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## Exercise Medicine Is Regenerative Medicine

Tommy Boone, PhD, MPH, MAM, MBA  
Board Certified Exercise Physiologist

Today, it is common knowledge that exercise is the equivalent of a drug that prevents and treats cardiovascular disease (1). That is why physical activity and regular exercise are known by the expression: Exercise is medicine! However, from the ASEP point of view (2), the correct expression is: Exercise medicine! In a nutshell, a person who exercises has a higher exercise capacity than someone who does not exercise, which correlates to a larger dose of exercise medicine that decreases mortality risk. Hence, individuals who are highly fit are statistically less likely to die of coronary disease and/or other chronic diseases.

Interestingly, while the benefits of exercise medicine represent both structural and physiological changes that decrease the risk of chronic diseases, there is increasingly more discussion of the beneficial effects of exercise on the vascular cells. The biology of endothelial cells reveals a variety of health related functions, particularly given the impact of exercise medicine on restoring a healthy endothelial phenotype.

The effect of exercise medicine on the muscles that contract to produce movement is linked to vasodilation and enhanced blood flow throughout the contracting muscle tissues. The result is an increase in the hemodynamics forces (i.e., shear stress and cyclic strain) and/or circulating factors released from adipose tissue and skeletal muscle that are believed to initiate endothelial adaptations in the arteries supplying the contracting skeletal muscles and nonworking tissues (3).

**Few people know how to take a walk. The qualifications are endurance, plain clothes, old shoes, an eye for nature, good humor, vast curiosity, good speech, good silence and nothing too much.**

*Ralph Waldo Emerson*

Interestingly, there is also evidence to support the adaptations induced by exercise medicine take place in healthy subjects as well as in the unhealthy (i.e., diseased states) subjects. This means exercise medicine should be prescribed to everyone, regardless of age, sex, healthy, or unhealthy. Individuals with preexisting cardiovascular risk factors benefit from regular exercise training just as non-diseased individuals do.

Importantly, exercise medicine is statistically associated with a decrease in strokes (e.g., cerebrovascular events) by decreasing arterial stiffness and the risk of carotid artery plaque, the likelihood of a rupture, and emboli. Thus, exercise medicine plays a significant role in the prevention and treatment of cardiovascular disease. Why, because exercise

**If we could give every individual the right amount of nourishment and exercise, not too little and not too much, we would have found the safest way to health.**

*Hippocrates*

medicine is anti-atherogenic, and it decreases oxidative stress through the up-regulation of the antioxidant enzyme, superoxide dismutase (4).

There are also exercise medicine-induced improvements in functional and cognitive outcomes due to the positive changes in vasodilator action and cerebral circulation in specific regions of the brain. Exercise medicine increases cardiac output that results in an increased blood flow across the endothelium, which creates a shear stress stimulus that increases the production and release of nitric oxide (NO) by the endothelium to dilate the vessels.

Aside from this very brief statement regarding exercise medicine and endothelial adaptations, there are other improvements in cardiorespiratory fitness, efficiency, and blood pressure. For example, specifically, with respect to the lungs, both at rest and during exercise, ventilation is improved with a larger tidal volume and lower frequency of breaths per minute. Similarly, the improved left ventricle pumps a larger volume of blood per beat (i.e., stroke volume) while beating less frequently per minute (i.e., heart rate is lower). Exercise medicine also improves tissue extraction of oxygen (i.e., arteriovenous oxygen difference) and the removal of carbon dioxide. The reduced fasting blood glucose and the increased insulin sensitivity also help to protect against lifestyle-related diseases.

While physical inactivity is a major risk factor that contributes to numerous chronic diseases (such as high blood pressure, heart disease, obesity, and type 2 diabetes), exercise medicine is the stimulus that produces myocardial and skeletal muscle adaptations and remodeling. The adaptations set the stage for increased substrate delivery and utilization, mitochondrial density and respiration, intrinsic oxidative capacity, contractile function, and resistance to fatigue (5). Exercise also increases skeletal muscle glucose uptake through an insulin-dependent pathway.

