

The vital function of physical activity, exercise, and diet in the management of COVID-19 Symptoms

Mostafa Khafaei

Human Genetics Research Center, Baqiyatallah University of Medical Sciences, Tehran, Iran



Highlights

- Mild exercise has a positive effect on the morbidity and mortality of administering influenza and herpes simplex virus (HSV-1) in the respiratory tract.
- Reduced physical exercise reduces insulin sensitivity, which tends to be linked to a slowed immune response and a blunting of macrophage activation.
- The American Sports Medicine Association (ACSM) notes that ensuring public health needs at least 150 minutes of moderate-intensity aerobic activity a week.
- Vitamin D is commonly recommended as a critical nutrient that enters the body through ultraviolet rays from the sun or certain foods such as fish and rice, egg yolks, and dried mushrooms.
- Appropriate zinc, selenium, and vitamin D has been suggested to be essential for immunity to other viral infections, immune function, and reduced inflammation.

Article Info

Receive Date: 18 August 2021

Revise Date: 25 September 2021

Accept Date: 02 October 2021

Available online: 10 October 2021

Keywords:

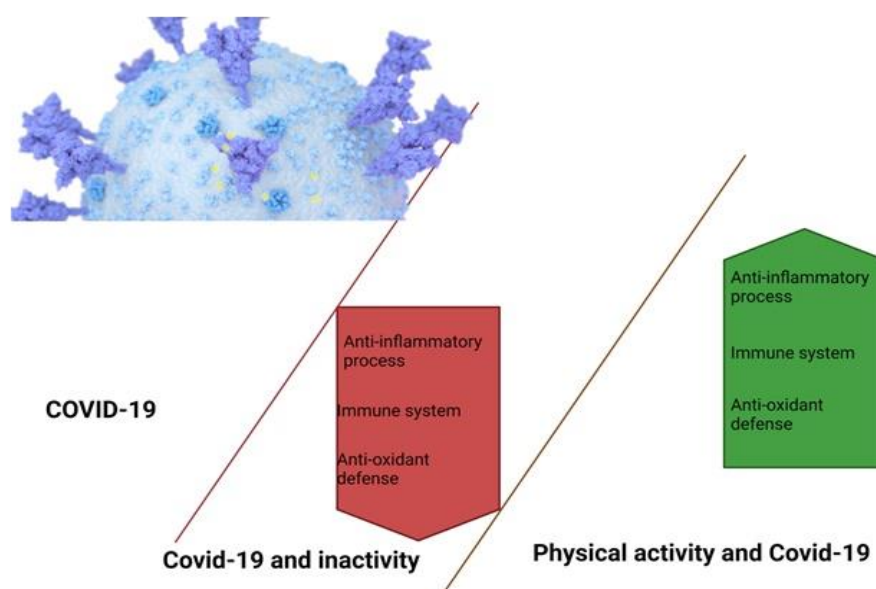
Coronaviruses

Physical activity

Interleukin-6

Middle East Syndrome (MERS)

Graphical Abstract



Abstract

The COVID-19 pandemic has caused many of us to stay constantly hospitalized and isolated. In addition, this has severe long-term mental health impacts such as depression, post-traumatic stress, anxiety, rage, anger, and opioid addiction. Consequently, it leads to the growth of Sedentary Death Syndrome and impairs the cognitive ability of individuals. Even so, it was shown to be necessary to support an individual's condition and general wellbeing when a person leads a physically active lifestyle or is involved in regular home exercise. Regular strength exercise in the home provides a variety of effects which has a direct positive effect on a person's mental health. as the WHO has recently mandated, the accumulation of at least sixty minutes of moderate-to-intensity physical activity every day for children aged 6 to 17, as well as on two days per week for adults in order to increase bone and muscular strength, there is a very strong correlation between getting enough exercise and becoming healthy.



Introduction

Coronaviruses are a group of viruses with a wide range of phenotypic and genotypic diversity; the rapid and steady spread of Coronavirus 2019 (COVID 19) has put many people's health and lives at risk and has posed several concerns for health systems in different countries. According to the literature, the four forms of coronas are Alpha, Beta, Gamma, and Delta (1). Coronaviruses have historically been associated with human infections followed by enzyme infections in birds and rodents (2). During the 2002 SARS epidemic and the 2012 Middle East Syndrome (MERS) outbreak, humans were infected and died (3). In late 2019, Wuhan, China, discovered the new influenza-like coronavirus known as a severe corona viral syndrome 2 (SARS-CoV-2), the complexity of a SARS outbreak is the same as the MERS ones (4, 5), it is transmissible, and has a beta-CoV genomic structure and belongs to the beta-CoV family, too (6). As a result, about 80% of the SARS-CoV-2 genome is similar to the SARS-CoV genome, Coronavirus penetration into host cells occurs through direct antigen-protein interactions inside the virion shell, and the homotrimeric class I transmembrane fusion protein is known as Spike stimulates host cell adhesion by its direct cellular associations with all host receptors or sugar molecules (Figure 1) (7, 8). As a result of COVID-19 having recently been determined to be a pandemic (widespread) and because of the lack of proven treatment, proper prevention and management of the disease is critical, Additionally, age (people over the age of sixty are at risk of death), gender (men are at higher risk for both prevalence and incidence), any medical condition that reduces immunity, and chronic diseases including diabetes, hepatitis, chronic lung disease, or kidney disease all increase the risk of COVID-19, There is no conclusive evidence on whether or factors are effective in curing COVID-19 and facilitating recovery (9). An active lifestyle is important for good health and happiness, exercise and physical activity have been shown to help reduce cardiovascular diseases, type 2 diabetes and certain forms of cancer, overweight and obesity (10), previous epidemiological data suggest that aerobic training has shown to help reduce viral infection (11), as a consequence, this research investigated the function of physical exercise in COVID-19 transmission and prevention.

