REVIEW

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Physiology of Exercise and Its Importance During COVID-19 Pandemic

COVID-19 Salgını Sırasında Egzersiz Fizyolojisi ve Önemi

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Abstract

Physical activity is important in the prevention and treatment of Coronavirus disease-2019 (COVID-19). There is a strong relationship between increased physical activity and improved general health during COVID-19 pandemic. Moderate aerobic exercises may be more beneficial than the exhausting exercises due to the post-COVID-19 syndromes or long-COVID. Regular program of aerobic exercise for 20-60 minutes in the form of cycling or walking with an intensity of moderate in repeated 2-3 sessions/week could safely enhance immune functions. The aim of this review is to highlight the recommendation to support exercise activities in the post COVID-19 period.

Keywords: Aerobic exercise, COVID-19 pandemic, health, physiology

Öz

Koronavirüs hastalığı-2019'un (COVID-19) önlenmesi ve tedavisinde fiziksel aktivite önemlidir. COVID-19 salgını sırasında fiziksel aktivite ile genel sağlığın iyileşmesi arasında güçlü bir ilişki vardır. COVID-19 sonrası veya uzun süreli COVID-19 sendromlarında orta düzeyde aerobik egzersizler yorucu egzersizlerden daha faydalıdır. Haftada 2-3 kere tekrarlanan, orta düzeyde, bisiklet veya yürüyüş şeklinde 20-60 dakikalık düzenli aerobik egzersiz programı bağışıklık fonksiyonlarını güvenli bir şekilde iyileştirebilir. Bu derlemenin amacı, COVID-19 sonrası dönemde egzersiz aktivitelerinin desteklenmesi önerisini vurgulamaktır.

Anahtar kelimeler: Aerobik egzersiz, COVID-19 salgını, fizyoloji, sağlık

Introduction

One of the most common challenges to body homeostasis is not a disease but an everyday activity: Exercise. Exercise comes in two major forms: Dynamic endurance exercises, which are distance running and cycling, and resistance training, which are weightlifting and strength training (1). These types of exercises have many different effects on body systems, especially immune system, cardiovascular-respiratory system, and muscle system.

Unidentified viral pneumonia cases were announced in December 2019, in the city of Wuhan, Hubei province, China (2). This unidentified virus extended all over the world in the following weeks. It was announced that viral pneumonia was a novel coronavirus [severe acute respiratory syndrome-coronavirus-2 (SARS-COV-2)] by a research center in China, on January 7, 2020, later named Coronavirus disease-2019 (COVID-19) by the World Health Organization (WHO) (3). The COVID-19 pandemic has changed the living conditions of people and has had an unfavorable effect on many sectors

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in the economic, social, and commercial fields in many fields such as health, education, industry, transportation, tourism, and sports around the world. While COVID-19 may cause asymptomatic or mild infection with rapid recovery, acute and permanent complications may occur in some cases. Severe COVID-19 can potentially lead to an extensive diversity of clinical disorders containing various body systems, such as ongoing shortness of breath, heart damage, pulmonary fibrosis, or embolism. Recovery may be prolonged for survivors and some patients have a long-term and debilitating illness, which lasts for up to 4 weeks. Quarantine and sedentary lifestyle has affected the individual's quality of life during the COVID-19 pandemic. It is stated that the quarantine processes lead to a decrease in individual's physical activity and increase in unhealthy nutrition. Supporting this information, many studies have demonstrated that the physical activity levels of individuals significantly decrease during the quarantine period, which causes many health problems including cardiovascular, respiratory neuromuscular function and depression. Studies have shown that there is a strong relationship between increased physical activity and improved general health during COVID-19 pandemic (4).

Factors Causing Exercise Restrictions in COVID-19 Patients

COVID-19, immune responses and exercise: The effects of exercise on the immune system have been extensively studied in recent years. It is the main subject of research whether exercise increases the resistance to infections by improving the immune system, or whether it makes it easier to catch infections by suppressing the immune system. Different effects may occur in both innate and acquired immunity. The effect of exercise on immune system functions depends on many variables such as the intensity, duration, severity of exercise and the physical fitness level of the individual (5,6). The studies have suggested that regular moderate-intensity exercise reduces the incidence of infections such as common cold, while intense exercise increases the ratio of upper respiratory tract infections, and the severity of exercise increases the risk of upper respiratory tract infections. In addition, regular moderate-intensity exercise increases the resistance against upper respiratory tract infections (7). While the immune system functions increase with mild and moderate exercise, strenuous exercise is one of the strongest types of stress that suppresses the immune response. The immune system is suppressed following intense prolonged exercise. Since exhausting exercises will increase the secretion of cortisol from the hypothalamus-pituitary-adrenocortical axis, they may have a suppressive effect on the immune system and make the individual temporarily susceptible to infections (8).