Both aerobic training and resistance training versus either type of training alone (as exercise medicine) are effective in decreasing insulin resistance in obesity and metabolic syndrome (6) and improving glycemic control in type 2 diabetics (7). Muscle hypertrophy

and neurological adaptations represent two additional important changes in health-related musculoskeletal function. The latter is the result of the collective improvements in motor unit activation, firing frequency, and synchrony of high-intensity motor units (8,9).

Chronic diseases are costly for everyone, and the bottom line is that the diseases are only going to increase without a serious exercise medicine intervention. The aging of the population and the sedentary lifestyle contribute to higher rates of heart disease, blood pressure, and diabetes (10). Exercise medicine is the most logical intervention both at a personal level and collectively by society. That is why every U.S. adult should engage in "...exercise training intensities of 40% (or perhaps even less) of maximal capacity..." (11) to reduce the risk of clinician visits and hospitalization. Yes, it is a major challenge but it is an absolute necessity to decrease the incidence of obesity, the risk of type 2 diabetes and heart disease, and several types of cancers, including breast, colon, and endometrium (12). Otherwise the decline in the number of Americans who exercise will continue to take its toll on the risk of numerous mind and body diseases.

One very important answer to this problem is exercise medicine with a dose of exercise as little as  $150 \text{ kcal}\cdot\text{d}^{-1}$  for 6 of the 7 d in a week (12), which could be fulfilled by the following combination of activities: (a) walking 35 min to complete 1.75 miles at a 20-min mile pace; (b) bicycling 15 min at a  $16 \text{ mi}\cdot\text{hr}^{-1}$  pace; and (c) running 15 min to

**Movement is a medicine for creating change in a person's physical, emotional, and mental states.**

*Carol Welch*

complete 1.5 mi at a 10-min mile pace. In addition to these examples, it is important for adults to understand that three 10-min bouts of exercise provide similar benefits as doing 30 min all at once. The fact that there is no amount of exercise that is insignificant and, thus doing even  $15 \text{ min}\cdot\text{d}^{-1}$  of walking has proven to significantly lower mortality rates (13,14).

Admittedly, coming to grips with the simplicity of the combination of activities as exercise medicine is not the complete prescriptive process. There also is the necessity for evaluating and educating the clients and/or patients to their ongoing physiologic and musculoskeletal changes and adaptations that result from the use of exercise medicine as a powerful therapy for preventing and/or ameliorating illness. The ASEP Board Certified Exercise Physiologists understand their role as healthcare professionals is to provide each client and patient with a detailed exercise plan designed to help ensure that the exercise medicine prescription works. This approach is critical to not only improving the heart, lungs, and muscular system, but decreasing depression as well.

Mandy Oaklander (15) says, "...exercise is, as of now, the best way to prevent or delay the onset of Alzheimer's, which is second only to cancer as the disease Americans fear most, according to surveys." Just think about the millions of Americans who would benefit if only they would exercise. The research in support of exercise medicine is striking and enormous. The healthcare cost of not exercising is extremely high in dollars

and in friends, colleagues, and family. That is why the role that sedentary lifestyle and obesity plays in non-communicable chronic diseases must be corrected.

As to obesity, in particular, Wang and colleagues estimated that by 2030, the obesity rate in the United States will increase to ~50% for men and 52% for women, with the total number of obese individuals increasing from 99 million in 2008 to 164 million by 2020 (16). Then, too, physical inactivity has a direct influence on risk factors that are linked to the development of non-communicable chronic diseases that result in death, which "...is expected to increase to more than 75% of all deaths by 2013" (17). The ASEP leadership believes that adults should get the healthcare services of an ASEP exercise physiologists to personalize the exercise medicine prescription. This is also why the following book was written, *ASEP's Exercise Medicine Text for Exercise Physiologists* (18).

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