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Review

The Preventive Role of Exercise on the Physiological, Psychological, and Psychophysiological Parameters of Coronavirus 2 (SARS-CoV-2): A Mini Review

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Abstract: The world has been severely challenged by the Coronavirus Disease (COVID-19) outbreak since the early 2020s. Worldwide, there have been more than 66 million cases of infection and over 3,880,450 deaths caused by this highly contagious disease. All sections of the population including those who are affected, those who are not affected and those who have recovered from this disease, are suffering physiologically, psychologically or psychophysiologically. In this paper we briefly discuss the consequences of COVID-19 on physiological, psychological and psychophysiological vulnerability. We also attempt to provide evidence in support of exercise management as a prevention strategy for improving and minimizing the physiological, psychological and psychophysiological effects of COVID-19. Moderate exercise including walking, yoga and tai-chi to name but a few exercise regimes are critical in preventing COVID-19 and its complications. Governments, public health authorities and the general population should maintain physical activity during the COVID-19 pandemic to prevent additional physical and mental distress.

Keywords: COVID-19; coronavirus disease; physiological effects; psychological effects; psychophysiological effects; exercise; physical activity

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1. Introduction

There has been a global pandemic of COVID-19 since 2019. The WHO reported 3,880,450 deaths associated with COVID-19 as of 23 June 2021 (World Health Organisation 2021). COVID-19 and associated public health measures may negatively affect individuals with physical, behavioral health (mental illness, substance abuse), financial insecurity and socioeconomic vulnerability. Recent studies suggest that the measures taken to curb the spread of the COVID-19 outbreak have generated issues throughout the population (Clemente-Suárez et al. 2020; Adhikari et al. 2020). It has been established and identified that the possible risk factors are related to physiological, psychological and psychophysiological vulnerability. Research suggests that impaired immunity may be the root cause of physiological, psychological and psychophysiological vulnerability. For instance, physiological complications due to the pandemic have been reported to be severe in immune-compromised people including the obese, overweight, elderly or subjects with metabolic syndrome or underlying pathologies. Similarly, anxiety and depression, the two major psychological complications reported during the COVID-19 pandemic are influenced by inflammatory pathways and neurotransmitters that are activated by an imbalance of the immune system. Furthermore, psychophysiological vulnerability during COVID-19 including a wide variety of health disorders, such as headaches, essential hypertension,

insomnia, asthma, gastrointestinal and dermatological conditions have been linked with modulation of cortisol levels and increases in pro-inflammatory cytokines. The purpose of this paper is to briefly discuss the consequences of COVID-19 on physiological, psychological and psychophysiological vulnerability; and to briefly outline the mechanisms of how exercise can help in modulating these factors. We have also attempted to provide evidence in support of exercise management as a prevention strategy for improving and minimizing the physiological, psychological and psychophysiological effects of COVID-19 (Figure 1).