During aerobic exercises, there is an increase in the number and functions of natural killer (NK) cells in our body (9). However, immediately after a single acute short-term and high-intensity exercise, the leukocyte concentration increases, and this increase is mostly carried out by neutrophils (10). The increase in the number of neutrophils progresses after exercise. The increase in lymphocyte concentration following prolonged exercise is almost twice that after short-term exercise (11). NK cells and B-cells are also suppressed after a single acute short-term and high-intensity exercise. Moreover, vigorous exercise causes an increase in circulating levels of cytokines such as interleukin (IL)-1, IL-6, and tumor necrosis factor (TNF)-α (12).

In severe forms of COVID-19, diffuse alveolar and interstitial inflammation occurs (13). While the rapid immune response represents the defense of first line against infection with the virus, the excessive inflammatory response of innate immunity can lead to systemic tissue damage. The infected immune system responds with a cytokine storm and hyperinflammation which itself leads to further multi-organ damage and even death. In other words, the immune-mediated damage developed in these patients is more harmful than the damage caused by the virus (14). Laboratory findings of COVID-19 patients are decreased or normal number of leukocytes and decreased lymphocyte count (15). Coronavirus triggers the release of a significant number of cytokines, which cause the activation of the immune system, especially IL-6 and other acute phase reactants (16). IL-6 receptors are expressed by almost all immune cells and have a major role in the proliferation and differentiation of immune cells. IL-6 is produced by the stimulation of SARS-CoV-2 itself or other immune cells. IL-6 is an important indicator of lung injury and was significantly associated with an increase in C-reactive protein, lactate dehydrogenase, ferritin and D-dimer levels. There is a relationship between the levels of IL-6 and the severity of COVID-19. The decrease in IL-6 level was related to the effectiveness of the treatment and the improvement of the disease, while the increase in IL-6 was associated with the progression of the disease and worsening of the clinical picture (17,18). Therefore, IL-6 level can be used as an important biomarker for the monitoring of the disease in severe COVID-19 cases. In a study, it was demonstrated that the higher levels of IL-6 and systemic inflammation markers

was associated with a poor prognosis and contributed to mortality (19).

Exercise is also thought to stimulate the mitochondrial biogenesis, thereby preventing severe forms of COVID-19 (20). Mitochondrial biogenesis is defined as the development of existing mitochondria that responds to metabolic, mechanical, and hypoxic stresses occurring in myocytes and the adaptation of skeletal muscle to exercise training. It has been suggested that muscle mitochondrial biogenesis increases with regular exercise, and this adaptation increases endurance performance in individuals. Mitochondrial biogenesis, and the amount and activity of oxidative proteins in mitochondria can be reduced as a result of mitochondrial dysfunction (21). As the infection progresses, redox-sensitive or redox-active intracellular pathways triggered by SARS-CoV-2 can put the reductive cycle into a process that makes it impossible to continue at physiological levels, in this case, the cells remain in an irreversible pathway, that is, in the oxidation clamp characterized by destruction (22). Advanced inflammation further provokes redox imbalance in favor of oxidation, and all components of the cardiovascular system collapse (23).

COVID-19, cardiovascular responses and exercise: Many studies have demonstrated the relationship between cardiovascular diseases and exercise (24,25). Research has shown that exercise has many benefits. These benefits comprising raising plasma high-density lipoprotein (HDL) cholesterol levels, decreasing plasma triglyceride levels, and lowering blood pressure (26). High blood pressure is a main risk factor for strokes, while elevated triglycerides and low HDL-cholesterol levels are linked with the development of atherosclerosis and increased risk of heart attack. It has been shown that regular aerobic exercises also reduce hypertension, which is one of the leading problems in the world. Studies have demonstrated that regular exercise lowers blood pressure in mild to moderate hypertension (27). It has also been revealed that moderate-intensity exercise can lower blood pressure more efficaciously than high-intensity exercise (28).

