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Exercise and well-being during COVID 19: time to boost your immunity

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Abstract

Introduction: The COVID-19 pandemic is causing devastating global morbidity and mortality. Worldwide measures are taken to prevent human to human transmission and improve general health. Public lifestyle and health are affected by social distancing and isolation. A strong host immune response to the novel coronavirus is a key factor, for protection against infection and avoiding reaching severe stages of the disease.

Areas covered: Pathophysiology and the human immune response of similar coronaviruses have been previously described. The novel coronavirus has distinct clinical stages related to the immune response. Exercise improves host innate immunity and affords protection to viral infections. Exercise also mitigates the negative effects of isolation including stress, anxiety and sedentarism, all of which further reduces immunity and increases non-communicable disease risk.

Expert opinion: Improving host immunity and mitigating the negative effects of isolation via physical activity is strongly justified. Exercise should be done in moderate intensities and volumes during the current pandemic, which is a nutritionally, psychologically, socially challenging environment in the presence of a virulent viral organism. Proactively creating innovative health promotion models with technology and government involvement with best available evidence should be encouraged to reduce physical inactivity during the current COVID-19 pandemic and after.

Keywords: COVID-19, Novel coronavirus, SARS-CoV-2, Pandemic, Exercise, Physical activity, Immunology, Immunity, Isolation, Social distancing, Quarantine

Article highlights

- Current strategies incorporated in preventing the spread of COVID-19 are to reduce human to human transmission with improved hygiene, physical distancing, and isolation.
- The immune system plays a vital role in preventing an individual from contracting the novel coronavirus and progressing into a severe stage.
- The negative nutritional, psychological, socioeconomic and behavioral effects of isolation can dampen the host immune response and metabolic health.
- The profound impact exercise has on improving the immune system, protecting the host from other similar viral infections and mitigating negative effects of isolation is well documented.
- Since the behavior of the virulent SARS-CoV-2 is still not fully understood and most people are confined to challenging environments, exercise should be done in moderate intensities and volumes, adhering to the current standard public health recommendations.
- Health promotion models developed in response to the COVID-19 pandemic and adoption of active living within one's residence may positively impact long term physical activity habits once social distancing and stay at home orders are removed.

1. Introduction

The coronavirus disease 2019 (COVID-19) pandemic has increased global morbidity and mortality[1]. The key strategies followed to mitigate its spread include social/physical distancing and hygiene, contact tracing, isolation, testing, monitoring, and boosting the immunity of individuals and the public. Developing vaccination is still at initial stages [2].

The clinical pattern of COVID-19 can be roughly divided into three stages: 1) stage I - an asymptomatic incubation period with or without detectable virus; 2) stage II - non-severe symptomatic period with the presence of virus; and 3) stage III - severe respiratory symptomatic stage with high viral load and inflammation [3]. Individuals at stage I, the stealth carriers who are the majority, are the least manageable because they can spread the virus in the community unknowingly; reasoning to the highly contagious nature of the virus [4]. According to statistics up to April 2020 about 15% of the confirmed cases progress to the severe phase, with a higher chance for fatality in patients over the age of 65 years and preexisting comorbidities, such as diabetes, heart disease, lung disease and a compromised immune system [5]. While mortality is highest in the elderly, a recent United States Morbidity and Mortality Weekly Report (MMWR) (March 2020) reported a significant percent of ICU admissions across all adult age groups (e.g., "36% among adults aged 45–64 years, and 12% among adults aged 20–44 years") [1] .

During the incubation and non-severe stages (i.e., Stage I and II), a specific adaptive immune response is required to eliminate the virus and to prevent disease progression to severe stages; for this to occur the host should be in good pre-existing general health with a favorable genetic phenotype (e.g., major-histocompatibility-complex antigen loci /HLA)[3] . Strategies to boost immune responses (e.g., experimented anti-sera or Interferon /IFNα) at

this immune defense-based protective phase and suppressing it in the second inflammation-driven damaging phase are particularly important [3].

To boost the immune status of the individual even before getting infected (i.e., before Stage I) by general health improvement (e.g., improving preexisting physical fitness, available appropriate nutrition, sleep, improving mental health) is an important public health intervention. This will be a challenge in the background of physical isolation related anxiety and stress, reduced access to food/finances, socioeconomic and behavioral challenges of the individual, families and society; all of these factors are significant present and future concerns.