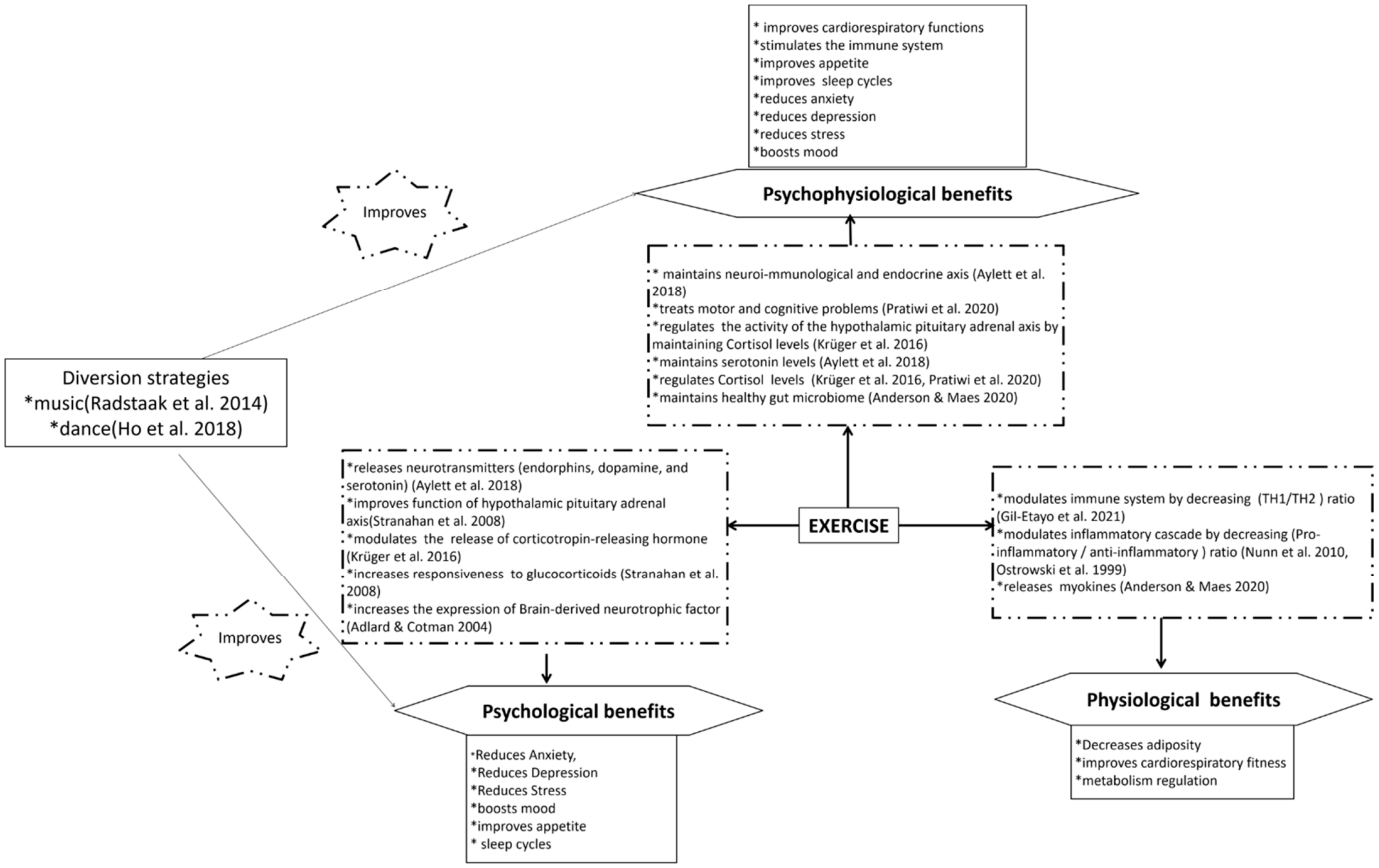

Figure 1. Summary figure showing the preventive role of exercise on physiological, psychological and psychophysiological effects of COVID-19.

2. Search Strategy

This paper was prepared from the presentation on idea presented in the symposium "Transnational and Transdisciplinary Lessons of COVID-19 From the Perspective of Risk and Management". A structured search strategy was conducted in PubMed and Google scholar to search for publications in English using the search term "COVID-19 OR SARS-CoV-2 OR CORONA" in combination with one of the following keywords: "physiological effects", "psychological effects", "psychophysiological effects", "exercise", "Yoga" and "tai chi". We focused on clinical trials, meta-analyses and review articles. We did not include research related with athletes and psychosocial factors. The search was completed on 21 June 2021. When many similar articles were available, the most recent articles were used. Additional papers were identified from random searches and the reference lists of retrieved articles. No date restriction was put on the search so that a longitudinal 'map' of the subject area could be obtained

