COVID-19 pandemic: Impact on athletes and nutritional considerations

Pandemia da COVID-19: Impacto nos atletas e considerações nutricionais

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Abstract and Keywords

On March 2020, the World Health Organization declared the SARS-CoV-2 outbreak a pandemic and government agencies announced social isolation and circulation restrictions measures worldwide. Athletes did not escape from the consequences of this pandemic and had their training and competition schedules interrupted or postponed.

The impact of COVID-19 and its consequences are not yet fully understood, but its possible implications on physical, mental, and behaviour dimensions have been discussed. This paper aims to review the existing literature on how this pandemic has affected athletes' life and to provide an insight into the current scientific evidence on the link between nutrition and COVID-19.

The lockdown may be responsible for increased injuries in athletes, unhealthy eating patterns with its consequent changes in body composition, and mental health problems, including eating disorders. Some micronutrients have been suggested as being promising for dealing with COVID-19. However, further research is needed to show their potential benefits. Nutritionists' action is essential to ensure the adequacy of the athletes' nutritional status during this period. Athletes should pay attention to their mental health and proper nutrition during lockdown in order to have a better return to their normal routines.

Keywords: COVID-19; pandemic; athletes; nutrition

Resumo e Palavras-Chave

Em março de 2020 a Organização Mundial de Saúde declarou que o surto de SARS-CoV-2 se tornou numa pandemia, e agências governamentais por todo o Mundo anunciaram medidas de isolamento social e de restrição à circulação. Os atletas não escaparam às consequências desta pandemia e tiveram os seus calendários de treino e competição interrompidos ou adiados.

O impacto da COVID-19 e as suas consequências ainda não são totalmente compreendidos, mas têm sido discutidas as suas possíveis implicações a nível físico, mental e comportamental. Este artigo tem como objetivo rever a existente literatura sobre a forma como esta pandemia afetou a vida dos atletas, e fornecer uma visão da atual evidência científica no que respeita à relação entre a nutrição e a COVID-19.

O isolamento pode ser responsável pelo aumento de lesões nos atletas, por padrões alimentares pouco saudáveis, e as suas consequentes alterações na composição corporal, e por problemas de saúde mental, incluindo perturbações do comportamento alimentar. Alguns micronutrientes têm sido sugeridos como sendo promissores para lidar com a COVID-19, contudo é necessária mais investigação para mostrar os seus potenciais benefícios. A ação dos nutricionistas é essencial para assegurar a adequação do estado nutricional dos atletas durante este período. Os atletas devem prestar atenção à sua saúde mental e a uma nutrição apropriada durante o confinamento, a fim de terem um melhor regresso às suas rotinas normais.

Palavras-chave: COVID-19; pandemia; atletas; nutrição

List of acronyms

AN – Anorexia Nervosa

BED – Binge Eating Disorder

BN – Bulimia Nervosa

DEB – Disordered Eating Behaviour

ED – Eating Disorders

ICU – Intensive Care Unit

NFL - National Football League

RDA – Recommended Dietary Allowance

SARS-CoV-2 - Severe Acute Respiratory Syndrome

URI – Upper Respiratory Infection

VO_{2max} – maximal oxygen uptake

WHO - World Health Organization

Summary

1. Introduction

In the end of 2019, a new and highly contagious coronavirus that causes severe acute respiratory syndrome (SARS-CoV-2) was identified in Wuhan, China. The disease resulting from the infection with the SARS-CoV-2, now designated COVID-19, quickly spread throughout the world and, on March 11, 2020, the World Health Organization (WHO) declared the "new coronavirus" outbreak a pandemic, leading government agencies to announce a lockdown and circulation restrictions measures all over the world[1, 2]. By 17 February 2021, there were 109 068 745 confirmed infections, including 2 409 011 deaths, due to COVID-19, worldwide[3]. The most common symptoms of infection include cough, fever, fatigue, musculoskeletal symptoms, anosmia, dysgeusia and gastrointestinal manifestations[4].