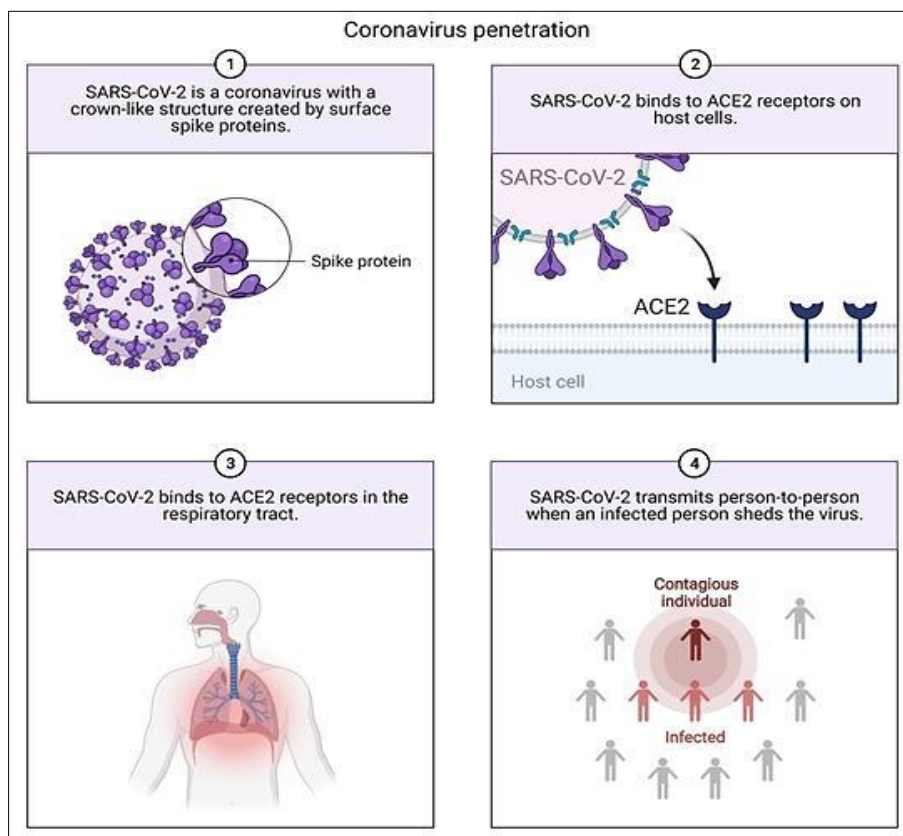


Figure 1. The spike (S) protein of SARS-CoV-2 plays a key role in the receptor recognition and cell membrane fusion process.

Covid-19 and inactivity

The common features of coronavirus-19 infection include dry cough, fatigue, and fever. There are no vaccinations or clinically proven effective treatments currently available. Medicines display some promising potential in the treatment of COVID- 19 patients. Right now, the only way to control the spread, prevalence, and mortality are social grooming and social distancing, this strain is new to our human immune system, so we have to rely on facets of our innate immunity in order to handle the first instance of infection (12). Like most viral infections, we will produce antibodies and cell-mediated virus-specific immune defenses over weeks if we are resistant to the infection, In most cases, the "training" of our immune systems, which relates to exposure, gives us long-lasting protection from reinfection or, when we are re-infected, disease effects are far less common (13). Physical exercise helps to boost the immune and antiviral defenses and animal trials have shown that before diagnosis, mild exercise has a positive effect on the morbidity and mortality of administering influenza and herpes simplex virus (HSV-1) in the respiratory tract. In other words, preclinical trials have shown that vigorous activity results in worse outcomes after respiratory virus infections.

A Follow-up study has concluded that the pathways responsible for these results are understandable (14). The essential antimicrobial lipase is mucosal lactoferrin because it can bind and block viruses in the cell membrane of the lysed cell so they are not able to infect. Furthermore, reduced levels or secretion of salivary immunoglobulin A may be linked with upper respiratory tract infection and can be binding to viruses and disabled (15).