3. Physiological Effects of COVID-19 and Its Management by Exercise

***Physiological Effects of COVID-19*:** The pandemic has caused physiological complications mostly in elderly populations including (age $\geq$ 60 years) the obese and overweight people with body mass indexes (BMI) over 25 kg/m^2 or even higher, these individuals contribute to increased risk of infection scores for COVID-19. According to our previous review we have demonstrated that more than 50% of the population with obesity and/or overweight were admitted for critical care and had high mortality (Wang et al. 2020). The condition of obesity refers to excess body fat, low-grade chronic inflammation and impaired immunity that is associated with many debilitating and life-threatening diseases. The list includes respiratory dysfunction, cardiovascular disease, diabetes, some cancers, metabolic risk and co-morbidities, some of which have been linked to more severe COVID-19 infections (Stefan et al. 2020). Additionally, inactivity has now been identified as one of the biggest COVID-19 risk factors. Researchers studied 48,440 adults (a cross-section of the racially diverse Southern California population with an average age of 47 years) between 1 January and 21 October 2020 who were tested positive for COVID-19. The data showed that 6.4 percent of participants were consistently active while 14.4 percent were consistently inactive. Surprisingly, 79.2 percent of respondents were inconsistent exercisers. Study results found that a person who is consistently inactive has higher risk levels for COVID-19 complications. Their risk is comparable to that of people over the age of 60 and those who have undergone organ transplantation. Hospitalization rates for inactive people were twice as high as those for consistently active people. Additionally, these individuals have a 1.73 times greater chance of needing care in the intensive care unit (ICU) and a 2.49 times greater chance of dying from COVID-19 (Narici et al. 2021). Narrowing down to the molecular level, Angiotensin-converting enzyme 2(ACE2) has been identified as a receptor for COVID-19 entry. ACE2 appears to be a receptor for COVID-19, and obesity may increase ACE2 expression in lung epithelial cells. Clearly, the more adipocytes present, the more ACE2 receptors there are to spread the virus. Additionally, COVID-19 exhibits hyperactive inflammatory responses. The immune system produces pro-inflammatory cytokines Interleukins (IL-6, IL-1β, IL-2, IL-15, IL-10, IL-13) and tumor necrosis factor-alpha (TNF-alpha) in response to an infection. When a virus attacks the immune system, it damages the parenchyma of the lungs and the bronchi and triggers respiratory discomfort resulting in adverse respiratory disorders. Further, it becomes serious enough to require medication (Jose and Manuel 2020; Stebbing et al. 2020; Gil-Etayo et al. 2021). Research also suggests that increased levels of IL-15 and a high T-helper 2 response are associated with a fatal outcome related to COVID-19 (Gil-Etayo et al. 2021). Research has established a significant reduction of %T helper 1 cells and %T helper 17 cells with higher activated %T helper 2 cells in COVID-19 patients compared with controls. Senescent T helper 2 cell percentage was observed to be an independent risk factor for death (Gil-Etayo et al. 2021).

***Exercise Benefits related to the Physiological Effects of COVID-19*:** As per our previous review we established that there are multiple advantages of exercise in relation to human health (Wang et al. 2020). These include decreased adipose tissue, improved cardio-respiratory fitness (CRF) and enhancement of metabolic homeostasis and even suppression of inflammation. The most effective way to lose weight is to increase daily energy expenditure through exercise or physical activity. Exercise, in particular, accelerates the breakdown of glycogen in the muscles and the liver; this results in the breakdown of fat in adipose tissue and muscle; and facilitates the oxidation of fatty acids in the muscles (Poirier and Després 2001). A higher CRF corresponds to a lower accumulation of visceral adipose tissue (overweight and obesity) (Brock et al. 2011). In addition, exercise improves oxygen delivery and uptake in exercising muscles. In studies involving subjects with a low baseline CRF, exercise interventions using different modalities (aerobic and resistance) at moderate intensities significantly improved CRF in overweight, obese middle-aged women and men (Church et al. 2010). In contrast, during physical inactivity, metabolic homeostasis is disrupted, leading to insulin resistance, reduced lipid clearance post-prandially, muscle decline and an increase in visceral adiposity (Pedersen and Febbraio 2012). Moreover,

chronic systemic inflammation resulting from metabolic disruption has been linked to persistent physical inactivity (Nunn et al. 2010). Hence, increased exercise would help prevent metabolic derangements. It has been found that moderate-intensity exercise of at least 150 min per week can lower the prevalence of metabolic syndrome (Donnelly et al. 2009). Additionally, it has been observed in previous studies that inflammation and exercise have a negative relationship. Infection leads to the overproduction of pro-inflammatory cytokines such as interleukins (IL-6, IL-2, IL15 etc.) and TNF-alpha (Ostrowski et al. 1999). On the other hand, individuals who perform more frequent and intense physical activity have lower levels of inflammatory biomarkers (IL-6, IL-1β, and TNF-alpha). Through its unique cytokine and hormonal effects, exercise intensity may affect T helper 1/T helper 2 cell balance. Exercises such as walking, tai chi and restorative yoga stimulate the T helper 1 response (Shimizu et al. 2008; Nieman et al. 2005; Raghavendra et al. 2009; Esch et al. 2007), while more intense workouts and longer durations stimulate T helper 2. Cortisol is lowered by low-intensity exercise and relaxing activities, while it is raised by high-intensity exercise and long-duration workouts. There has been evidence that cortisol increases the development of T helper 2 cells and decreases that of T helper 1. Exercise may also push the body toward a more T helper 2 dominated state (as muscle-derived IL-6 behaves differently from TNF-alpha-associated IL-6) and associated IL-10. Muscle-derived IL-6 and associated IL-10 are anti-inflammatory (Narici et al. 2021) and enhances the body's immune response. However, low- to medium-intensity high-volume resistive exercise, that is easily implemented at home, will have positive effects, particularly if combined with a 15–25% reduction in daily energy intake. The combination of these regimens seems ideal for preserving neuromuscular, metabolic, and cardiovascular health (Narici et al. 2021). Furthermore, individuals have been advised to perform 150 min of moderate intensity exercise per week initially to obtain the necessary amount of exercise. This exercise intensity seems favorable in modifying the effects of COVID-19. A larger amount of exercise should be followed for significant weight loss and to prevent weight gain. Generally, 11,000 steps per day with 64–170 steps/minute and at least 10 min duration is sufficient for healthy adults (Wang et al. 2020).