COVID-19 infection can lead to cardiac arrhythmias, myocarditis, and other cardiovascular complications, with potentially fatal consequences. Pathophysiological mechanisms of cardiac injury may include T-cell and cytokine-mediated hyperinflammatory reaction, or direct myocardial cell infection (29). Cardiac involvement may also be associated with high expression of angiotensin converting enzyme-2 (ACE-2). ACE-2 is a membrane glycoprotein found in epithelial cells of many organs in the body, mainly in the heart, lungs, and kidneys, and is a homolog of ACE. It catalyzes the conversion of angiotensin (ANG)-2 to ANG-1-9 and ANG-1-7, respectively. Since the SARS-CoV-2 spike protein binds to ACE-2 and enters the cell, ACE-2 expression and/or polymorphism has been shown to have an impact on susceptibility to SARS-CoV-2 infection and outcomes of COVID-19 disease (30,31). The ACE-2 protein is a component of the renin-angiotensin-system (RAS) as well as being a transmembrane receptor for the virus. In a study, it was revealed that the binding of SARS-CoV-2 to ACE-2 receptor decreased the immunity and the anti-inflammatory action exerted by mitochondria (20). Besides this information, many studies demonstrated the relationship between ACE-2 levels and training. In a study, it was suggested that high intensity interval exercise increased plasma ACE-2 levels, while moderate intensity continuous exercise increased the urinary concentration of ACE-2 (32). Klöting et al. (33) suggested that intensive physical exercise induced ACE-2 expression in skeletal muscle but led to lower circulating ACE-2 levels. That may be due to the fact that intensive physical exercise caused hypoxia in skeletal tissue and was involved in increased tissue ACE-2 expression. Although its underlying mechanism is still unclear, it is thought that high-intensity exercises increase tissue ACE-2 levels which inhibits mitochondrial anti-inflammatory function, while moderate-intensity exercises increase plasma ACE-2 levels which prevent infection (20).

Exercise Recommendations for COVID-19 Patients

According to the WHO, a sedentary lifestyle is among the main risk factors for deaths occurring all over the world. In addition, it has been revealed that 150 minutes of physical activity per week in adults and even individuals with chronic diseases reduce the risk of ischemic heart disease by 30%, the risk of type II diabetes by 27%, and the risk of breast and colon cancer by 20-25% (34). However, moderate aerobic exercises may be more beneficial than the exhausting exercises due to the post-COVID-19 syndromes or long-COVID (35). Microorganisms, especially viruses, can enter the body and cause infections when immunity is weakened after high-intensity exercise (11). Therefore, light, and moderate intensity exercise should be chosen especially during this period. Even in recovering cases, a return to vigorous physical exercise can develop heart damage and suppress immune system, which can pose a health risk (36).

If there is not any structural damage and symptoms of COVID-19, it is possible to return to exercise. Employees in jobs that require intense physical activity should be alert to the risks of cardiovascular and other complications

from COVID-19 and provide specific inquiry for COVID-19 complications during return-to-work fitness assessments (37).

Conclusion

Regular exercise can reduce the dose of the drug used in chronic diseases or eliminate the need for the drug. It reduces the risk of heart disease and other chronic diseases. It strengthens the immune system, reduces stress, helps to lose weight, and strengthens the muscle and bone structure. It increases one's self-confidence. As a result of all these, it increases the life span and quality of life of the individual. Physical activity is important in the prevention and treatment of COVID-19. For the post COVID-19 patients, it may be beneficial to evaluate exercise capacity and it should be supported to start previous exercise activities under the control of sports physicians. In post COVID-19 period, patients may follow a regular program of aerobic exercise for 20-60 minutes in the form of cycling or walking with an intensity of moderate, may be repeated 2-3 sessions/week. Thus, it could safely enhance immune functions.

Ethics

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: A.K., K.E., N.D., Design: A.K., K.E., N.D., Data Collection or Processing: A.K., K.E., N.D., Analysis or Interpretation: A.K., K.E., N.D., Literature Search: A.K., K.E., N.D., Writing: A.K., K.E., N.D.

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