Physical activity and COVID-19

To mitigate the impact on the states, the federal, state, and local governments have implemented various preventive and reduction strategies to try to reduce the pressure of COV-19 (16), these policies include encouraging social distancing, at home, work, and policies that support working from home and closing schools when they are not necessary. Although these interventions are critical in fighting the pandemic, they've increased in obesity and frailty, as with obesity, physical inactivity exacerbates complications and raises the likelihood of death in people with chronic conditions or severe respiratory infections (17), reduced physical exercise reduces insulin sensitivity, which tends to be linked to a slowed immune response and a blunting of macrophage activation (18). Exercise raises a person's physiological reserve, thus reducing the likelihood of coronary, metabolic and several forms of carcinogenic diseases (19). As physical activity offers both prophylactic and anti-inflammatory effects, including improved macrophage responses, antipro-migratory cytokines, and a reduction in inflammation, it has immuno-surveillance advantages. Thus, it is critical to promote physical exercise consistent with state and local prevention strategies in order to aid in disease control and build physiologic reserve outside the immediate SARS-CoV-2 pandemic (20).

The physiological effect of physical exercise

Furthermore, metabolic diseases such as asthma, diabetes, insulin resistance, dyslipidemia, obesity, renal and cardiovascular disease, and liver and kidney disease all increase the risk of contracting COVID-19, Exercise, on the other hand, can aid in weight reduction, increased respiratory system function, hormone homeostasis regulation, and reduced inflammation (21), age, pre-existing medical conditions and obesity have all been reported as risk factors for COVID-19 infection or death (22). Daily physical exercise has been found to improve the immune system of the elderly, certain fitness regimens, though, are not feasible in the elderly due to joint and muscle problems. Multiple trials have been performed to examine the immediate impact of exercise on the elderly's immune system, and the findings indicate that even a single session may be beneficial (23). However, studies on athletes and their immune system responses during short- and long-term training have shown that regular exercise enhances the immune system, meaning that athletes might be more susceptible to the coronavirus than others (24). In the other hand, evidence is scarce on the long-term effect of training on the immune system of the elderly (25). Furthermore, due to the presence of the ACE2 enzyme; obese individuals are

more susceptible to COVID-19 infection. Since ACE2 is a coronavirus receptor (26), increasing the number of calories spent through exercise can result in weight reduction and, as a result, a lower risk of contracting COVID-19. Physical activity promotes the breakdown of muscle and liver glycogen, which of turn promotes fat breakdown in adipose and muscle tissue, resulting in weight loss .previous study has shown that physical exercise of any sort greatly reduces fat mass in obese people. According to research, respiratory and cardiovascular fitness are inversely related to obesity; hence, maintaining a good degree of respiratory and cardiovascular fitness while maintaining a healthy body weight may be an important defensive tool in the battle against coronavirus (27).

Exercise can improve the performance of the cardiovascular system by increasing both the supply of oxygen and the consumption of oxygen by the muscles. Church et al., found that after six months of daily physical exercise, men aged 45 to 75 had a substantial increase in oxygen consumption, indicating a pulmonary system boost. According to Church et al., incorporating fitness or resistance conditioning greatly increased the lung function of women and men with inadequate respiratory systems (28). Cytokines such as Interleukin-2 (IL-2), Interleukin-7 (IL-7), Interleukin-10 (IL-10), Granulocyte Colony-stimulating Factor (G-CSF), Interferon-gamma Inducible Protein (IP-10), Monocyte Chemoattractant Protein 1 (MCP-1), Macrophage Inflammatory Protein 1A (MIP1A), and Tumor Necrosis Factor-alpha (TNF) are Similarly, quarantine has changed people's habits (29). Inadequate physical activity raises the possibility of venous thromboembolism, which may lead to cardiovascular symptoms and, in extreme cases, death. A change in venous thromboembolism in reported COVID-19 patients, according to researchers, can result in increased mortality. As a result, it has been proposed that everyday physical activity strengthens the immune system and promotes homeostasis (30).

Physical activity mode during COVID-19 Pandemic

People have suffered from infectious and non-communicable diseases for a long, but the rising popularity of COVID-19 has re-focused public health concerns on infective diseases. At the beginning of the 20th century, progress in infectious diseases prevention and care became a priority, but fatalities from non-communicable conditions tended to increase, during the second half of the twentieth century, increasing global mortality rates moved the emphasis away from contagious to non-communicable diseases, and the science community worked to improve understanding of non-communicable disease prevention and care (31). Regrettably, modern habits encourage inactivity and sedentary conduct. Social exclusion and government/public steps that have exacerbated this condition by creating an unstable situation, self-induced, or imposed isolation on people have made it worse. These factors find it impossible to achieve a healthy level of physical activity, People of all socioeconomic classes, ethnicities, and ages can preserve their wellbeing during periods of loneliness by engaging in 150 minutes of moderate-intensity physical exercise or 75 minutes of vigorous-intensity physical activity each week, or a mixture of the two, Two or three days a week of muscle-strengthening exercises including large muscle groups are required, For children and youth, at least 60 minutes of intensive or moderate-intensity physical activity (PA) is recommended (32).