4. Psychological Effects of COVID-19 and Its Management by Exercise

***Psychological Effects of COVID-19*:** A state of psychological distress is a state of emotional suffering caused by stressors and demands that people have difficulty in coping with. It is usually characterized by feelings of depression and anxiety (Arvidsdotter et al. 2016). Globally, adolescents of varying backgrounds experience higher levels of anxiety, depression, and stress due to the pandemic and have become frequent consumers of alcohol and recreational drugs (Jones et al. 2021). Based on US Census Bureau, around 56.2% of adults (age = 18–24 years), 48.9% of adults (age = 25–49 years), 39.1 % adults (age = 50–66 years) and 29.3% of adults (age = 65+ years) have been reported to have anxiety and/or depressive symptoms during the pandemic (Anon 2020). The most common psychological effects of COVID-19 on the general population are depression and anxiety. Among the general population, changing social dynamics, such as social distancing, restricted movement and lockdown, have led to severe behavioral and psychological changes. Due to the imposition of lockdown, people work from home, attend online classes and are restricted from visiting established social networks, such as religious meetings, which result in people suffering from stress problems and non-regulation of emotions, that help individuals develop resilience. In addition to social changes, people also experience severe mental and emotional changes due to their fear of getting the disease and uncertainty about their futures. This results from having been confined, abnormally reduced social/physical contact with others, and losing familiar habits are all directly related to feeling distressed, bored, socially isolated and frustrated (Reynolds et al. 2008; Hawryluck et al. 2004). Frustration and loneliness can be attributed to inhibitions from daily activities, interruption of social necessities, and not participating in social network activities (Jeong et al. 2016). The prevalence of loneliness may be associated with depression and suicidal behavior

(Serafini et al. 2020). An evaluation of depression and anxiety in Hong Kong during the COVID-19 pandemic revealed that 19% of the 500 respondents had depression and 14% had anxiety. Additionally, 25.4% reported that their mental health had deteriorated since the pandemic (Choi et al. 2020). Even people who are infected with the disease mainly suffer from anxiety and depression. A study conducted in Hubei on COVID-19 patients (n = 460) revealed that 304 people were diagnosed with somatization symptoms (66.09%), followed by depression (53.48%), anxiety (46.30%), insomnia (42.01%) and self-mutilating or suicidal thoughts (23.26%) (Wang et al. 2021). Existing studies have shown that those who have been exposed to the risk of infection may develop pervasive fears about their health, worries about infecting others, and fear of infecting family members. Cognitive, emotional, and behavioral disorders are reported to be associated with gender-based differences during the COVID-19 pandemic in many studies. Mostly women showed significant higher anxiety, depression, precautionary behavior and emotional responses and acute stress levels than men (Levkovich and Shinan-Altman 2021; García-Fernández et al. 2021; Hou et al. 2020). Focusing on the molecular level, research suggests that cortisol levels were significantly higher in patients with COVID-19 than in individuals who had not contracted the disease. They suggest that COVID-19 patients with highly elevated cortisol levels are more likely to quickly deteriorate in relation to health status. Patients with a cortisol baseline level of 744 or less survived on average for 36 days. Survival was only 15 days for patients with levels over 744 (Tan et al. 2020).