Athletes did not escape from the consequences of this pandemic and had their training routines and competition schedules completely disturbed[2, 5]. Being in general young and healthy, athletes have lower risk for serious illness, but the effects of the infection are difficult to predict. Prevention strategies are equally essential in order to reduce the risk of virus transmission and short and long-term adverse effects, in case the athlete is infected and has to be isolated[4]. Literature suggests that the isolation forced by the pandemic brought new challenges to athletes, with a clear impact both physically and mentally, leading in some cases to the adoption of unbalanced eating habits, sleep deprivation, loneliness, and addictive behaviours[2, 6]. Among the adverse effects are changes in body composition, with an increase in fat mass and a reduction of muscle mass, an impaired immune system, cognitive deficits, insomnia and even depression[2].

When we discuss the relationship between nutrition, diet, and COVID-19, we are faced with two issues: on one hand, how this disease impacts on what we eat, particularly since we are confined to our homes, which greatly affects our eating behaviour; on the other hand, how what we ingest can or not, help reducing the risk of infection and severity of the disease. Nutrition plays a key role in improving athlete's health and performance by potentially reducing fatigue, decreasing the risk of injury, optimising training, and enhancing recovery, being essential to balance energy intake and expenditure with the ingestion of necessary nutritional constituents[7]. In light of such drastic daily life changes, it is worth giving some thought on how the athlete can maintain a healthy diet and an adequate energy balance during COVID-19 lockdown, with all the existing limitations on physical activity[7].

This paper aims to overview the many aspects of athletes' life that may be affected by this pandemic, regarding physical performance, eating habits and mental health. Besides, this paper provides an insight into adequate nutritional strategies to athletes and what current scientific evidence tells us about the role of nutrition in the management of COVID-19.

2. Methodology

A literature search was performed by searching in the online scientific databases PubMed and Scopus, in addition to a manual search of relevant journals, between November 2020 and February 2021. The keywords used for the research were a combination of the following: "COVID-19", "athletes", "lockdown", "pandemic", "nutrition", "dietary habits", "mental health", "eating disorders", and "immunity". In a more advanced stage, the nutrients/ supplements addressed in this review (vitamin D, vitamin C, zinc, creatine, and probiotics), combined

with the terms described above, were also used as search terms. References cited in the originally selected articles were also collected. The relevance of publications was firstly judged based on titles and abstracts. There were 72 papers that remained, including relevant retrieved articles, published between 2001 and 2021.

3. COVID-19's impact on Athletes' Life

3.1. Energy Expenditure Modifications Imposed by Lockdown

With lockdown, athletes needed to conduct training ate home, often with online training programs or videoconferences. However, this cannot mimic a training scenario under usual conditions[7, 8]. One of the main constraints is the limitations in space, material and human resources needed[7, 9]. Thus, for some, home training is limited to strength, muscular endurance exercises, and stretching[7]. The decrease in training intensity and consequent reduction in physical fitness can be reflected in loss of competitiveness upon their return to competition[9]. When the training stimulus is inappropriate or insufficient, the adaptations previously obtained suffer a partial or complete loss, known as detraining[10]. Although athletes are exposed to some level of detraining over time, in "off-season" periods or due to illness or injury, the decrease in physical activity is not comparable to that of lockdown[2]. Detraining affects the musculoskeletal, respiratory, and cardiovascular systems, and may result in a decline in maximal oxygen uptake (VO_{2max}), reduced endurance, loss of strength, power, muscle mass, and flexibility[8, 11]. The rate of muscle atrophy may be even higher in elite athletes. The mechanical properties of the tendons also deteriorate, increasing injury risk[10, 11]. In 2011, following 4 months lockout of the

National Football League (NFL), players were without normal access to their facilities and staff, which resulted in a high number of Achilles tendon ruptures in the preseason[11]. Therefore, consideration should be given to the length of the detraining period, the level of physical activity the athlete maintained during this time, and whether the athlete contracted COVID-19[2, 8]. It important for athletes to maintain a training routine, not only due to maintenance of physical fitness, but also to prevent the consequences of detraining[9].

