THE PHYSICAL ACTIVITY IN GLOBAL POPULATION DURING AND AFTER COVID-19 PANDEMY

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ABSTRACT

Key words: covid, global population, health, physical activity

The purpose of our review was to summarize the COVID-19 disease and its effect on decreasment in the physical activity in global population. In the review, the negative effect of COVID-19 on human health is presented, followed by an overview of studies that examined the relationship of physical activity levels and the COVID-19 pandemy. At the end of the review, we briefly discuss the recommendations on how to safely return to physical activity after COVID-19. The review showed significant decrease in PA during the pandemy and strong relation with low physical activity levels and severity of COVID-19 course of a disease.

INTRODUCTION

Coronavirus disease (COVID-19) is an infectious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which was first detected in December 2019 in the city of Wuhan, China (1, 2, 3). Due to the COVID-19 attack, tens of thousands of patients have been hospitalized, with additional thousands of millions of people forced to stay at home or lockdown facilities. Although the virus usually first invades and infects lung and respiratory track tissue, in extreme cases, almost all major organs in the body are now known to be negatively affected, often leading to severe systemic failure in some people. Immobilization due to hospitalization and bed rest and physical inactivity due to sustained quarantine and social distancing can negatively regulate the ability of organs systems to resist viral infection and increase the risk of damage to the immune, respiratory, cardiovascular, musculoskeletal systems, as well as the brain (4). Clearly, this dramatic change in lifestyle, resulting from immobilization, quarantine, and physical inactivity, can cause a second-wave attack on the health and well-being of the infected as well as general population (5).

The purpose of this review is to summarize the findings of the authors on COVID-19, how the pandemic situation affected the level of physical activity in the global population and what secondary effects can cause inactivity to human body, mainly to the immune, respiratory, cardiovascular, musculoskeletal systems and brain. In this review impact of COVID will discuss, what changes occur in human systems, and what was the physical activity of global population during this pandemic.

COVID, HEALTH AND PHYSICAL ACTIVITY

COVID-19 is strongly affecting the function of main human body systems, in this part we will discuss mostly impact on respiratory, cardiovascular, musculoskeletal systems and brain function.

COVID-19, INACTIVITY AND RESPIRATORY SYSTEM

There are many cases in which COVID-19 patients developed respiratory failure and required mechanical ventilation (MV) to maintain adequate pulmonary gas exchange (6). Although MV is often a life-saving intervention, an unwanted consequence of prolonged MV is the rapid development of respiratory muscle weakness due to diaphragm muscle atrophy and contractile dysfunction (collectively termed ventilator-induced diaphragm dysfunction, VIDD). VIDD is clinically significant because diaphragmatic weakness is a major contributor to the inability to remove patients from the ventilator (7). Given that respiratory muscle weakness is a primary risk factor for failure to wean the ventilator, developing strategies to protect the diaphragm against MV-induced weakness has become a priority in critical care medicine (4). Although many organ systems adapt in response to endurance exercise training, the structural and functional properties of the lung and airways are not altered due to exercise training (8). However, while the gas-exchange side of the respiratory system does not adapt to exercise training, the “pump” side of the respiratory system undergoes adaptive changes in response to endurance exercise. Specifically, endurance exercise training promotes numerous biochemical alterations in the diaphragm muscle, resulting in a phenotype that is protected against several challenges, including prolonged MV (9-10).

COVID-19, INACTIVITY AND CARDIOVASCULAR SYSTEM

The effects of inactivity promote genes that are detrimental to health. Inactivity for any reason reduces heart health and increases the long-term risk of coronary artery disease and sudden cardiac death (4). Muscle aches that accompany influenza and corona viral infections are the well-known symptom and a result of direct and indirect damage to the tissue. Muscle soreness is probably due to a combination of direct tissue infection and the inflammatory response of cytokines released to combat viral invasion. Excess cytokine release (cytokine storm) is the dark side of the immune response that is responsible for tissue damage beyond that of direct viral infection. While both the heart and peripheral muscles are infected by viruses, heart muscle infection has short- and long-term consequences. COVID-19 is no different and, as a novel virus, trigger more extensive tissue damage in the heart. Heart muscle infection leads to myocarditis with the potential for acute myocardial infarction, heart failure, and/or arrhythmia (11,12,13). Systemic viral infections also cause an inflammatory reaction that irritates the lining of the arteries (14). During the COVID-19 pandemic, PA and exercise play a positive role in individual health outcomes.