Exercise Benefits on the Psychological Effects of COVID-19: Numerous studies have shown the positive effects of exercise on anxiety and depression (Ströhle 2009; Stonerock et al. 2015; Stubbs et al. 2017), and exercise is widely accepted as a non-invasive means of treating or preventing those conditions (Rosa Rimes et al. 2015; Mikkelsen et al. 2017). Relaxation techniques and breathing exercises have been recommended as an intervention for COVID-19 patients to reduce acute anxiety, although more evidence is needed (Khawam et al. 2020). It was found that aerobic exercise was effective in treating anxiety and depression in a study of exercise treatment for clinical anxiety. Exercise programs with a high intensity gain more benefits than programs with a low intensity y (Aylett et al. 2018). Some of the most helpful exercises in reducing anxiety include running, swimming, cycling, walking, dancing and even gardening (Hu et al. 2020). Exercise releases neurotransmitters in the body called endorphins, dopamine, and serotonin. They are natural chemicals produced in the brain that helps our body cope with stress. This boosts mood by releasing serotonin, improves appetite and sleep cycles (Aylett et al. 2018). The dysfunction of hypothalamic–pituitary–adrenal (HPA) axis, the increased secretion of corticotropin-releasing hormone (CRH), the impaired responsiveness to glucocorticoids, the increased size and activity of the pituitary were all observed in patients with depression. The ability of exercise on regulating HPA supported physical exercise as one of the methods to improve depressive symptoms (Stranahan et al. 2008). In contrast a study suggests that moderate-to-vigorous physical activities were negatively related to the symptoms of depression. The study proposed that increased light activity and reduced sedentary behavior might contribute to the decreased prevalence of depression (Kandola et al. 2020). At the molecular level, decreased brain-derived neurotrophic factor (BDNF) level is a vulnerability factor for anxiety (Janke et al. 2015). Numerous studies have found that physical exercise can increase the expression of BDNF in the dentate gyrus (area of the brain where all sensory parts come together to create unique representations and memories and is critical for memory and learning) (Adlard and Cotman 2004). Physical exercise was found to be able to restore BDNF to pre-stress levels, suggesting that exercise protects against stress-induced decreased levels of BDNF (Adlard and Cotman 2004). Exercise can also control inflammation, which is a possible mechanism to help reduce anxiety. As reported in a previous study, elevated levels of the pro-inflammatory cytokine C-reactive protein was associated with anxiety disorders (Vogelzangs et al. 2013). Intriguingly, exercise conferred its beneficial effect on anxiety by regulating inflammatory systems (Flynn et al. 2007). Yoga, an ancient eastern practice consisting of breath control, physical postures and meditation,

has demonstrated beneficial effects in patients with severe anxiety symptoms, although the effect was relatively mild (Saeed et al. 2019). A study examined the effect of Tai Chi, a traditional Chinese martial art, on anxiety in older adults and found that those receiving medical therapy could benefit from Tai Chi exercise, but those only receiving medical therapy in isolation, could not (Song et al. 2014). As far as mental health is concerned, aerobic exercise interventions have proven to successfully to reduce depression in patients with low to moderate symptoms (Morres et al. 2019; Schuch et al. 2016). The alleviating effects of aerobic exercise interventions on self-reported depressive symptoms in clinical depression have been shown to be comparable to those of antidepressant treatments (Dinas et al. 2011; Blumenthal et al. 2007). Therefore, during the current pandemic, aerobic exercise can help to protect from an increase in depressive symptomatology in people with a diagnosis of clinical depression who already suffer from mild to moderate depressive symptoms. Exercise can also help in preventing depressive symptoms in people at risk for depression. Moreover, aerobic exercise interventions have been found to be effective in anxiety disorders (Generalized Anxiety Disorder, Panic Disorder, Obsessive-Compulsive Disorder, Social Phobia) (Aylett et al. 2018), and stress-related disorders such as post-traumatic stress disorder (Franklin and McCullough 2009), i.e., disorders that are expected to increase during the current pandemic. This psychological issue may not only occur in COVID survivors or health workers, but also the general population (Bohlken et al. 2020; Petzold et al. 2020). As far as clinical anxiety symptoms are concerned, aerobic exercise interventions do not achieve the same effects as psychopharmaceutic treatment in clinical anxiety patients (Carek et al. 2011), but it has proven itself as an adjunctive therapeutic treatment for anxiety disorders in several randomized controlled trial studies (Jayakody et al. 2014). In addition, as a means of primary prevention with respect to the current pandemic, already an acute bout of aerobic exercise of moderate intensity (>21 min) can successfully reduce anxiety (Rebar et al. 2015). Additionally, there is a mood-regulatory effect possible after just seven minutes of aerobic exercise (low to moderate intensity).