Maintaining regular, daily physical activity is a critical component of a healthy lifestyle [6]. Exercise is a subcategory of 'physical activity that is planned, structured, and repetitive and has as a final or intermediate objective to improve or maintain one or more dimensions of physical fitness'[7]. Many countries have seen an increase in physical inactivity and sedentarism at pandemic proportions over recent years and has likely further accelerated due to the COVID-19 pandemic [8].Sedentary behaviour is defined as any waking behaviour characterized by an energy expenditure ≤1.5 METs while in a sitting, reclining or lying posture [9]. Physical inactivity is used to describe people who are performing insufficient amounts of moderate- and vigorous-intensity activity by not meeting specified physical activity guidelines.(e.g. World Health Organization (WHO) /American College of Sports Medicine (ACSM) physical activity guidelines) [10]. In this context, promoting physical activity has never been more critical.

This review on physical activity and exercise during the COVID-19 pandemic is mainly focused on the healthy populations. Clinically suspected and laboratory confirmed patients should follow government guidelines.

2.

2.1. Immune response – the critical innate immunity

The human immune system with innate and adaptive responses is a highly intricate network of cells and molecules designed to keep the host free from infection and disease [11]. Currently, only limited information is available on the host immune response to the novel coronavirus (SARS-CoV-2). Based on previous studies it is known that the similar viruses (SARS-CoV and MERS-CoV) can interfere with multiple steps during initial innate immune response [12]. The longer incubation period (~2-14 days) seen in the novel coronavirus is probably due to the immune evasion properties and efficiently escaping host immune detection at the early stage of infection. The delayed or dampening type I IFN responses and prolonged viral persistence exacerbates inflammatory responses, interrupting adaptive immune activation. These facts strongly indicate that innate immune response to SARS-CoV-2 can be a critical factor for disease outcome [12].

2.2. Immune system and exercise

The profound impact exercise has on the normal functioning of the immune system is well documented [13, 14, 15]. Although currently there is no scientific data available regarding the effects of exercise on SARS-CoV-2, the available evidence indicates that exercise can protect the host from many other viral infections including influenza, rhinovirus (another cause of the common cold) and herpesviruses [16].

An acute exercise bout (moderate-to-vigorous intensity aerobic exercise, less than 60 min) compared to being inactive is known to stimulate the ongoing exchange and redeployment of distinct and highly active immune cell subtypes between the circulation and peripheral tissues (e.g., mucosal surfaces including respiratory and gut epithelia), which

conduct immune surveillance and strengthen the innate immune response [14]. In particular, each aerobic exercise bout improves the anti-pathogen activity of tissue macrophages in parallel with an enhanced recirculation of immunoglobulins, anti-inflammatory cytokines, neutrophils, immature B cells and a dramatic influx of natural killer (NK) cells, and CD8+ T cells [17, 18]. Similar pattern of immune response changes in different intensities have also been observed during moderate-intensity resistance exercise training[19].

Acute and chronic moderate-intensity exercise down-regulates excessive inflammation within the respiratory tract which is mediated through multiple pathways [16]. With daily exercise, these acute changes operate through a summation effect to enhance immune defense activity, improve immune regulation, and improve metabolic health [14]. Chronic exercise over a period of >6 months has been shown to prevent age-related immune dysfunction/immunosenescence, chronic low-grade inflammation and improve the effectiveness of 'flu' vaccination in elderly populations without harmful side effects [20]. This exercise-induced effect on immune function is especially beneficial for the elderly as they have been shown to be particularly vulnerable to increased health risks if infected with COVID-19. There is evidence showing that regular physical activity and leading an active lifestyle is beneficial, to immune function and limit or delay immunological aging[21].

Randomized clinical trials consistently support an inverse relationship between moderate-intensity exercise training and the incidence of upper respiratory tract infections (URTI). Several epidemiologic studies also suggest that regular physical activity is associated with decreased mortality and incidence rates for influenza and pneumonia[17].