Establishing an exercise regime after a pandemic

When starting a PA or exercise routine during a pandemic, it is critical to follow public policy recommendations on social distance and grooming behaviors. Avoiding prolonged stretches of sitting, taking brief movement or workout breaks, participating in online fitness courses, and encouraging movement by mobile devices such as phone apps and wearable sensors are all easy ways to increase physical activity and decrease sedentary behavior (33). Walking, stair climbing, raising and carrying groceries, chair squats, pushups, sit-ups, rope jumping, yoga, Pilates, and Tai Chi are all examples of low-impact home exercises that do not need a large space or equipment and can be done at any time of day. A beginner's fitness program can continue with low-intensity activity for brief amounts of time and advance progressively to more intensive PA or longer-term exercise periods. Because certain operations may be performed at home, the challenge associated with locating

facilities with sufficient room and specialized equipment is diminished or removed (34). Any beginning physical exercise or workout regimen should plan for at least a half-hour of mild physical exercise every day or at least twenty minutes of vigorous physical activity any other day. At least twice a week, strengthening-type exercises can be integrated into daily activities (35). Individuals who are predisposed to chronic diseases such as cardiovascular or respiratory disease should seek advice on physical exercise from health care providers. It is required that children and teenagers aged five to seventeen years accumulate at least 60 minutes of low- to moderate-intensity physical activity every day. Additionally, at least three days a week, vigorous-intensity workouts to strengthen muscle and bone should be performed (36).

Duration, length, and intensity of exercise

The term "exercise" refers to a set of variables. When setting goals, the extraordinary variables that must be considered are form, period, length, and weight. These objectives varied according to circumstance and may involve weight loss, muscle gain, or increased performance (37). The American Sports Medicine Association (ACSM) notes that ensuring public health needs at least 150 minutes of moderate-intensity aerobic activity a week. Resistance and high-intensity resistance training (HIIT) workouts, such as Cross Fit, must be performed at a particular intensity, pace, and length, according to a World Health Organization publication. Resistance training and HIIT are usually performed in short bursts varying from a few seconds to a few minutes (38). Notably, physical training and HIIT are not approved for weight loss, but diet and cardiovascular exercise are. To prevent infection, inflammation, and ultimately reduced immune function during the COVID-19 pandemic, the intensity, length, and frequency of resistance exercises or HIIT must be adjusted to the individual's degree of readiness.

Diet program

To support the immune system after exercise, it is recommended to eat macro-and micronutrients in adequate quantities and proportionate to the duration and intensity of the exercise. Several sources, however, assert that several athletes eat unhealthy diets rich in sugar and fat as a result of restrictions and quarantine, impairing immune function. Fasting has been shown in research to decrease the number of inflammatory factors, including oxidative stress, reactive protein C (CRP), and interleukin-6 (IL-6) (39). The fundamental definition of the relationship between foods, nutrition, inflammation, and oxidative stress is broadly recognized based on prior studies. This was emphasized in the formulation of the anti-inflammatory dietary index, for example. As a consequence, it is important to pay attention to micro and macronutrients in order to reduce the risk of contracting COVID-19. Anti-inflammatory and antioxidant elements in plant-based diets include Omega-3 fatty acids, Vitamin A, and Vitamin C (40). Protein deficiency can raise the risk of infection and can have unintended consequences for athletes, such as reduced efficiency and muscle mass loss (41).

Additionally, calories must be adjusted according to the speed, duration, and frequency of exercise, as well as physiological considerations, in order to optimize the immune system's operation and, to a certain extent, increase the duration of the open window. Vitamin D is commonly recommended as a critical nutrient that enters the body through ultraviolet rays from the sun or certain foods such as fish and rice, egg yolks, and dried mushrooms (42). Appropriate zinc, selenium, and vitamin D have been suggested to be essential for immunity to other viral infections, immune function, and reduced inflammation. Vitamin D deficiency has been linked to an increased risk of acute respiratory infections, especially in patients with COVID-19. Vitamin D, in general, inhibits monocytes' production of IL-1 and TNF; hence, vitamin D can play a critical role in lowering the risk of COVID-19. A recommended dose of 10,000 IU of vitamin D per day for several weeks has been suggested (43).

Although numerous studies on vitamin D have been performed across the world, only a few have examined its consumption in athletes. Vitamin D levels in athletes differ according to training seasons (summer or winter), training hours, geographical location, training environment (indoors or outdoors), and use of skin protection.

Due to the restrictions and quarantine, as well as the exclusion of citizens in the outdoors and unprotected from the heat; consuming a vitamin D-rich diet can help improve immune system function.