5. Psychophysiological Effects of COVID-19 and Its Management by Exercise

***Psychophysiological Effects of COVID-19*:** Psychophysiology studies investigate the physiological effects of the psychological processes and behavior, as well as the impact of behavioral or psychological manipulations on the body. Psychophysiological measures include techniques designed to assess activity in a variety of bodily systems. As a result of psychological and psychosocial stressors/triggers, a person may experience depression, anxiety, panic attacks, somatic symptoms or posttraumatic stress disorder symptoms, delirium, psychosis or even suicidality. The term psychophysiology has been used to refer to a wide variety of disorders, such as headaches, essential hypertension, insomnia, asthma and gastrointestinal and dermatological conditions (Clemente-Suárez et al. 2020). Constrictions and restrictions mean a sudden end to citizens' normal lives. As a result, the individual begins to display symptoms of anxiety caused by social isolation, lack of mental hygiene habits and repeated exposure to negative news and information. Feelings of sadness, apathy, fear, uncertainty, frustration, irregular circadian cycles, insomnia, hyper vigilance and difficulty concentrating may accompany this illness. COVID symptomatology can trigger feelings of shame, social stigma and even guilt. The subject can mistake some symptoms, such as headaches, migraines or irritation in the throat, for COVID symptoms despite not being infected. The social isolation measures imposed by governments around the world led to a sharp decline in physical activity as recreation facilities, athletic centers, gyms, public parks, playgrounds and schools were forced to close. Furthermore, the gut microbiome may play a crucial role, since it is known that gut bacteria are responsible for mental disorders such as depression and anxiety (strongly present during the pandemic) (Anderson and Maes 2020; Keely et al. 2012). The gut microbiome may modulate the pathophysiology of COVID-19 by altering the immune system and triggering reactions (Anderson and Maes 2020). Additionally, many of the conditions that appear to increase the risk of COVID-19 fatalities are associated with altered gut permeability and dysbio-

sis, such as obesity, diabetes, cardiovascular disorders and lung and respiratory airway inflammation (Anderson and Maes 2020). Stress makes the population more vulnerable to viral infection by affecting the second brain, the gut microbiome (Narici et al. 2021). COVID-19 is predominantly a pulmonary condition, highlighting the importance of the gut, since previous studies have identified a gut-lung axis which suggests that respiratory infections are associated with changes in gut microbiota (Keely et al. 2012). In this way, microbial metabolites and certain endotoxins may have an impact on the lung through the bloodstream, and inflammation may have a reciprocal impact on the gut microbiota (Dumas et al. 2018). The increase in pro-inflammatory cytokines directly leads to a down regulation of hormones that maintain circadian rhythms (Markus et al. 2018). Narrowing to the molecular level there have been recent studies suggesting how psychological stress may also lead to higher levels of corticotropin-releasing hormone (CRH) in the brain, thereby contributing to cortisol production (Vanuytsel et al. 2014). CRH influences inflammatory cytokines and the production of TNF alpha, so its role in the emergence of COVID-19, and therefore its severity and fatalities, is likely to be linked to CRH. This raises the intriguing possibility that COVID-19 could also influence the gut microbiota.