2.3. Is there such a thing as too much exercise?

Studies conducted in athletes during periods of intensified vigorous training and competition (e.g. running marathon) lasting more than 60 minutes, show a decrease in

circulating immune cells in peripheral blood 1-2 hours following the activity and returning to pre-activity levels after 24 hours[14]. This phenomenon, termed "open-window theory of susceptibility to infections", has been attributed to immune suppression and susceptibility to URTI with highly demanding doses of exercise[17].

This hypothesis is now being debated due to: 1) unavailability of strong studies with dose responses [17]; and 2) the effect of other factors present prior to the exercise bout which impacts immune system competency, including psychological stress and anxiety [22], nutritional deficiencies [23], poor hygiene and virulent organisms peripheral to exercise *per se* [17].

Ideally, we believe that the general public is advised to adhere to the standard WHO /ACSM recommendations of at least 150 minutes per week of moderate-intensity aerobic physical activity or at least 75 minutes of vigorous intensity aerobic physical activity throughout the week and 2 sessions per week of muscle strength training [24, 25]. Since the behavior of the virulent SARS-CoV-2 is still not fully understood and most people are confined to nutritionally and psychologically challenging environments, it may not be advisable to perform exercise sessions at excessive intensities and volumes.

3. Social isolation, anxiety and increased disease risk

Periods of isolation and confinement away from day to day work ,reduced access to daily needs/finances, sense of insecurity in combination with fear of contagion, quarantine and stigma, as well as with potential (mis)information overload ("infodemic")[15] can all lead to psychological stress and anxiety. This can elevate glucocorticoids such as cortisol and can inhibit many critical functions of our immune system, increasing host susceptibility infection and also aggravation of non-communicable disease (NCD) risk [26].

Studies have shown that exercise can mitigate the negative effects of stress to maintain immune function, particularly during prolonged periods of isolation and confinement. Studies conducted in astronauts in space travel (extreme isolation) for nearly 6 months, who were physically active before launch and had a higher pre-launch cardiorespiratory fitness and muscle endurance, had a better immune response compared to astronauts who were not fit [27].Numerous studies and meta-analyses show that exercise itself is associated with reduced anxiety in clinical settings explained via a number of biological, as well as psychological, mechanisms [28]. It is also known to improve health-related quality of life in varied clinical settings [29].

Countries with a high burden of NCDs has the potential to aggravate these conditions due to this challenging time and the effects of confinement (i.e., less access to medicine/medical care, outdoor activity and quality nutrition as well as increased stress due to confinement, socioeconomic reasons and poor individual coping mechanisms of behavioral risk factors). A large evidence base exists regarding the benefits of exercise and physical activity in preventing and managing NCDs [30]. Current national policy should quickly move toward developing novel public health and wellbeing models using innovative technology-based interventions which can be practiced while staying at home, maintaining social connectivity and physical distancing during this expected long home stay.

4. Recommendations to be physically active during this time

The WHO [25] and ACSM [24, 31] have outlined physical activity recommendations to follow during this period which could be culturally adapted. The following sections provide suggested recommendations in the context of the COVID-19 pandemic; **Table 1** lists physical activity and general health recommendations in the context of COVID-19.

4.1. General Population Recommendations

During confinement, individuals should avoid sedentary behavior as much as possible. If watching TV, one should get up during every commercial (or periodically) or if working in your computer get up and walk 2-3 minutes every 20 minutes. Walk around the home or do an active chore like sweeping/cleaning the house or gardening .Performing some activity has shown to have positive health benefits compared to no activity [24].

All adults should strive to ultimately achieve a total of at least 150 minutes per week of moderate-intensity aerobic physical activity or at least 75 minutes of vigorous intensity aerobic physical activity throughout the week and 2 sessions per week of muscle strength training [24, 25] (see practical tips below Table 1). Previously sedentary and physically inactive individuals should start with some activity - starting with light intensity (slow walk around the house) for 10-15 minutes per day and gradually progress to achieve the above general recommendations. Research suggests not to start unaccustomed exercises but do functional exercises as able (i.e., walking, marching, stepping, sit up from a chair) [32]. Adults greater than 65 years are advised to follow the same recommendations as younger adults. The older adults who cannot do so should be active through light activities and avoid sedentary behavior as functionality allowable[25].