On the positive side, regular exercise and exercise promote cardiorespiratory fitness and longevity. For healthy individuals, it is recommended to remain physically active and exercise during and after the COVID-19 pandemic and to stop exercise when developping the symptoms or signs of an infection develop. If exertion-related symptoms such as palpitations, chest pain, exercise intolerance, or dyspnea occur during return to exercise, evaluation with cardiac imaging and stress testing evaluation may be indicated to rule out COVID-19 cardiac damage before progressing to higher PA levels (4).

COVID-19, INACTIVITY AND MUSCULOSKELETAL SYSTEM

The increased demands from the contracting skeletal muscles during exercise represent a major challenge to body homeostasis provoking a plethora of responses in several organs. As a result of the accumulation of activity sessions, the organism adapts to metabolic demands. PA and exercise adaptations refer to the long-term changes that occur in our body as a consequence of PA and training (15). However, the musculoskeletal system, one of the largest tissues in the body, is the main target of exercise training. Plasticity describes the ability of our muscles to adapt to variations in activity and work demand. The adaptive event involves the whole muscle fiber structure from the sarcolemma to the mitochondria, including the myofibrils, the extracellular matrix, and the capillaries surrounding the muscle fibers (16). Health authorities have asked a large number of people to stay home in quarantine for an extended period of time, and this recommendation poses a significant challenge for remaining physically active. Several models have given us information on the effects of inactivity on the musculoskeletal system: bed rest and limb immobilization are extreme experimental models (17). Physical inactivity is associated with many detrimental effects, including loss of aerobic fitness (∼7% reduction in the peak in healthy young adults), musculoskeletal, and cognitive decline. It is also associated with metabolic effects that include alterations in insulin signaling that lead to increased peripheral insulin resistance, increased inflammation, as well as alterations in adipose tissue lipolysis and mitochondrial pathways. In skeletal muscle, physical inactivity-induced reduction in insulin sensitivity contributes to the distribution of energy substrates into other tissues, which increases central fat accumulation (15,17,18).

The body needs regular muscular activity during the day, whereas some of the most powerful mechanisms regulating disease susceptibility, such as mitochondrial function and the lipoprotein metabolism, are being downregulated during physical inactivity. PA and exercise are essential in preserving muscle mass through the activation of muscle protein synthesis. Research shows that deterioration of mitochondrial homeostasis due to muscle immobilization can lead to organic and systemic inflammation, an important mechanism for the pathogenesis of COVID-19 (4,15,17).

COVID-19, INACTIVITY AND BRAIN FUNCTION

COVID-19 has been shown to not only affect the respiratory system of the human body, but several researches also refer to damage to brain function. It has been shown that when the SARS-CoV-2 types of virus were administered intranasally to mice, the virus translocated into the thalamus and brainstem and was significantly lethal suggesting that the CNS could be one of the targets of SARS-CoV-2. It is suggested that the virus can reach the CNS via neural circuits through transsynaptic pathways (19). The relatively long virus latency period of 5-12 days would allow the virus to significantly damage medullary neurons, and in fact, patients infected by SARS-CoV-2 reported severe neurologic symptoms manifested as acute cerebrovascular diseases, impaired consciousness, and skeletal muscle symptoms (20). One of the most common protections against virus infections is quarantine. However, social isolation often causes psychological and mental disorders, including acute stress disorder, exhaustion, detachment from others, irritability, insomnia, poor concentration, indecisiveness, fear, and anxiety. Data suggest that depression, anxiety, and posttraumatic disorders have significant effects on the immune system, resulting in mast cell activation, increased generation of cytokines such as IL-1, IL-37, TNFα, IL-6, and C-reactive protein (21). Sustained reductions in habitual movement can contribute to a multitude of negative health consequences. According to the World Health Survey, including responses from 237,964 individuals, physical inactivity is associated with an odds ratio of 1.32 for future states of anxiety. (22). A meta-analysis that combined the results of 49 prospective studies found that people with low activity levels were at increased risk for depression (23). However, it is well documented that regular exercise-induced adaptations improve the effectiveness of immune system, whose actual level could affect the severity of SARS-CoV-2 infection. In fact, the inflammatory process generated by ROS can be more effectively detoxified by antioxidant systems in various organs, including the brain of well-trained individuals from adaptations to exercise training. In addition, exercise training can efficiently decrease depression, and is one of the power modulators of the neuroprotective and antidepressive effects of PA and exercise is the brain-derived neurotrophic factor (BDNF). The effect of exercise in the brain can elicit systemic influences throughout the entire body, as exercise-induced euphoria is associated with the release of endogenous opioids (endorphins) (24,25,26,27).