***Exercise Benefits on the Psychophysiological Effects of COVID-19*:** Exercise is not only likely to reduce stress, it also improves sleep as well, and it is a well-established fact that exercise has many benefits for overall health. General and mental health benefits of physical activity and regular aerobic exercise with respect to the functioning of the central nervous system, the peripheral autonomous nervous system, the immune system, mental health, stress and well-being have already been explored (Rosa Rimes et al. 2015). Regular aerobic exercise at a moderate level reduces respiratory tract infections because it stimulates the immune system (hormonal effects and cellular effects) (Krüger et al. 2016). Active lifestyles and regular aerobic exercise can save lives by preventing mental and physical health problems. Regarding the current SARS-CoV-2-Coronavirus pandemic, it is important to note that particularly aerobic exercise focused on endurance and cardiorespiratory fitness has positive effects on physical and mental health, particularly sports that involve large amounts of muscle. Besides stimulating the immune system (neuroimmunology and endocrine axis), it also improves cardiorespiratory functions, relieves anxiety and depression, and functions as a buffer against chronic stress by facilitating bodily recovery and reducing perceived stress symptoms. Mental and physical health are interdependent, as are physical activity's effects on both. The benefits of aerobic exercise have been observed in longitudinal and quasi-experimental studies on clinical patient groups (with neurological, somatic and mental disorders) and in healthy subjects without a history of chronic disease (Blair 1996; Franklin and McCullough 2009; Gerber and Pühse 2009; Haskell et al. 2007). During a pandemic lockdown, it is imperative for people with or without a history of lifestyle-related diseases or mental disorders to exercise regularly and stay physically active in order to avoid long-term harm to their physical and mental health. Fitness benefits are typically curvilinear and occur even with relatively low volumes of exercise. Furthermore, exercise positively impacts cognitive, daily, psychosocial and neuroendocrine functions. For instance, Tai-chi is beneficial for treating cognitive problems. Researchers have observed increased and reduced activity of the HPA axis in schizophrenia patients, though studies have shown both hyperfunction and hypofunction of the HPA axis which controls cortisol levels. They found that reducing salivary cortisol levels (a neuroendocrine indicator of stress and immunity, which can provide insights into the possible physiological mechanisms behind this effect) (Ho et al. 2014). Another study involved examining the physiological and psychological impacts of walking in urban parks throughout winter, spring, and early summer. A total of 12 middle-aged and older adults were involved in walking (11–15 min) in an urban park in Japan. To determine physiological responses, their heart rate and blood pressure were measured. The results show that walking in urban parks leads to physiological, psychological relaxation and varied landscape appreciation (Pratiwi et al. 2020). Exercise guidelines generally recommend that 150 min per week of moderate-intensity aerobic activity, such as brisk walking, and/or 75 min of vigorous-

intensity exercise, such as jogging, cycling, swimming, or aerobics. A combination of resistance training, strength-endurance training and yoga, targeting large muscle groups such as the legs or the entire body, is also highly recommended.

As stress is characterized by high levels of arousal and negative effects, mood regulation is a core function of stress recovery. Therefore, mood-regulating strategy involves redirecting cognitions and actions away from the stressor, the so-called diversion strategy. Music as a diversion strategy and results in psychophysiological recovery from stress. Music has been shown to lower anxiety and improve mood. There is some evidence that different music styles can impact psychophysiological recovery differently. Compared with listening to heavy metal, listening to classical music and music selected by the listener, helps in reducing stress. It decreases anxiety and increases relaxation. Listening to classical music after a stressful event decreased systolic blood pressure (Radstaak et al. 2014). Dance movement therapy (DMT) and physical exercise were examined in a study conducted for older adults with dementia. DMT participants showed significant reductions in depression, loneliness, and negative mood, as well as improving daily functioning and the diurnal cortisol slope. At 1-year follow-up, the effects on daily functioning and the cortisol slope remained unchanged. The study results suggest that DMT can be utilized as a multifaceted intervention to improve various aspects of functioning in older adults with declining cognitive abilities (Ho et al. 2018).

The use of artificial intelligence (AI) has increased in COVID-19 research, especially in Detection, classification, severity, and mortality risk assessment. Tracking coronavirus by using AI has already demonstrated its potential to stratify high-risk patients. This technique has also proven to be effective in predicting the infection rate in real time (Rogers 2021; Phillips 2021). Physical education (PE) can also be improved by incorporating AI. A practical understanding of education based on a technical understanding educational and research activities are taking place in all fields in order to consider new ideas pertinent to their respective fields. In case of physical education technology the new ideas are lacking in comparison to other academic fields (Lee and Lee 2021). Additionally, it is crucial to build an integrated research workforce and establish an effective research infrastructure. Similarly, in order to facilitate the comprehensive advancement in exercise, we must develop an environment for modern technology development in the field of physical education, and develop overall AI-related exercise applications.

6. Conclusions

Exercise has multiple benefits in combatting the vicious cycle of the physiological, psychological and psychophysiological impacts of COVID-19. Exercise could provide stimulation for the human constitution and could provide potential benefits on resisting the virus. These measures if implemented sooner may reduce underlying pathologies and contribute to the reduction of mortality associated with the COVID-19 pandemic. The health benefits of exercise, as well as its potential to save lives, should be promoted to future generations, governments, and policymakers. Additionally, future focus should be drawn on developing an environment for AI-related exercise applications. In addition, some important considerations should be considered. It is essential to realize the importance of mind relaxation techniques using music, dance and breathing exercises in conjunction with increases in physical activity. In addition, individuals should strictly follow social distancing and avoid mass gatherings in public areas while performing exercises during the COVID-19 pandemic.

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