Practical Exercises Guidance in the COVID-19 Epidemic

Public health policies aimed at preventing virus spread between persons have made it impossible for many participants to join organized fitness initiatives such as recreation centers, professional sports complexes, and wellbeing centers. Although anti-discrimination laws have decreased many people's ability to partake in organized fitness activities, they have strengthened their desire for recreational physical activity such as family hikes, hiking, canoeing, gardening, and yard work. Traditional aerobic endurance exercises such as jogging, cycling, swimming, and rowing are often excellent ways to fulfill physical activity needs, if done outdoors (while keeping a safe social distance) or using home ergometer devices. Pilates, meditation, and dance are also ideal options for individuals who are afraid to work out outside the house. These latter exercises require minimal equipment, and a variety of courses are accessible through video or the Internet. Additionally, since these drills are scalable and can be adapted for athletes ranging from beginners through experienced, they are an ideal substitute for conventional aerobic exercises. Along with conventional strength training, body weight, isometric, resistance band, and hand-held weight movements can be used. The American College of Sports Medicine has some excellent tools for staying fit during a pandemic. Additionally, the National Strength and Conditioning Association's COVID-19 Taskforce has developed realistic plans and recommendations to support participants and organized sports members in scheduling a healthy return to training strategically (44).

Social inspiration, which many individuals need to begin or continue an exercise routine, is especially difficult to come by in the current pandemic climate. Personal wellness, social workout courses, and team activities all prosper from their transparency and shared encouragement. This assistance encourages people to contribute more fully to fitness plans and to accomplish the physical activity and health-related objectives. Additionally, social networking, social support networks, and peer-to-peer health programs can possess the wisdom and inspiration required to promote these behavioral improvements. Additional steps can be taken to relax stay-at-home orders/recommendations (45). It is important that anyone who uses public gyms and fitness centers maintains an acceptable social gap and follows aggressive personal grooming and sanitation procedures. The Centers for Disease Control and Prevention (CDC) has given safety advice for individuals and groups utilizing outdoor services (46). Furthermore, the CDC recommended recreational sports and summer camps.

Although both terms are different, they all fall under a theoretical risk spectrum. In childhood athletics, physical fitness and skill-building exercises done at home with family members pose the least danger, whereas close-contact squad games against individuals from various regional areas pose the greatest risk. Physical exercise is often critical for ensuring good wellbeing and competitiveness in the wake of a pandemic. Maintaining a good body weight increases immune function and may help defend against severe effects of respiratory infections. Given the virus's strong transmissibility, individuals must use diligence in identifying healthy physical activity areas and adhering to health officials' guidelines to prevent the virus from spreading (47, 48).

Conclusion

COVID-19 is a coronavirus infection that is triggered by the coronavirus SARS-CoV-2. The 2020 global COVID-19 pandemic has been intensified by sports events, and it now affects all aspects of life, including work, transport, athletics, and exercise. Although social isolation and good grooming are important for infection prevention, moderate activity and proper sleep will help reduce the risk of SARS-CoV-2 infection as well as the length and intensity of symptoms. In the other side, strenuous exercise can be avoided. Although lockdowns are successful at reducing infection rates, they also result in detraining, especially in countries where outdoor exercise is prohibited. Exercise at home can help reduce the detrimental effects and health risks of detraining.

Unless and unless herd immunity is created, which is likely to be transient, or widespread vaccination is achieved, exercise vendors and organizers of sports mass events must perform risk analyses and employ special hygiene, social distancing, and face masks, among other measures, to reduce the risk of resurrected outbreaks. The duration of immunity following SARS-CoV-2 infection and the seasonality of SARS-CoV-2 infections will determine the scope and magnitude of subsequent outbreaks, and new COVID-19 outbreaks are likely to occur for many years to come.

