



Movement and nutrition in COVID-19

| Opinion

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Abstract: Movement and nutrition appear to play important roles in the management of the novel coronavirus disease 2019 (COVID-19). Moderate physical exercise has a positive impact on immune function, can counteract age-associated immune deficiency and is capable of reducing the incidence of respiratory diseases. Exercise can also mitigate the negative effects of home confinement due to quarantine and of other preventive measures, which may lead to an increase in sedentary behaviours and a reduction in physical activity. Regular physical exercise may have benefits in regard to infection risk, mental problems, such as anxiety and depression, and maintenance of body weight as well as the prevention and management of chronic disease. Since evidence evaluating dietary supplementation in COVID-19 is lacking, a reliance on supplements to prevent or treat COVID-19 would be premature. A balanced diet containing sufficient amounts of macronutrients and diverse micronutrients is required for an optimally functioning immune system. High-energy diets and obesity are major risk factors for a more severe course of COVID-19. Population-wide body weight control is therefore an important preventive measure. Other lifestyle-related factors, such as reducing smoking rates and limiting alcohol intake, are also important in decreasing disruptive effects on immune functioning and improving ability to overcome infection.

Keywords: COVID-19; physical activity; exercise; food; nutrition; lifestyle.

1. Introduction

The novel infectious coronavirus disease 2019 (COVID-19) pandemic, caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has significant effects on both physical and mental health [1–4]. In addition to serious pathology in the respiratory tract, COVID-19 appears to cause extrapulmonary manifestations affecting the cardiovascular, gastrointestinal, urinary and nervous systems [5]. The development of effective and safe vaccines, antiviral agents and passive immunotherapy is highly desirable. However, comprehensive preventive and therapeutic measures may remain elusive in the foreseeable future. Recent announcements of COVID-19 vaccine candidates with 90% efficacy in clinical trials should not engender complacency, since many uncertainties regarding the effects of

these vaccines on the course of the pandemic remain, and little safety data is currently available [6]. In the socio-economic rush towards mass vaccination, longer-term safety investigation should not be neglected. The effect of the vaccines in older people or those with underlying conditions is at present unknown, as is the extent to which vaccination is able to reduce the severity of infection. The period of immunity conferred by the vaccines is also unclear. First-generation vaccines may become a tool in the public health response to the pandemic but are unlikely to be the ultimate solution that many at present expect [7]. Even were vaccines able to confer protection from COVID-19, they may not be capable of reducing transmission of the virus. Furthermore, vested interests related to the introduction of vaccines need to be considered [8].

Currently, the most effective measures in halting the transmission of SARS-CoV-2 and preventing chronic complications of COVID-19 are unarguably physical distancing, face masks and eye protection [9,10]. However, lifestyle-related factors, such as physical activity and nutrition, may also be able to influence the risk for COVID-19.

2. Physical activity and sport

While home confinement can be a safe measure against the spread of SARS-CoV-2, it may also lead to an increase in sedentary behaviours and a reduction in physical activity, thus exacerbating the established pandemic of physical inactivity [11–13]. Studies conducted in China and South Korea in the spring of 2020 following the outbreak of COVID-19 reported the temporary adoption of a sedentary lifestyle in almost 60% of adults during confinement to their homes [14] and a decrease in the use of play and sports facilities in 90 % of children [15].

A close relationship between regular exercise and immune function has been demonstrated [16]. Several studies have shown that moderate exercise can act as a countermeasure to immune senescence and age-associated immune deficiency [17]. The positive impact of exercise on the immune system, its protection of the host from viral infections and its mitigation of negative effects of isolation is well documented [18]. Physical exercise may have either positive or negative effects on immunity depending on the nature, duration and intensity of exercise [19]. Both lack of exercise and long-term high-intensity exercise are associated with immune decline [20,21], while regular moderate intensity training can significantly improve immune function and reduce the incidence of respiratory diseases [22]. Regular bouts of short-lasting moderate intensity exercises (up to 45 min) have been suggested to be immuno-enhancing, while repeated bouts of long-lasting arduous intensity exercises (more than 1.5 h) can be immunosuppressive [23,24]. Prospective studies have shown that regular physical activity decreases the risk of infection [25] and the burden of latent viral infections [26]. Regular moderate-intensity physical activity has also been shown to reduce the incidence, duration and severity of respiratory infections [27–31]. Epidemiological data suggests that regular physical activity is associated with a reduction in the incidence of and mortality from influenza and pneumonia [32]. Immunomodulation induced by low-to-moderate exercise might also enhance immune responses playing a role in the spread of infection with COVID-19 [33].