Children and adolescents should be allowed to be active with moderate to vigorous intensity physical activity/active play for 60 minutes per day as time and space allows. For children 2-5 years, this should be for 180 minutes per day [31] with 3-4 year olds doing 60 minutes of moderate to vigorous intensity physical activity [25, 31]. We recognize social distancing and confinement makes these recommendations a challenge, and, as such, creative approaches to facilitate increased physical activity are needed. For example, skipping rope is an entertaining aerobic exercise which also strengthens bones and muscles, especially if you do not have enough space at home. Involving the whole family in a game with them can help facilitate social interaction and engagement [24].

We believe individuals diagnosed with one or more chronic conditions (e.g., diabetes, heart disease, high blood pressure, cancer, etc.) who were previously assessed by a physician and were active can follow the above adult guidelines. For individuals who were not active before COVID-19, it is advised to start with light intensity activity daily for 10- 15 minutes [25] until advised to progress by a health professional. If an individual is on a weight reduction program, it is better to maintain weight without excessive exercise.

4.2. Recommendations for Individuals who Exercise Regularly and Athletes

For individuals who were participating in a regular exercise program, in particular high-intensity, high-volume training (>1-2 hours per day), pre COVID-19, it may be prudent to titrate the training regimen during this period to 'maintain' fitness with periodization and adequate rest in between sessions. Trying to meet the above adult guidelines [25] and limiting excessive intensities and volumes of aerobic exercise training per day and 2-3 days of resistance training per week, with adequate rest between sessions, good hydration, hygiene, adequate sleep and adequate carbohydrate intake, will help to maintain immune function [14].

In countries where strict stay-at-home guidelines are lifted, a stepwise and a gradual process needs to be implemented for the resumption of normal training for athletes as well as individuals in the general public who engage in recreational exercise training [33]. The resumption of training should be decided contextually to optimally reduce the risk of viral infection/spread using the best available scientific evidence.

5. Individuals exposed to COVID- 19

Giving detail recommendations to COVID- 19 clinical populations is beyond the scope of this review. While adhering to the guidelines provided by the respective governments and health authorities ,all exposed individuals can follow the advices produced by the American College of Sports Medicine [24]: ***1) A person under quarantine but not infected -*** There are

no recommendations to limit physical activity if do not have any symptoms. If symptoms develop (cough, fever or shortness of breath) you should contact a qualified health care provider [24]; 2) ***A person under quarantine confirmed infected*** - individuals who are infected, but without symptoms, can continue moderate-intensity activity, but need to use symptoms as a guide. Maintain quarantine and physical distance to prevent spreading the coronavirus to others. If you develop symptoms, stop physical activity and notify the treating physician [24]. We propose if previously sedentary it is advisable to inform the treating physician before starting exercise; 3) ***Severe and critically ill patients - Early Rehabilitation Therapy -*** The Handbook of COVID-19 Prevention and Treatment 2020, developed from the clinical experience in managing COVID-19 in China published by the First Affiliated Hospital, Zhejiang University School of Medicine China recommends, Early Rehabilitation Therapy for severe and critically ill patients. These include position management, respiratory training, and physical therapy. The goal of early rehabilitation intervention is to reduce breathing difficulties, relieve symptoms, ease anxiety and depression and lower the incidence of complications [34].

6. Conclusions

Effectiveness of the human immune system can play a vital role in preventing an individual getting the novel coronavirus infection and progressing into a severe stage. The profound positive effects of exercise on immunity, in particular innate immunity, justify the current public health recommendations promoting physical activity during COVID-19. The COVID-19 pandemic has required the implementation of unprecedented social distancing and stay at home orders to slow its spread. These measures have likely contributed to profound decreases in physical activity and increases in sedentary time. In addition, the negative psychological and social effects of isolation can dampen the immune response and the

metabolic health. Evidence has shown that exercise can counteract these effects. To curb the long-term consequences of increased sedentary time, decreased physical activity and the effects of social isolation, the widespread adoption of active living within one's residence is required. If successful, its adoption may positively impact long term physical activity habits once social distancing and stay at home orders are removed.