3.2. Changes in Dietary Habits During Lockdown

Quarantine-related changes in nutritional habits may be due to factors such as: a possible reduction in goods availability; limited access to food due to restricted shopping opening hours; and possible easier access to unhealthy foods[12]. This possible desire for hedonic and highly palatable foods may be related to anxiety and unease, emotions that often follow chronic stress and may trigger excessive food intake[12, 13]. Because of anxiety around future food shortages, people often prefer long shelf-life foods, higher in salt, sugar, or trans-fat content[12]. One cross-sectional study in young adults during the pandemic suggested a greater risk for increased food ingestion in people who suffer from mental stress[14]. A survey conducted among the Italian population, reported a perception of weight gain in 48.6% of the population[15]. One international survey reported higher intakes of unhealthy foods, out-of-control eating, and increased snacking between meals[16]. In Portugal, a survey by the Directorate-General of Health stated that respondents claimed to have consumed more fruit (29.7%) and vegetables (21%), but also more sweet snacks (30.9%), as well as snacking more often (31.4%). 26.4% of the sample had the perception of having increased weight during this period[17].

The general situation of uncertainty and stress may also instigate disturbances in sleep patterns and sleep quality. As a result, it leads to changes in appetite regulating hormones: a decrease in leptin and an increase in ghrelin, potentially promoting increased appetite and decreased satiety[18, 19]. Excessive food intake and frequent consumption of ultra-processed foods, can promote weight gain, increased risk of injury, or gastrointestinal problems[9].

3.3. Adequate Nutritional Strategies During Lockdown

Although athletes are frequently healthy, there are athletic populations with increased risk of disease, often those with higher body fat[20]. But, of greater concern than an eventual gain in fat mass, could be a loss of muscle mass in athletes[21]. In addition to the possible fear of gaining weight, for those with COVID-19, anorexia may also occur due to the anosmia and loss of taste, and to the elevated levels of inflammatory cytokines[22].

Evidence is scarce on the relationship between food and immune system boosting and, to date, there are no specific food or supplement recommendations that can prevent or help in the treatment of COVID-19[23]. Despite this, in order to maintain immune health, athletes should match their energy intake to expenditure, avoid calorie deficit, have an adequate amount of energy from carbohydrates (following individual needs) and ensure an adequate protein intake[24, 25]. It is also important to assure the intake of a good ratio of omega-3/omega-6 fatty acids and limited intake of saturated and trans fats, high ingestions of whole grains, proper intake of vitamins (A, B6, B12, C, D, E), minerals (zinc, cooper, selenium, and iron), and phytochemicals[26, 27]. Micronutrient deficiencies can be corrected through diet or through supplementation[28].

Deficiency in muscle protein synthesis is considered to be the major reason for atrophy due to muscle disuse for more than 2 weeks. This suggests that nutritional strategies to compensate for anabolic resistance may be effective in mitigating muscle loss[21]. Due to reduced levels of energy expenditure, achieving an optimal macronutrient intake that helps maintain muscle mass, while not promoting a large increase in fat mass, can be a challenge for some athletes. So, daily protein intake is recommended at 1.6-2.5 g/kg of body weight, evenly distributed throughout the day (about 25-40g protein/meal) and ensuring a high leucine content (2.5-3g/meal). The intake of slowly digested proteins such casein prior to sleep, may be particularly relevant. In addition, creatine supplementation may be relevant given its potential to attenuate the loss of muscle mass and strength[21, 29].

3.4. The Pandemic's Impact on Mental Health

Recent studies have shown that athletes are one of the populations that may suffer the most with the COVID-19 pandemic, with elite athletes suffering from mental health disorders at equivalent or even higher rates than non-athletes[30, 31]. Reported prevalence of anxiety and depression among elite male athletes in team sports is almost 45%; among elite female athletes, mental health disorders are also prevalent, especially eating disorders (ED)[32]. Some mental health disorders can be aggravated, such as anxiety, obsessive-compulsive disorder, and depression[30]. Some contributors to worsening symptoms of mental health disorders in athletes are: isolation from society; training and competition cancellation; loss of income; and fear of getting infected and/or infect others[30]. Regarding the social bonding effect during exercise, it appears that group training increases pain thresholds compared to training alone[8]. At an international level,

variations in the degree of confinement across the globe have created concern that some may have an advantage or disadvantage in preparing for competitions, based on region they are in[8]. Throughout the lockdown period athletes should be encouraged to talk to health professionals and access support groups[8].