DECREASMENT OF PHYSICAL ACTIVITY DURING COVID

Health authorities have asked a large number of people to stay home in quarantine for an extended period of time, and this recommendation poses a significant challenge for remaining physically active. Several models have given us information on the effects of inactivity in the musculoskeletal system: bed rest and limb immobilization are extreme experimental models. Reduction in daily walking steps may indicate a more physiological model of reduced PA that reflects the risk of long-term confinement. In terms of steps walked, ∼10,000 steps/day is generally considered a high level of PA, while ∼1500 steps/day is classified as a low level of AP. Physical inactivity is associated with many detrimental effects, including loss of aerobic fitness (∼7% reduction in $\dot{V}O_2$ peak in healthy young adults), musculoskeletal and cognitive decline (4, 17). There are several studies that present a negative impact of COVID-19 on PA. Travakol et al. (28) collected data from all patients who visited the respiratory emergency department from March 20, 2020 to April 24, 2020 at the University Hospital. The outcome measures were body mass index, diet quality evaluated with a 16-item food intake questionnaire, and physical activity level evaluated using the global physical activity questionnaire. Data from 200 patients were analyzed. The results investigated that patients with lower levels of physical activity or lower MET.min/week were affected by a more severe form of the disease ($p = 0.05$ and $p = 0.03$, respectively). They found that patients with a healthier diet pattern were affected by lower severity of illness ($p < 0.05$). The results investigated that physical inactivity was significantly associated with the severity of COVID-19 disease. Furthermore, the correlation between the duration of signs and symptoms and physical activity suggested that patients with low physical activity suffered from a more prolonged illness compared to groups with moderate to a high level of physical activity, however, it was not significant between groups (666.4 vs 813.7 METs.min/week) ($p < 0.05$) (28).

The relation between physical activity and respiratory tract infections is controversial and is mostly correlated with exercise intensity. In 2020, a large sample size ($n = 387{,}109$) was published in favor of the effect of physical activity on reducing risk of hospital admission of patients with COVID-19, but the assessment was only in the last week before the disease (29). However, in a new large cross-sectional study, the authors concluded that regular sports participation may decrease disease severity. Furthermore, hospitalization of athletes with regular sports participation was

33% lower than that of the non-athletic group (30).

In another study (31), the Pennington Biomedical COVID-19 Health Behavior Survey was used for analyses and mixed-effect linear and generalized linear models to estimate the effects of individual-level factors on changes in PA levels during COVID-19 restrictions. Participants (n = 4376) provided information on PA behaviors before and during the COVID-19 shutdown. Overall, PA levels declined by a mean ± SD of 112 ± 1460 MET·min·wk-1 during the COVID-19 shutdown; however, the changes in PA were heterogeneous, and 55% of the participants reporting increases in or maintenance of PA during that time. Several social and demographic factors were significantly related to the declines in PA, including high prepandemic PA levels, living alone (difference = 118 MET·min·wk-1), low household income (difference between the highest and lowest income group = 363 MET·min·wk-1), COVID-19-related income changes (difference = 110 MET·min·wk-1), and loss of employment (difference = 168 MET·min·wk-1) (31).