7. Expert opinion

Due to the COVID-19 pandemic most countries are facing devastating health, economic and social challenges. The prevention of human to human transmission, managing the severe disease, mitigating negative effects of isolation seem to be some of the major health challenges. Based on evidence, a strong host immune response is vital to face the above challenges which could be accomplished by improving general heath. The WHO has recommended guidelines to improve general heath including physical activity, nutrition, mental health, behavior and individual coping strategies. This review provides evidence-based support for the COVID-19 physical activity recommendations while highlighting important considerations. One in particular, is the recommendation to perform exercise in moderate intensity and duration, as highly demanding doses of exercise have been attributed to immune suppression and susceptibility to URTI in a nutritionally and psychologically deprived environment. When stay home orders are lifted, a stepwise and a gradual process needs to be implemented for the resumption of normal training for athletes and for wider public who were engaged in recreational exercise training. It is important to note that due to the lack of exercise-based research on COVID 19, activity recommendations will likely evolve in this rapidly changing environment the world now lives in.

Adopting new exercise behaviors will be challenging for individuals that face many uncertainties surrounding safety and ability to acquire basic needs (food, shelter, finances

etc.) in certain communities. The current physical activity recommendations should be incorporated while the basic needs are fulfilled by respective state authorities. Providing evidence-based support for the physical activity recommendations is vital for their adoption by the community during this pandemic. Additionally, customizing already existing recommendations with practical tips and applications may increase the likelihood of adherence. Monitoring the physical activity patterns of individuals during this time will be important to modify the current recommendations and be prepared for similar scenarios in the future. Perhaps, areas requiring the most attention are underserved communities, where other demands are high, and accessibility is low.

The barriers and facilitators of adoption and maintenance of the proposed new behavior (being active in the residence) will also depend on the duration of the pandemic and how quickly communities can return to standard living conditions prior to the pandemic The widely experienced physical activity barriers will spur future research efforts that investigate strategies for self-empowerment, sustainability and general wellbeing in the post COVID-19 time. Future research on exercise should focus on a more holistic, general health and wellbeing model rather than only effects of exercise and physical activity investigated in isolation.

It is unlikely that NCDs will decrease in the future, but rather increase partly due to inactivity associated with “stay at home” and “work from home” orders. Strategies to keep people active in their own residencies will be an important area of study even when the stay home restrictions are lifted. With the abundance of studies conducted on exercise and NCDs; the exercise effects of communicable diseases with dose response relationships is a gap in the literature that need to be fulfilled.

During ‘social distancing’ strategies, communities appear to be taking advantage of digital platforms to stay socially connected while complying with distancing guidelines. The

increased familiarity of communicating through these digital platforms may facilitate the implementation of innovative technology-based interventions to promote a physically active lifestyle.

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These articles are of interest as they describe the clinical, immunological pattern of the (SARS-CoV-2) virus and similar viruses (3), with up to date evidence on immunological response to exercise (14,15,17,18) and current recommendations of exercise during the COVID-19 period (24,25,31).

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Table 1: Tips for staying physically active during the COVID-19 pandemic

- Determine to take care of yourself during this period. Deciding to be healthy can help others in your family make the same choice
- Identify an 'active space' in the house to do exercise. Utilize exercise equipment if available (e.g., yoga mats, dumbbells, resistance bands).
- Have a specific time in the morning or evening to do exercise and get into a routine timetable. Try to make each day meaningful with small achievable physical activity goals. The overall goal each day should be to *move more and sit less*.
- Aerobic exercise
    - Beginning with short bouts (e.g. 2, 5, 10 or 20 minutes) throughout the day is beneficial and may improve adherence if you have not participated in an exercise program before.
    - Try to have fun with exercise take alternative days of doing exercise to a TV/online exercise program or having an active play with kids.
- Find ways to do simple muscle strengthening exercises using your body weight around your home [35]
    - Squats or sit-to-stands from a sturdy chair (10 repetitions x 3 times with 30 sec rest in between).
    - Push-ups against a wall, the kitchen counter or the floor depending on ability (10x3).
    - Plank (hold 15 seconds x 3 times).
- Try to eat healthy every day.
- Adults should sleep of 7-8 hours each day (children should have more) to maintain your immunity.

- Exercise is a behavior. If you are new to it, adherence will be difficult initially. Call a friend who does regular exercise for motivation [36].
- Minimize screen and sitting time for the whole family.