3.5. Eating Disorders and Disordered Eating

Among the mental health problems associated with isolation there are eating disorders (ED) such as anorexia nervosa (AN), bulimia nervosa (BN), binge eating disorder (BED), and disordered eating behaviour (DEB)[18, 32]. The prevalence of ED or DEB among athletes is estimated to range from 0-19% in men and 6-45% in women[32], considerably higher than in non-athletes, where the percentage ranges from 5-13% overall[33]. Evidence on elite athletes is scarcer, but it also shows a significantly higher prevalence than in non-athletes[32]. This difference may be attributed to the greater pressure to improve their physique and performance, and to characteristics of athletes, such as perfectionism[33-35]. It is already suggested that this pandemic may have exacerbated ED symptoms in the general population[36, 37]. The modification of the usual training conditions may lead some athletes to fear weight gain[38] and to compensate this by drastically reducing their food intake or overtraining[39, 40]. Being isolated at home can promote an increased contact time with social media, where there is high pressure to meet an ideal physical appearance[40]. Also, there may be a compromise in access to food that is usually considered as "safe" from the athlete's perspective, which may lead to some anxiety[37]. One of the main consequences of ED is their high mortality rate with the risk of premature death being 6-12 times higher in women with AN[38, 41]. The main cause of death in ED is suicide (20% of deaths in

AN, and 23% in BN) or cardiac arrhythmia[41]. More than 60% of elite female athletes have reported being subjected to body shaming comments from coaches [32]. It is critical to make coaches aware that their relationship with athletes can promote a reduced or increased risk of ED[38].

3.6. Nutrition, Immune Function, and COVID-19

"We are not just fighting a pandemic; we are fighting an infodemic" said WHO Director-General, Tedros Adhanom Ghebreyesus[42]. The growth of digital interaction has led to a fast spread of misinformation and disinformation and the media hardly provides enough background for consumers to understand the findings[43]. Sharing disinformation through social media can influence knowledge, attitudes and beliefs related to health[44] and be harmful to those who are more susceptible[45]. This is particularly relevant at this time, as there has been a substantial increase in pseudoscientific claims regarding possible treatments and supplements against COVID-19[46]. An excessive anti-inflammatory reaction may diminish the immunity response and thus increase susceptibility to infection. Although anti-inflammatory dietary constituents can have a beneficial effect in a state of hyper-inflammation, as with COVID-19, there must be caution with high doses of isolated anti-inflammatory compounds to avoid overly suppressing inflammation and the immune system[26]. Given the restricted therapeutic window and controversial effects of some of these micronutrients, it is strongly recommended to obtain their nutritional benefits by adopting healthy eating habits[26]. Indiscriminate supplementation with any nutrient is therefore not recommended, as there should first be a proper assessment of whether nutritional deficiencies exist[47]. Despite the conflicting evidence, to date the micronutrients with the most evidence supporting possible benefits in immune function are

vitamin D, vitamin C, and zinc[27]. This does not necessarily apply to COVID-19, therefore, the following analysis.

3.6.1. Vitamin D

One in every two athletes may have a vitamin D inadequacy[48]. Also, quarantine encourages less sun exposure, therefore less vitamin D production[18]. Despite the large number of studies on vitamin D and infection risk, we must be careful when interpreting its results. It must be kept in mind that correlation and association are not equal to causation, and it is still unclear whether low vitamin D levels are a cause or a consequence of COVID-19[49]. A 2017 meta-analysis of 25 randomised controlled trials and 10 933 participants, showed an overall protective effect against acute respiratory tract infections, mainly in those with greater deficiency in baseline vitamin D levels and those receiving daily/ weekly supplementation[50]. In 2020, a systematic review of observational studies, suggested there is no relationship between low vitamin D levels and increased risk of infection with COVID-19, but that the deficiency is associated with greater disease severity and mortality[51]. Regarding the specific association of vitamin D with COVID-19 outcomes, the only two clinical trials to date suggest that low vitamin D status may be associated with worse clinical consequences, as vitamin D-deficient patients diagnosed with COVID-19 who received high dose vitamin D supplement had reduced the need for Intensive Care Unit (ICU) admission, improved clinical rehabilitation, and lowered oxygen requirement[49]. Thus, monitoring is recommended and a 1000 IU/day of D3 from autumn to spring is suggested to maintain sufficient levels, when needed[25]. This is not a consensual issue among the scientific community: some researchers propose that much higher

doses may be beneficial against COVID-19, namely doses of 10,000 IU/day of vitamin D3 for several weeks, followed by 5000 IU/day[46]. Thus, further investigation is required before any recommendation can be made about the effect and possible prophylactic or therapeutic values of vitamin D supplementation regarding COVID-19[27, 46].