As regular exercise is essential for health, Wilke et al. (32) examined the effect of pandemic-related confinements on physical activity levels (PA). A multinational survey was conducted in 14 countries. The times spent in moderate to vigorous physical activity (MVPA) as well as in only vigorous physical activity (VPA), were assessed using the Nordic Physical Activity Questionnaire (short form). Data were obtained for leisure and occupational PA pre- and during restrictions. Compliance with PA guidelines was calculated based on the recommendations of the World Health Organization (WHO). In total, n = 13,503 respondents (39 ± 15 years, 59% women) were surveyed. Compared to pre-restrictions, overall self-reported PA decreased by 41% (MVPA) and 42.2% (VPA). The reductions were higher for occupational vs. leisure time, young and old vs. middle-aged persons, previously more active vs. less active individuals, but similar between men and women. Compared to before the pandemic, compliance with WHO guidelines decreased from 80.9% (95% CI 80.3-81.7) to 62.5% (95% CI: 61.6–63.3). The results suggest that PA levels have decreased substantially worldwide during the COVID-19 pandemic (32).

Castañeda-Babarro et al. (33) The study evaluated how self-reported PA and sedentary time (ST) have changed during confinement in the Spanish population. 3800 healthy adults (aged 18 to 64 years) residing in Spain answered the short international physical activity questionnaire (IPAQ-S) twice between 23 March and 1 April (confinement). Data analysis was carried out taking into consideration meeting general PA recommendations before confinement, age, and gender. Self-reported PA decreased significantly during confinement in our sample. Vigorous physical activities (VPA) and walking time decreased by 16.8% ($p < 0.001$) and 58.2% ($p < 0.001$), respectively, while ST increased by 23.8% ($p < 0.001$). The percentage of people who met the 75 min/week of VPA recommendation decreased by 10.7% ($p < 0.001$) while the percent of people who reached 150 min/week of moderate activity barely changed (1.4%). The group that performed the highest VPA before confinement showed the greatest decrease (30.5%, $p < 0.001$). Men reduced the time in VPA more than women (21% vs. 9%, respectively) who even increased the time in moderate PA by 11% ($p < 0.05$) and reported less increase in ST than men (35% vs. 25.3%, respectively) (33).

Another study from Iran (34) found that 670 adults included in the study and grouped based on age and gender. The short-form International Physical Activity Questionnaire (IPAQ, SF) was distributed to participants through an online survey. The Wilcoxon signed-rank test was used for statistical analyses. The results showed that the level of physical activity decreased significantly during COVID-19 compared to before COVID-19 in both the sexes and the age groups ($p < 0.001$). Additionally, this study found that a total of 78% of participants did not meet the physical activity guidelines during COVID-19 in Iran (34).

The Canadian study (35) confirmed similar findings. Participants were students ($n = 125$) from the University of Saskatchewan and Regina. An online questionnaire was administered retrospectively (for the prepandemic) and prospectively (during the pandemic) to examine students' dietary intake, physical activity, and sedentary behaviour. Overall, nutrient and caloric intake was significantly reduced ($p < 0.05$) during the pandemic, and alcohol intake increased ($p = 0.03$). Before the pandemic, 16% and 54% of the participants met the Canadian 24-Hour Movement Guidelines for adults (18 to 64 years) of 150 min of moderate–vigorous physical activity and 8 h or less of sedentary activity, respectively. Only 10% met the guidelines for physical activity while 30% met the guidelines for sedentary behavior during the pandemic. The minutes per week spent participating in moderate to vigorous physical activity during the pandemic decreased by approximately 20% ($p < 0.001$). The hours spent in sedentary activities increased by 3 h per day ($p < 0.001$). The alarming fact of this study needs to be underlined.

During COVID-19, the nutrient and caloric intake of university students decreased, and the alcohol intake increased significantly.

The levels of physical activity levels decreased, and the sedentary activity increased significantly during COVID-19.

During COVID-19, students did not engage in sufficient physical activity to compensate for increased sedentary behaviour (35).