References

1. Banerjee A, Kulcsar K, Misra V, Frieman M, Mossman K. [Bats and coronaviruses](https://doi.org/10.3390/v11010041). *Viruses* 2019; 11(1): 41. <https://doi.org/10.3390/v11010041>
2. Schoeman D, Fielding BC. [Coronavirus envelope protein: current knowledge](https://doi.org/10.1186/s12985-019-1182-0). *Virology* 2019; 16(1): 1-22. <https://doi.org/10.1186/s12985-019-1182-0>
3. Zumla A, Hui DS, Perlman S. [Middle East respiratory syndrome](https://doi.org/10.1016/S0140-6736(15)60454-8). *Lancet* 2015; 386(9997): 995-1007. [https://doi.org/10.1016/S0140-6736\(15\)60454-8](https://doi.org/10.1016/S0140-6736(15)60454-8)
4. Cohen J, Normile D. [New SARS-like virus in China triggers alarm](https://doi.org/10.1126/science.367.6475.234). *Science* 2020; 367(6475): 234-235. <https://doi.org/10.1126/science.367.6475.234>
5. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, Zhao X, Huang B, Shi W, Lu R, Niu P. [A novel coronavirus from patients with pneumonia in China, 2019](https://doi.org/10.1056/nejmoa2001017). *N Engl J Med* 2020; 382(8): 727-733. <https://doi.org/10.1056/nejmoa2001017>
6. Yang M, Abdalrahman H, Sonia U, Mohammed AI, Vestine U, Wang M, Ebadi AG, Toughani M. [The application of DNA molecular markers in the study of Codonopsis species genetic variation, a review](https://doi.org/10.14715/cmb/2020.66.2.3). *Cell Mol Biol* 2020; 66(2): 23-30. <https://doi.org/10.14715/cmb/2020.66.2.3>
7. Zhang N, Wang L, Deng X, Liang R, Su M, He C, Hu L, Su Y, Ren J, Yu F, Du L. [Recent advances in the detection of respiratory virus infection in humans](https://doi.org/10.1002/jmv.25674). *J Med Virol* 2020; 92(4): 408-417. <https://doi.org/10.1002/jmv.25674>
8. Chan JF, Kok KH, Zhu Z, Chu H, To KK, Yuan S, Yuen KY. [Genomic characterization of the 2019 novel human-pathogenic coronavirus isolated from a patient with atypical pneumonia after visiting Wuhan](https://doi.org/10.1080/22221751.2020.1719902). *Emerg Microbes Infect* 2020; 9(1): 221-236. <https://doi.org/10.1080/22221751.2020.1719902>
9. Zhang L, Liu Y. [Potential interventions for novel coronavirus in China: A systematic review](https://doi.org/10.1002/jmv.25707). *J Med Virol* 2020; 92(5): 479-490. <https://doi.org/10.1002/jmv.25707>
10. Jakobsson J, Malm C, Furberg M, Ekelund U, Svensson M. [Physical activity during the coronavirus \(COVID-19\) pandemic: prevention of a decline in metabolic and immunological functions](https://doi.org/10.3389/fspor.2020.00057). *Front Sports Act Living* 2020; 2: 57. <https://doi.org/10.3389/fspor.2020.00057>
11. Collao N, Rada I, Francaux M, Deldicque L, Zbinden-Foncea H. [Anti-Inflammatory Effect of Exercise Mediated by Toll-Like Receptor Regulation in Innate Immune Cells—A Review: Anti-inflammatory effect of exercise mediated by Toll-like receptor regulation in innate immune cells](https://doi.org/10.1080/08830185.2019.1682569). *Int Rev Immunol* 2020; 39(2): 39-52. <https://doi.org/10.1080/08830185.2019.1682569>
12. Elisma N, Labanni A, Rilda Y, Asrofi M, Arief S. [Green synthesis of copper nanoparticles using Uncaria gambir Roxb. leaf extract and its characterization](http://dx.doi.org/10.31788/RJC.2019.1245347). *Rasāyan J Chem* 2019; 12(4): 1752-1756. <http://dx.doi.org/10.31788/RJC.2019.1245347>
13. Din MI, Arshad F, Hussain Z, Mukhtar M. [Green adeptness in the synthesis and stabilization of copper nanoparticles: catalytic, antibacterial, cytotoxicity, and antioxidant activities](https://doi.org/10.1186/s11671-017-2399-8). *Nanoscale Res Lett* 2017; 12(1): 1-5. <https://doi.org/10.1186/s11671-017-2399-8>
14. Jain D, Daima HK, Kachhwaha S, Kothari SL. [Synthesis of plant-mediated silver nanoparticles using papaya fruit extract and evaluation of their anti microbial activities](https://doi.org/10.1002/nbm.1457). *Dig J Nanomater Bios* 2009; 4(3): 557-563. <https://doi.org/10.1002/nbm.1457>
15. Lavie CJ, Ozemek C, Carbone S, Katzmarzyk PT, Blair SN. [Sedentary behavior, exercise, and cardiovascular health](https://doi.org/10.1161/CIRCRESAHA.118.312669). *Circ Res* 2019; 124(5): 799-815. <https://doi.org/10.1161/CIRCRESAHA.118.312669>