3.6.2. Vitamin C

At the moment, no studies allow us to conclude if Vitamin C could be beneficial in the treatment of COVID-19[52]. However, previous evidence on other respiratory tract infections, prompted the start of clinical trials for severely hospitalised cases[46]. Evidence suggests that supplementing with vitamin C shortened the duration of colds by 8% in adults and by 14% in children, and also reduced colds severity[46]. There must be caution with athletes since vitamin C supplementation can impair performance by diminish training-induced adaptations in doses higher than 0.2-1.0g/day. To lower oxidative stress without undermining training adaptations, five daily portions of fruit/ vegetables, might be sufficient[53]. If we are referring to treatment of settled infections, significantly larger doses (>1g/day) will be needed to compensate the inflammation[54]. Some encouraging results have also been obtained with high-dose vitamin C administration in 50 COVID-19 patients in China[55]. However, the existing data is not sufficient to recommend for or against the use of vitamin C to treat COVID-19 in non-critically and critically ill patients[56].

3.6.3. Zinc

Zinc is critical for immune cell and its deficiency may impair cell-mediated immunity and increase susceptibility to infection[46]. A meta-analysis from 2017 suggests that zinc lozenges (75mg/day of elemental zinc) can reduce the duration

of common colds by 33%, starting at the early symptoms[57]. Concerning prophylactic supplementation, no recommendation can be made at the moment. Supplementation with high doses of zinc should be avoided as it may diminish immune function[25]. There is no evidence to say if it can be used to treat COVID-19, so it is not advisable to exceed the recommended daily allowance (RDA) of 8 mg for women and 11 mg for men[56, 58].

3.6.4. Creatine

Creatine monohydrate is viewed as the most powerful nutritional supplement for athletes to improve their high intensity exercise capacity and to increase muscular mass[59]. Moreover, it has been shown that it may play a beneficial role in recovery following exercise, in reducing the risk of injuries and improving recovery from injury[60]. Short and long-term safety studies have reported its safety and tolerability, being the usual protocol a single dose of 3–5 g/day[60]. Thus, creatine may be another supplement of interest in the wake of COVID-19, due to its shown positive effects like increasing functional recovery in chronic obstructive pulmonary disease and easing cystic fibrosis, stroke, and respiratory insufficiency. There are no disease-specific recommendations, however the above-mentioned doses may support pulmonary rehabilitation in COVID-19[61]. When faced with SARS-CoV-2 infection, the dysfunction in respiratory capacity is not to be despised. Since it is already a supplement widely used by athletes, it could be another helping hand in recovery.

3.6.5. Probiotics

By modulating the gut microbiota, probiotics may be beneficial for resistance to respiratory and gastrointestinal infections[62]. Despite the low quality

of the evidence, a Cochrane review (n=3720) found a reduction of 47% in upper respiratory infection (URI) incidence and 2 days shortening of an episode of URI[63]. Some studies reported an enhanced response to seasonal influenza vaccination[28]. Given the reported safety profile it might be a supplement with potential interest to reduce the severity and duration of viral respiratory infections. However, the benefits of probiotics depend on the strain as well as the dose administered, and most of the evidence on probiotics refers to lactobacilli or bifidobacteria[28, 62].

3.7. Life after COVID-19

For some athletes who had COVID-19, its symptoms, such as cough, tachycardia, and extreme fatigue, remained persistent and residual for many weeks or months after the initial infection[8]. Another COVID-19 common symptom which may persist for some time is the loss of smell. The current evidence regarding pharmacological therapy of this post-viral olfactory dysfunction is not supportive of the use of any specific drug[64]. Olfactory training is a non-pharmacological therapy option that attempts to improve olfactory function through repeated exposure to stimulating aromas, such as essential oils, about 2-4 times a day, for several weeks[65]. Previous studies have shown good results of olfactory training in olfactory dysfunction of different etiologies[65, 66], and now a recent meta-analyses, that included only patients with post-viral olfactory disfunction, has also shown improvements in olfactory function among these individuals[64].

