Cardiovascular fitness

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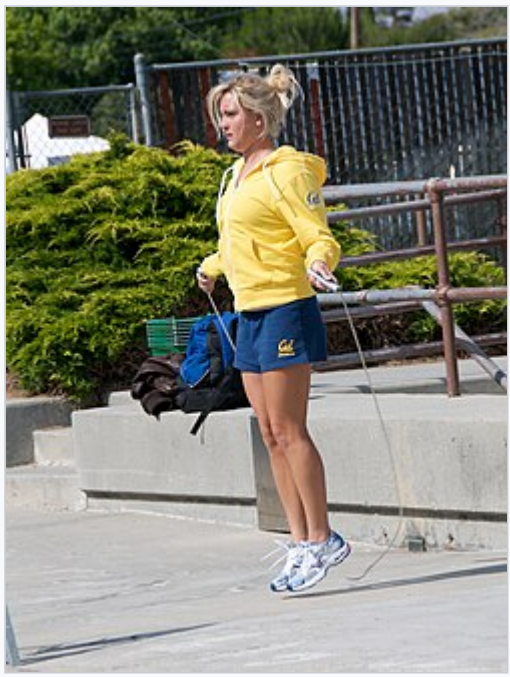
For physical exercises commonly referred to as "cardio", see aerobic exercise.

Cardiovascular fitness is a component of physical fitness, which refers to a person's ability to deliver oxygen to the working muscles, including the heart. Cardiovascular fitness is improved by sustained physical activity (see also endurance training) and is affected by many physiological parameters, including cardiac output (determined by heart rate multiplied by stroke volume), vascular patency, and maximal oxygen consumption (i.e. VO_2 max).[1]



A young woman jumping rope. This exercise is a type of cardio and increases cardiovascular fitness.

Cardiovascular fitness measures how well the heart and blood vessels can transport oxygen to the muscles during exercise. It is an important component of overall fitness and has been linked to numerous health benefits, including a reduced risk of cardiovascular disease, improved cognitive function, and increased longevity. A study published in the *American Journal of Epidemiology* found that higher levels of cardiovascular fitness were associated with a lower risk of mortality from all causes, including cardiovascular disease and cancer.[2]

This article addresses cardiovascular health as well as fitness, because the two are dependent on each other. However, "cardiovascular health" often refers to the normal, non-diseased function of the heart as defined by medical professionals. While the definition of health is still controversial and debated, it is frequently used in contrast to disease, whereas "cardiovascular fitness" further describes the performance of the heart and blood beyond normal functioning, or simply a non-diseased state. This article will focus on cardiovascular fitness, and reference health and disease to support this topic. For more information on cardiovascular health and disease, see cardiovascular disease.

Physiology of the circulatory system [edit]

The cardiovascular system collectively refers to the heart and the blood vessels, which include arteries, capillaries, and veins. The heart and vessels function to distribute oxygenated blood to the body's organ systems where oxygen diffuses into cells to aid in the generation of ATP (a molecule used throughout the body to as a form of energy). Once the oxygen diffuses into cells, the blood is then "deoxygenated" and returns to the heart, where it is pumped into the lungs to receive more oxygen. The blood is then considered "oxygenated" and delivered from the lungs to the heart again, where it is pumped to the rest of the body. For more information, see circulatory system.

Cardiovascular "fitness" is defined as the ability of the heart and blood vessels to deliver oxygenated blood to the whole organism. Many diseases and conditions can reduce cardiovascular fitness by three main mechanisms:

1. **Obstructing the flow of blood from the heart through the vessels,** e.g. coronary artery disease, peripheral artery disease, atherosclerotic disease, stenosis, aneurysms, etc.
2. **Inhibiting the flow of blood through the heart,** e.g. valvular diseases (stenosis, sclerosis, ischemia to the papillae muscles), myocardial ischemia, constrictive pericarditis, etc.
3. **Reducing the return of blood to the heart, referred to as "preload,"** e.g. venous insufficiency, orthostatic hypotension, pericardial effusion, etc.