16. Carlson SA, Adams EK, Yang Z, Fulton JE. Peer Reviewed: Percentage of Deaths Associated With Inadequate Physical Activity in the United States. *Prev Chronic Dis* 2018; 15: E38. <http://dx.doi.org/10.5888/pcd18.170354>
17. Luzi L, Radaelli MG. Influenza and obesity: its odd relationship and the lessons for COVID-19 pandemic. *Acta Diabetol* 2020; 57(6): 759-764. <https://doi.org/10.1007/s00592-020-01522-8>
18. Jiménez-Pavón D, Carbonell-Baeza A, Lavie CJ. Physical exercise as therapy to fight against the mental and physical consequences of COVID-19 quarantine: Special focus in older people. *Prog Cardiovasc Dis* 2020; 63(3): 386. <https://doi.org/10.1016/j.pcad.2020.03.009>
19. Chen P, Mao L, Nassis GP, Harmer P, Ainsworth BE, Li F. Coronavirus disease (COVID-19): The need to maintain regular physical activity while taking precautions. *J Sport Health Sci* 2020; 9(2): 103. <https://doi.org/10.1016/j.jshs.2020.02.001>
20. Wen L, Zhang Y, Yang B, Han F, Ebadi AG, Toughani M. Knockdown of Angiotensin-like protein 4 suppresses the development of colorectal cancer. *Cell Mol Biol* 2020; 66(5): 117-124. <https://doi.org/10.14715/cmb/2020.66.5.21>
21. Kissler SM, Tedijanto C, Goldstein E, Grad YH, Lipsitch M. Projecting the transmission dynamics of SARS-CoV-2 through the postpandemic period. *Science* 2020; 368(6493): 860-868. <https://doi.org/10.1126/science.abb5793>
22. Wang M, Baker JS, Quan W, Shen S, Fekete G, Gu Y. A preventive role of exercise across the coronavirus 2 (SARS-CoV-2) pandemic. *Front Physiol* 2020; 11. <https://doi.org/10.3389/fphys.2020.572718>
23. Hu S, Tucker L, Wu C, Yang L. Beneficial effects of exercise on depression and anxiety during the Covid-19 pandemic: A narrative review. *Front Psychiatry* 2020; 11: 1217. <https://doi.org/10.3389/fpsy.2020.587557>
24. Letieri RV, Furtado GE. Physical exercise during coronavirus disease (COVID-19): Recommendations to remaining active in periods of confinement. *An Acad Bras Cienc* 2020; 92. <https://doi.org/10.1590/0001-37652020200691>
25. Simpson RJ, Cosgrove C, Ingram LA, Florida-James GD, Whyte GP, Pircher H, Guy K. Senescent T-lymphocytes are mobilised into the peripheral blood compartment in young and older humans after exhaustive exercise. *Brain Behav Immun* 2008; 22(4): 544-551. <https://doi.org/10.1016/j.bbi.2007.11.002>
26. Simpson RJ, Lowder TW, Spielmann G, Bigley AB, LaVoy EC, Kunz H. Exercise and the aging immune system. *Ageing Res Rev* 2012; 11(3): 404-420. <https://doi.org/10.1016/j.arr.2012.03.003>
27. Chan KK, Dorosky D, Sharma P, Abbasi SA, Dye JM, Kranz DM, Herbert AS, Procko E. Engineering human ACE2 to optimize binding to the spike protein of SARS coronavirus 2. *Science* 2020; 369(6508): 1261-1265. <https://doi.org/10.1126/SCIENCE.ABC0870>
28. Church TS, Earnest CP, Skinner JS, Blair SN. Effects of different doses of physical activity on cardiorespiratory fitness among sedentary, overweight or obese postmenopausal women with elevated blood pressure: a randomized controlled trial. *JAMA* 2007; 297(19): 2081-2091. <https://doi.org/10.1001/jama.297.19.2081>
29. Poirier P, Després JP. Exercise in weight management of obesity. *Cardiol Clin* 2001; 19(3): 459-470. [https://doi.org/10.1016/S0733-8651\(05\)70229-0](https://doi.org/10.1016/S0733-8651(05)70229-0)
30. Martin CK, Johnson WD, Myers CA, Apolzan JW, Earnest CP, Thomas DM, Rood JC, Johannsen NM, Tudor-Locke C, Harris M, Hsia DS. Effect of different doses of supervised exercise on food intake, metabolism, and non-exercise physical activity: The E-MECHANIC randomized controlled trial. *Am J Clin Nutr* 2019; 110(3): 583-592. <https://doi.org/10.1093/ajcn/nqz054>
31. Lippi G, Sanchis-Gomar F, Henry BM. Coronavirus disease 2019 (COVID-19): the portrait of a perfect storm. *Ann Transl Med* 2020; 8(7): 497. <https://doi.org/10.21037/atm.2020.03.157>
32. Naghavi M, Abajobir AA, Abbafati C, Abbas KM, Abd-Allah F, Abera SF, Aboyans V, Adetokunboh O, Afshin A, Agrawal A, Ahmadi A. Global, regional, and national age-sex specific mortality for 264 causes of death, 1980–2016: a systematic analysis for the Global Burden of Disease Study 2016. *Lancet* 2017; 390(10100): 1151-1210. [https://doi.org/10.1016/S0140-6736\(17\)32152-9](https://doi.org/10.1016/S0140-6736(17)32152-9)