Daily moderate-intensity physical activity undertaken in the home is well suited to maintaining physical fitness

while avoiding infection with SARS-CoV-2 [11,34]. Active videogames (exergames) may be an easy-to-use mode of home-based exercise and also a useful tool for reducing social isolation and anxiety during quarantine periods [35]. The effectiveness of aerobic exercise in regard to mental problems, such as anxiety and depression, has been demonstrated [36,37]. Exercise, particularly when engaged in outdoors, was found to be associated with a perception of improved general and mental health during the COVID-19 pandemic [38].

During times of confinement, a physically active lifestyle is important for both physical and mental health. Regular physical exercise during the COVID-19 pandemic may have benefits in respect of infection risk, mental problems, maintenance of body weight and the prevention and management of chronic disease. In view of the adverse impact of the COVID-19 pandemic on children's movement and play behaviours [39], the promotion of physical exercise in children deserves special attention [15]. Maintaining or increasing levels of physical activity can reduce the risk of respiratory infections in children [40]. Recommendations for promoting healthy movement behaviours among children during the COVID-19 pandemic have been published [15].

In summary, exercise during the present coronavirus pandemic is important in preventing the health risks associated with physical inactivity [41] as well as increasing wellbeing and immunity and reducing stress and anxiety [14,42]. The available findings call for further investigations of the value of exercise as an effective intervention in the management of COVID-19 [43].

3. Food and nutrition

An optimally functioning immune system is critically dependent on adequate nutrition. Both malnutrition and overnutrition can adversely affect immune responses. Nutritional deficits in energy, protein and micronutrients, caused by malnourishment and starvation, can impair the immune system and consequent resistance to infection [44,45]. Micronutrients, such as vitamins and trace elements, are known to play essential roles in both innate and adaptive immune responses, and micronutrient homeostasis is central to the maintenance of a healthy immune system [46]. Deficiencies in micronutrients can decrease immunity to disease, while supplementation has been found to improve immunity to viral infections [47]. Micronutrients may have the potential to augment immune function and defend against COVID-19 [48]. However, the purported significance of these compounds in naturally occurring infections derives primarily from

animal studies, while the findings of studies in humans are inconsistent. The efficacy of micronutrients in infectious diseases can be affected by a wide array of factors including the type of pathogen, the dose, timing and duration of supplementation, and the characteristics of target populations. Evidence evaluating dietary supplementation in COVID-19 is lacking for most micronutrients [49].

Vitamin D has received particular attention in the recent months of the COVID-19 pandemic. The vitamin has often been suggested to be involved in decreasing the risk of microbial infection [50], and an increase in susceptibility to immune-mediated disorders, such as chronic infections, has been linked in epidemiological studies to inadequate vitamin D concentrations [51]. Observational studies have found that vitamin D deficiency was associated with an increased risk of viral acute respiratory infection, and vitamin D supplementation has shown protective effects in a meta-analysis of clinical trials [52]. A recent retrospective cohort study assessing plasma 25-hydroxyvitamin D levels found that participants who were PCR-positive for SARS-CoV-2 had statistically significantly lower 25-hydroxyvitamin D concentrations than PCR-negative individuals; this finding was also confirmed when the participants were stratified according to age >70 years [53]. These preliminary observations suggest that vitamin D supplementation might be useful in reducing the risk of SARS-CoV-2 infection. In a meta-analysis with a total of 1,368 COVID-19 positive patients, vitamin D deficiency was significantly associated with poorer patient outcomes and prognosis [54]. This result was unaffected by potential confounding factors, such as age, sex, or comorbid conditions, suggesting that vitamin D deficiency could play an independent causative role in the manifestation of disease severity.