In contrast, a search in 6 databases (PubMed, Embase, SPORTDiscus, Scopus, Web of Science and CINAHL) was conducted on 23 July 23, 2020 (36). Medical subject headings and keywords related to PA and COVID-19 were combined to conduct the online search, which covered the period from January to July 2020. In total, 1,784 articles were retrieved. After removal and title, abstract, and full text screening, 41 articles were included. Most of the included studies were quantitative and collected data through online interviews/questionnaires, with sample sizes larger than 100 and composed of adults and older adults. Changes in PA levels due to the COVID-19 pandemic were the most assessed result, followed by the association between mental health problems and PA. Only 2 studies evaluated the direct effects of PA on COVID-19 (36).

RECOMENNDATIONS FOR PHYSICAL ACTIVITY INCREASMENT

A risk-stratification approach can help maximise safety and mitigate risks, and a number of factors need to be taken into account. First, is the person physically ready to return to activity? In the natural course of covid-19, deterioration that indicates a severe infection often occurs around a week from symptom onset. Therefore, the consensus is that a return to exercise or sporting activity should occur only occur after an asymptomatic period (37). Return to exercise after at least seven days without symptoms and begin with at least two weeks of minimal exertion. Patients should use daily self-monitoring to track progress, including when to seek further help (37). Public health recommendations (i.e., stay-at-home orders, parks, gymnasiums, and fitness centers) to prevent SARS-CoV-2 spread have the potential to reduce daily physical activity (AP). These recommendations are unfortunate because daily exercise can help combat the disease by strengthening our immune systems and counteracting some of the comorbidities such as obesity, diabetes, hypertension, and serious heart conditions that make us more susceptible to the severe COVID-19 disease (4). During periods of isolation, all socioeconomic groups, ethnicities, and ages should maintain good health by following the WHO PA recommendations of 150 minutes of moderate intensity or 75 minutes of vigorous-intensity PA per week, or a combination of both (38). Muscle strengthening activities involving major muscle groups are recommended on two or more days a week. In children / adolescents, the recommendations include at least 60 minutes per day of vigorous or moderate intensity PA (39).

When it comes to returning to PA, Salman et al. (37) recommend using the Borg rating of perceived exertion (RPE) scale to determine what kind of PA is appropriate based on individual level. Authors divided the return to PA to 5 phases. Phase 1 is to prepare for return to PA and recommends mostly breathing, stretching, and gentle walking with RPE no more than 6-8. Phase 2 is for low-intensity activity such as walking, yoga, gardening, or household tasks with RPE 6-11 and graduate increasing until walking without problem for 30 minutes during 11 RPE (37,40).

Phase 3 is aimed at moderate intensity PA such as aerobic or strength work with 12-14 RPE. Phase 4 follows phase 3, but increasing the volume of active days to the ratio 2:1 (active day : rest day) and recommends progress to exercise 7 days a week with monitoring fatigue levels. Finally, phase 5 is for returning to regular PA programs with RPE 15+ or as tolerated without any other problems (37).

IMPACT PANDEMIC OF SLOVAK, CZECH AND POLAND

A decrease in physical activity was also found in the countries of Slovakia, the Czech Republic and Poland (41,42,43,44). The impact of the pandemic on these countries has been significant. High hypoactivity has been found, so the goal in these countries should be to increase physical activity. The impact of hypoactivity on human health is enormous and therefore a pandemic due to hypoactivity should be avoided after a pandemic caused by COVID19.

CONCLUSIONS

There is a large amount of evidence linking COVID-19 disease with malfunctioning if respiratory, cardiovascular, musculoskeletal systems or brain functions. Researchers found a significant decrease in PA during and after the COVID-19 pandemic, related to pandemic restrictions, sedentary lifestyle, or poor quality of life. Several studies found an increase in unhealthy habits in students and the global population. Therefore, this finding indicates the need to consider an integrated and comprehensive approach to reduce the inactivity caused by COVID-19 to prevent the secondary effect of pandemic on human health and quality of life. A decrease in physical function and, in some cases, a persistence of symptoms can be observed in patients, who overcame the infection period

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