33. Piercy KL, Troiano RP, Ballard RM, Carlson SA, Fulton JE, Galuska DA, George SM, Olson RD. [The physical activity guidelines for Americans](https://doi.org/10.1001/jama.2018.14854). JAMA 2018; 320(19): 2020-2028. <https://doi.org/10.1001/jama.2018.14854>
34. Anderson E, Durstine JL. [Physical activity, exercise, and chronic diseases: A brief review](https://doi.org/10.1016/j.smhs.2019.08.006). Sport Med Health Sci 2019; 1(1): 3-10. <https://doi.org/10.1016/j.smhs.2019.08.006>
35. World Health Organization. [Global strategy on diet, physical activity and health](https://www.who.int/dietphysicalactivity).
36. Kandola A, Ashdown-Franks G, Hendrikse J, Sabiston CM, Stubbs B. [Physical activity and depression: Towards understanding the antidepressant mechanisms of physical activity](https://doi.org/10.1016/j.neubiorev.2019.09.040). Neurosci Biobehav Rev 2019; 107: 525-539. <https://doi.org/10.1016/j.neubiorev.2019.09.040>
37. Boecker H, Sprenger T, Spilker ME, Henriksen G, Koppenhoefer M, Wagner KJ, Valet M, Berthele A, Tolle TR. [The runner's high: opioidergic mechanisms in the human brain](https://doi.org/10.1093/cercor/bhn013). Cereb Cortex 2008; 18(11): 2523-2531. <https://doi.org/10.1093/cercor/bhn013>
38. Colberg SR, Sigal RJ, Yardley JE, Riddell MC, Dunstan DW, Dempsey PC, Horton ES, Castorino K, Tate DF. [Physical activity/exercise and diabetes: a position statement of the American Diabetes Association](https://doi.org/10.2337/dc16-1728). Diabetes Care 2016; 39(11): 2065-2079. <https://doi.org/10.2337/dc16-1728>
39. Sun Y, Wang Q, Yang G, Lin C, Zhang Y, Yang P. [Weight and prognosis for influenza A \(H1N1\) pdm09 infection during the pandemic period between 2009 and 2011: a systematic review of observational studies with meta-analysis](https://doi.org/10.1080/23744235.2016.1201721). Infect Dis 2016; 48(11-12): 813-822. <https://doi.org/10.1080/23744235.2016.1201721>
40. Laddu DR, Lavie CJ, Phillips SA, Arena R. [Physical activity for immunity protection: Inoculating populations with healthy living medicine in preparation for the next pandemic](https://doi.org/10.1016/j.pcad.2020.04.006). Prog Cardiovas Dis 2021; 64: 102. <https://doi.org/10.1016/j.pcad.2020.04.006>
41. Andersen CJ, Murphy KE, Fernandez ML. [Impact of obesity and metabolic syndrome on immunity](https://doi.org/10.3945/an.115.010207). Adv Nutr 2016; 7(1): 66-75. <https://doi.org/10.3945/an.115.010207>
42. Zhou F, Yu T, Du R, Fan G, Liu Y, Liu Z, Xiang J, Wang Y, Song B, Gu X, Guan L. [Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study](https://doi.org/10.1016/S0140-6736(20)30566-3). Lancet 2020; 395(10229): 1054-1062. [https://doi.org/10.1016/S0140-6736\(20\)30566-3](https://doi.org/10.1016/S0140-6736(20)30566-3)
43. Khafaei MA, Rahim F. [Cross-country comparison of case fatality rates of COVID-19/SARS-COV-2](https://doi.org/10.24171/j.phrp.2020.11.2.03). Osong Public Health Res Perspect 2020; 11(2): 74. <https://doi.org/10.24171/j.phrp.2020.11.2.03>
44. Hales CM, Carroll MD, Fryar CD, Ogden CL. [Prevalence of obesity among adults and youth: United States, 2015–2016](https://www.nchs.gov/data/briefs/288.pdf). NCHS Data Brief 2017; 288: 1-8.
45. Di Gennaro F, Pizzol D, Marotta C, Antunes M, Racalbuto V, Veronese N, Smith L. [Coronavirus diseases \(COVID-19\) current status and future perspectives: a narrative review](https://doi.org/10.3390/ijerph17082690). Int J Environ Res Public Health 2020; 17(8): 2690. <https://doi.org/10.3390/ijerph17082690>
46. Peçanha T, Goessler KF, Roschel H, Gualano B. [Social isolation during the COVID-19 pandemic can increase physical inactivity and the global burden of cardiovascular disease](https://doi.org/10.1152/ajpheart.00268.2020). Am J Physiol Heart Circ Physiol 2020; H1441-H1446. <https://doi.org/10.1152/ajpheart.00268.2020>
47. Mattioli AV, Puviani MB, Nasi M, Farinetti A. [COVID-19 pandemic: the effects of quarantine on cardiovascular risk](https://doi.org/10.1038/s41430-020-0646-z). Eur J Clin Nutr 2020; 74(6): 852-855. <https://doi.org/10.1038/s41430-020-0646-z>
48. Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, Qiu Y, Wang J, Liu Y, Wei Y, Yu T. [Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study](https://doi.org/10.1016/S0140-6736(20)30211-7). Lancet 2020; 395(10223): 507-513. [https://doi.org/10.1016/S0140-6736\(20\)30211-7](https://doi.org/10.1016/S0140-6736(20)30211-7)

Copyright © 2021 by CAS Press (Central Asian Scientific Press) + is an open access article distributed under the Creative Commons Attribution License (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

How to cite this paper:

Khafaei M. [The vital function of physical activity, exercise, and diet in the management of COVID-19 Symptoms](https://doi.org/10.24171/j.phrp.2020.11.2.03). Cent Asian J Med Pharm Sci Innov 2021; 1(5): 227-235.