In a pilot randomised open label, double-masked clinical trial, 76 consecutive patients, hospitalised with COVID-19 infection and receiving the best available therapy as standard care, were allocated at a 2:1 ratio through electronic randomisation on the day of admission to either take oral calcifediol (0.532 mg) or not to receive the supplement. Patients in the calcifediol group received oral calcifediol (0.266 mg) on days 3 and 7 and then weekly until discharge or admission to an intensive care unit [55]. Of 50 patients treated with calcifediol, one required admission to the intensive care unit (2%), while 13 of 26 untreated patients required admission (50%). None of the patients treated with calcifediol died, and all were discharged without complications. The 13 patients not treated with calcifediol and not admitted to intensive

care were discharged. Of the 13 patients requiring intensive care, two died and 11 were discharged [55]. This pilot study has demonstrated that administration of high doses of calcifediol significantly reduced the need for intensive care treatment in patients requiring hospitalisation due to COVID-19. While calcifediol may be able to reduce the severity of the disease, larger population studies with groups properly matched will be required to provide a definitive answer.

Various food plants, such as garlic, ginger, blueberries and others, have been suggested to have antiviral and immunomodulatory effects [56]. However, evidence of their efficacy in humans is weak or non-existent. Food bioactives, such as polyphenols and carotenoids, are thought to have antiviral efficacy. Hypotheses regarding antiviral benefits of polyphenols [57] and carotenoids [58] are based mainly on research in cell cultures and animal models. Beneficial effects of food bioactives on viral infections in humans are questionable, since no controlled trials of these compounds have yet been conducted. While conventional probiotics have been recommended in COVID-19 management guidelines [59], their efficacy in the prevention or therapy of COVID-19 is unconfirmed [60].

People with non-communicable conditions, such as obesity, diabetes and hypertension, are at heightened risk of severe COVID-19 [61–63]. Obesity appears to have a substantial impact on pathogen defense and immunity, and a link has been demonstrated between obesity and various infectious diseases [64]. Obesity has modulatory effects on populations of immune cells critical in the response to SARS-CoV-2 [65]. Using 75 scientific studies on COVID-19 published in Chinese or English, a series of meta-analyses were conducted on the association of obesity with various COVID-19-related issues, from infection risk to case fatalities [66]. Pooled analysis showed that obese individuals were 46% more likely to test positive for COVID-19, and those who had contracted SARS-CoV-2 were more than twice as likely to be hospitalised, were 74% more likely to be admitted to an intensive care unit and were almost 50% more likely to die [66]. Furthermore, COVID-19 vaccines may be less effective in overweight or obese individuals than in non-obese people due to a decreased immune response and mechanisms similar to those responsible for a greater risk of primary infection.

In summary, experimental findings in animals and preliminary observations in humans suggest a role of micronutrients and food bioactives in the prevention of COVID-19. Since evidence evaluating such dietary supple-

mentation in COVID-19 is lacking, a reliance on this approach in the prevention or treatment of COVID-19 would be premature. A balanced diet containing diverse food bioactives and micronutrients may have supportive effects in COVID-19. Overweight and obese people require special attention, with an emphasis on avoidance of infection and reduction in body weight.

4. Conclusion

Movement and nutrition are important factors in the management of COVID-19. Regular moderate intensity training can significantly improve immune function and reduce the incidence of respiratory diseases. A physically active lifestyle may also counteract the negative impact of prolonged phases of social distancing on physical and mental health during the COVID-19 pandemic. While no foods, single nutrients or dietary supplements have been proven to be capable of preventing infection with COVID-19, a balanced diet containing sufficient amounts of macronutrients and diverse micronutrients is a prerequisite of an optimally functioning immune system. Since high-energy diets and obesity are major risk factors for a more severe course of COVID-19, population-wide body weight control is an important preventive measure. Other lifestyle changes, such as a reduction in smoking and alcohol intake and improved sleep patterns, may also help reduce the risk of infection and aid in preventing severe COVID-19 [67].

Conflict of interest

The authors declare no conflict of interest.

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