After COVID-19, given the possible risk of complications, it is recommended a gradual return-to-play protocol, paying attention to physical and psychological aspects[67].

4. Critical Analysis

The consequences of COVID-19 and its impact are not yet fully understood. There is rational to believe that this period of isolation will cause a reduction in performance and an increased risk of injury in athletes, however the changes caused are highly variable from athlete to athlete[68] and only in the future it will be possible to understand in what extent this may have compromised the athletes' health. It is important to provide practical advice to athletes to help them reduce the unintended consequences of enforced quarantine, as well as a service to support their mental health. Regarding isolation's impact on an athlete's eating habits, it could really depend on their mindset: for some, being confined at home might lead to the consumption of energy-dense food, by impulse or anxiety; for others, the fear of gaining fat mass can lead to exaggerated calorie restrictions that can result in greater loss of muscle mass, or even trigger ED in more susceptible individuals. Thus, it may be recommended to be vigilant regarding the energy intake, though a very restrictive diet is not advisable during this period[9]. In the case of athletes who already suffer from ED, it is appropriate to discuss with the athlete and other members of the treatment team, the risks versus benefits of face-to-face follow-up during the lockdown[30]. As self-care strategies for athletes during this pandemic, it is recommended to: have a regular daily routine that tries to mimic a typical workday; have a structured work space and environment; maintain regular physical and mindfulness activities; not neglect proper nutrition; and stay in communication with others by using video conferencing tools[8]. COVID-19 may also contribute to inadequate nutrition due to increased economic stress and consequent food insecurity[36, 69]. The financial

situation can be a significant issue for some athletes, in particular for those who are economically independent[70, 71].

Further research is needed to show the potential benefits of nutritional supplements to decrease infection burden in athletes, without attenuating training adaptations. If considering supplementation, athletes must ensure that the supplement is from a trusted source, with a low risk of containing prohibited substances[25]. Despite the possible interest of Vitamin D, Vitamin C and Zinc, it is important to be aware that this evidence is often imported from other respiratory diseases of infectious origin, and therefore there is no evidence yet to recommend their use. Regarding Vitamin D, although there is no consensus and some advocate taking higher doses, this may not be the most recommended approach. Its supplementation at high doses (70,00 IU/week) may be counter-productive, especially with a rapid withdrawal. Lower doses of vitamin D3 are more appropriate for athletes and withdrawal should probably be gradual[72].

This is an especially critical time for athletes and all those involved in the sporting community, who end up being confronted with a large amount of information and often from sources that lack credibility. This review provides a compilation of some of the main issues that may affect the lives of athletes during this pandemic and provides some insight into the current available evidence, as well as underline some issues that should be taken into consideration in future studies. However, there are considerable limitations. Due to the novelty and severity of the period we are going through, there are many uncertainties and many assumptions that have been made. Also, there is a great need to get practical recommendations on how to deal with this situation. For this reason, there is a noticeable desire to publish a large amount of literature, which does

not guaranty good quality. There is also still little data available on a successful and safe return to sport after lockdown. Further standardised, better characterised clinical trials in different populations and considering their nutritional status are essential to further investigate the possible impact of supplementation on SARS-CoV-2 infection. More than ever before, an effort is needed by the scientific community to respond to current needs without, compromising accuracy. There is still a long way to go to provide a better understanding of what we can do to better manage this pandemic and its consequences for the athletes' lives.

5. Conclusions

The isolation due to the pandemic of COVID-19 has had a profound impact on athletes' lives. The physical, psychological, and physiological changes generated by the current situation may promote modifications in the eating behaviour pattern, body composition, and sports performance. Athletes who pay attention to their mental health, keep good nutritional habits, and maintain strength and conditioning physical activities during isolation will have less difficulties when returning to their normal training and competition routines. More studies addressing dosage and micronutrient combinations in different populations are needed to be able to support the possible benefits of supplementation with certain micronutrients, thus make concrete recommendations. The action of nutritionists is essential in the promotion of athletes' nutrition education, in the management of eating disorders, and/or when the athlete's food intake is compromised.

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