These diseases are collectively referred to as "cardiovascular disease" (CVD). Ultimately, reduced cardiovascular fitness can lead to heart failure and ischemia, reducing the body's aerobic metabolism of energy to the degree that cells die and the organ can no longer perform its function. Therefore, treatment and prevention of these disease is key to maintaining and improving cardiovascular fitness to optimize the function of the whole body.

Assessing cardiovascular fitness [edit]

Cardiovascular fitness can be assessed through various methods, including maximal oxygen uptake ($\dot{V}O_{2max}$), which is the maximal amount of oxygen that can be used during exercise. Biomarkers, such as those used for assessing blood lipids, inflammation, glucose tolerance, and hemostasis, may be used to monitor progress during the development of cardiovascular fitness.[1]

The role of exercise in cardiovascular fitness [edit]

Regular physical activity is essential for improving cardiovascular fitness.[1] The American

Heart Association recommends at least 150 minutes of moderate-intensity aerobic exercise or 75 minutes of vigorous-intensity aerobic exercise per week to improve cardiovascular fitness and reduce the risk of cardiovascular disease.[3]

Cardiovascular changes attributed to aerobic exercise [edit]

During aerobic exercise, cardiac output and oxygen consumption (VO2) increase, following the Fick equation: VO2 = Cardiac Output x Arteriovenous oxygen difference. Cardiac output results from stroke volume and heart rate (CO = HR x SV). Age-adjusted maximum heart rate is estimated with HRmax = 220 bpm - [subject's age]. Stroke volume rises due to enhanced preload and myocardial contractility, though excessively high heart rates may reduce cardiac output by shortening left ventricular filling time.[4]

Chronic aerobic exercise improves cardiovascular function through adaptations like increased left and right ventricular function, raising cardiac output and maximum oxygen consumption. Vascular changes, such as reduced arterial stiffness and better endothelium-dependent vasodilation (from nitric oxide), also occur. These adaptations help mitigate age-related declines in cardiac performance. While people with cardiovascular disease (CVD) see lesser structural adaptations, exercise remains beneficial, underscoring its role in cardiac rehabilitation.[4]

Physical activity reduces CVD mortality, with high fitness levels linked to fewer CVD risk factors, including obesity and hypertension. For instance, Barry et al. found that individuals with low cardiorespiratory fitness had double the mortality risk of fit individuals, regardless of BMI, while individuals with high cardiorespiratory fitness had similar survival rates (again, regardless of BMI).[4][5]

Prescribing exercise: type, dosing, and adverse effects [edit]

Moderate-intensity continuous exercise is standard for CVD patients, though high-intensity interval training (HIIT) may offer superior cardiorespiratory and cardiac improvements. The *Physical Activity Federal Guidelines* suggest 150 minutes of moderate or 75 minutes of vigorous weekly aerobic activity, yet over half of adults fall short of these targets. Studies show even low doses of activity (e.g., <6 miles of running per week) can significantly reduce all-cause and CVD mortality risks.[4]

Resistance training complements aerobic exercise by enhancing muscular fitness, which reduces cardiovascular risk factors, improves insulin sensitivity, and decreases atherosclerosis. It's recommended to incorporate resistance exercise twice weekly for at least 15–20 minutes, particularly in older adults and those with heart failure.[4]

Excessive endurance training can negatively impact cardiac function, causing myocardial

injury markers, chamber dilation, and reduced right ventricular function. Long-term, this training may result in adverse remodeling, fibrosis, and increased arrhythmia risk, notably atrial fibrillation. Optimal exercise volumes are under 30 miles of running or 46 miles of walking per week, as higher volumes may reduce cardiovascular benefits.[4]

Despite the risks of excessive exercise, the primary public health concern remains insufficient physical activity.[4]

References [edit]

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