superheavyweight man died from one. "Lose weight" should be your mantra.

RANKED BY SPORT

Tests conducted at the Human Performance Laboratory of Oregon State University with elite competitive athletes found that VO_2 max can vary widely. Here's what the researchers learned:

Sport	VO_2 max
Nordic skiers	80-88
Distance runners	70-80
Cyclists	65-75
Basketball/bodybuilding	55-65
Shot, discus, hammer	35-45
Powerlifters	35
Sedentary individuals	25-35

BODYBUILDING CAN BE A HEART-HEALTHY ACTIVITY.

SPORT'S HEART

In evaluating the chronic effects of weight training on cardiovascular function, it's important to be specific as to the type of lifting you do. Basically, how you train determines the acute and chronic effects on your cardiovascular system.

Bodybuilding

Bodybuilding has proven effective in developing muscular endurance and cardiovascular fitness. Cardiovascular improvement is related to selection of exercises, training intensity, duration of the rest periods between sets and exercises, total number and frequency of training sessions, and initial fitness level. Clinical research indicates that

circuit training can lower diastolic blood pressure in borderline hypertensive individuals.

Interval Training

Interval weight training, a much more intense form of circuit weight training, is not recommended for hypertensive individuals. Interval training is mainly designed for endurance athletes wanting to maximize their aerobic and anaerobic levels of fitness.

Powerlifting

Powerlifting has the greatest potential to produce exercise-induced hypertension. When you execute a heavy squat, bench press, or deadlift, your heart's forced to work against a high after-load pressure. After-load pressure develops in response to high arterial blood pressure because blood flow is reduced when your muscles contract strongly. How hard your heart must work during a lift is determined to a great extent by the arterial pressure required to drive the blood through to the muscle that's contracting the hardest. Studies have shown that one to two years of powerlifting increase left ventricle thickness and mass with no increase in cardiac output. But you must realize that this is a physiological condition and not a pathological one, meaning that it may not be detrimental to you.

VAN HATFIELD PUSHES HIS HEART TO THE LIMIT DURING THE MEDLEY IN STRONGMAN. (FOR MORE ON VAN, SEE PAGE XX.)

Your cardiac output is greatly increased during lifting. This increased output ensures adequate blood flow to your working muscles.

Other factors influencing an increase in blood pressure during heavy lifting are prolonged breath holding, the Valsalva maneuver (making a forcible expiration against a closed glottis), and wearing a lifting belt and suit. Blood pressure readings up to 450/350 mm Hg have been recorded.

While the acute effects of heavy lifting on cardiac function pose no health threat to an aerobically fit lifter with normal resting systolic blood pressure (below 130 mm Hg), they may have serious implications for those of you with borderline systolic hypertension (140 to 159 mm Hg). High systolic pressure is associated with a higher risk of coronary artery disease and stroke.

Elevated diastolic pressure can cause damage to the kidneys and to blood vessels throughout the body.

In weight-lifting-induced hypertension, when the resistance against which the left ventricle must pump (after-load) is chronically elevated, the cardiac muscle pathologically grows in size. The total oxygen consumption of the heart, already increased by the work of expelling blood against a raised pressure, increases further because there's more heart muscle. Therefore, any decrease in venous blood flow to the heart has more serious consequences in borderline hypertensive lifters than it does in normal individuals.

Weightlifting

Olympic-style lifting places the least strain on the cardiovascular system. Because the snatch and the clean and jerk are executed quickly with no prolonged breath holding, there's no sharp rise in blood pressure. Elite lifters, excluding heavyweights, are noted for having a high level of cardiovascular fitness.

HEALTHY HEART

To counter the chronic effects of heavy lifting on the heart, you need to do a minimum of 15 minutes of aerobic cool-down at a low to medium intensity (heart rate between 110 and 120) immediately following training. This provides your heart an opportunity to work against a low perfusion pressure while at the same time enhancing venous return.

You can also easily fulfill your long-term cardiovascular fitness needs through cross-training. On your nonlifting days, you could power walk, bike, or use a stair stepper for a minimum of 30 minutes. However, any form of nonstop aerobic activity that gets your heart rate up to 110 beats per minute will pay major dividends in greater cardiovascular fitness and overall health.

Resources

- Bertovic, D.A., et al. Muscular strength training is associated with low arterial compliance and high pulse pressure. Hypertension 33(6):1385-1391, 1999.
- Brown, S.R., et al. Echocardiographic characteristics of competitive and recreational weight lifters. Journal of Cardiovascular Ultrasonography 2:163-165, 1983.
- Burke, A.P., et al. Cause of sudden death in athletes. Cardiology Clinics: The Athlete's Heart 10(2):303-317, 1992.
- Clemstein, M., et al. The effects of anabolic-androgenic steroids upon resting and peak exercise left ventricular heart wall motion kinetics in male strength and power athletes. Journal of Science and Medicine in Sport 6(4):387-397, 2003.
- Colan, S., et al. Left ventricular function in elite athletes with physiological cardiac hypertrophy. Journal of the American College of Cardiology 6:545-549, 1989.

WEIGHTLIFTERS EXPERIENCE VERY LITTLE CARDIOVASCULAR STRAIN.

- De Piccoli, B., et al. Anabolic steroid use in bodybuilders: An echocardiographic study of left ventricular morphology and function. International Journal of Sports Medicine 12:408-412, 1991.
- Ehsani, A.A. et al. Rapid changes in left ventricular dimensions and mass in response to physical conditioning and deconditioning. American Journal of Cardiology 42:52-56, 1978.
- Fagard, R.H. Impact of different sports and training on cardiac structure and function. Cardiology Clinics: The Athlete's Heart 10(2):242-256, 1992.
- Ferenchick, G.S., and S. Adelman. Myocardial infarction associated with anabolic steroid use in a previously healthy 37-year-old weightlifter. American Heart Journal 124:507-508, 1992.
- Hurley, B.F., et al. Effects of high intensity strength training on cardiovascular function. Medicine and Science in Sports and Exercise 16:438-488, 1984.
- Kavanagh, T. Take Heart. Toronto: Key Porter Books, 1998.
- Luke, J.L., et al. Sudden cardiac death during exercise in a weightlifter using anabolic androgenic steroids: Pathological and toxicology findings. Journal of Forensic Science 35:1441-1447, 1990.
- MacDougall, J.O., et al. Arterial blood pressure response to heavy resistive exercise. Journal of Applied Physiology 58:785-790, 1985.
- Messerli, F.H. Chemical determinants and consequences of left ventricular hypertrophy. American Journal of Medicine 75:1-3, 1983.
- O'Shea, J.P. Quantum Strength Fitness. Corvallis, OR: Patrick's Books, 2000.
- Osler, W. The Evolution of Modern Medicine. New Haven: Yale University Press, 1921.
- Pearson, A.C., and M. Schiff. Left ventricular diastolic function in weight lifters. American College of Cardiology 58:1254-1259, 1986.
- Sherwood, L. Human Physiology: From Cells to Systems. St. Paul, MN: West Publishing, 1988.
- Ullrich, M. and M. Younis. Cardiac hypertrophy in weightlifters: Only in steroid users. Medicine and Science in Sports and Exercise 22(2):s64, 1990.
- Vitcend, A.M., and P. Hanson. Impairment of left ventricular function during maximum isometric dead lifting. Journal of Applied Physiology 69:2062-2066, 1990.