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STRATEGIES FOR ENHANCING ELITE ATHLETES' RESILIENCE AGAINST UPPER RESPIRATORY INFECTIONS DURING THE COVID-19: AN EXPLICATION OF EXERCISE INTENSITY AND VACCINATION

Shamshaid Ahmed
Lecturer, Department of Physical Education and Sports Sciences, University of Gujrat, Gujrat, Pakistan. Email: Shamshaidwarraich956@gmail.com

Saadullah
MS Scholar, Sarhad University of Science and Information Technology, Peshawar, Pakistan. Email: maliksaadkhan58@gmail.com

Bria Bukhari
M.Phil. Scholar, Department of Sports Sciences and Physical Education, Muslim Youth University, Islamabad, Pakistan. Email: Briasyed@gmail.com

Shuaib
Assistant Professor, Department of Respiratory Therapy, Rehman Medical Institute, Peshawar, Pakistan. Email: shuaibshalmani666@gmail.com

Abstract

Competitive players require regular training schedules that keep them in optimum health, but the tough, rigorous training weakens their immune systems and exposes them to COVID-19 which may limit their performance. There is another important issue that professional athletes raise about vaccination – namely, how it will be related to the training process. In this study, our purpose is to investigate the effects of various levels of training intensity and vaccination on the immunological system of elite athletes. To explore this, the authors conducted a systematic literature review from 1988 to 2022 through various databases like Google Scholar, Scopus, Web of Sci, ISC, and PubMed by using specific keywords. The results derived from this review imply that for high-intensity exercise, the immune system may be compromised, but it is suggested that elite athletes should not block exercising even when infected. They should instead avoid high-intensity training and focus more on low to moderate-intensity training as this has been proven to boost the immune system and maintain the body's endurance levels. Moreover, it is recommended that athletes avoid high-intensity training before and after vaccination and instead, they should practice moderate or low-intensity exercises. This approach seeks to achieve an optimum in fitness and upkeep of immune strength.

Keywords: Elite Athletes; Immune System; High-Intensity Training; COVID-19; Exercise Immunology.

Introduction

The immune system is considered a critical line of defense that guards humans. body against bacteria and virus infections and other factors in the environment (Yazdanpanah et al., 2020). The proper functioning of the kidneys is affected by many factors such as age, gender, diet, diseases, exercise routines, eating habits, and fitness levels (Brolinson & Elliott, 2007). Conspicuously, both acute and chronic effects of physical exercise exert a powerful impact on the regulation of the immune system (Khoramipour et al., 2021). The exercise-induced alteration in the immune response is known to depend on several factors including frequency, intensity, duration, and type of exercise performed as has been documented in the literature (Pedersen & Hoffman-Goetz, 2000). Additionally, it is relevant to note that overtraining, chronic, and high-voltage exercises may negatively affect the immune response, well researched (Simpson et al., 2020). This matter is particularly relevant to elite athletes since they often use high-intensity training as a necessity for attaining national and international achievements which makes them vulnerable to infections (Hekmatikar et al., 2021). URTI includes community-acquired respiratory infections, which are fresh infections with rapid onset and maximal manifestation into the upper respiratory passage comprising nasal passages, sinuses, nasal cavity passage, and the pharynx (Miko et al., 2019). As we noted above, athletes engaged in vigorous exercise training are at a higher risk, with statistics indicating that their likelihood of falling ill to URTI in case of pathogen exposure is 2-6 times higher than that of non-athletes (Ronsen, 2005). In addition, the relationship between URTI and COVID-19 has been well-documented, while highlighting how vulnerable top athletes are to this novel virus. The immune system then comes out as a significant predictor of the performance of elite athletes with immune depression being a threat to athletic performance (Gleeson, 2007). This has become even more pertinent in light of COVID-19 started in 2020, which underlines the need for a better understanding of immunity and immune responses in athletes. These findings are fully consistent with the now well-documented phenomenon that a sudden withdrawal from exercise leads to a substantial decrement in immunological function. In elite athletes with compromised immunity or respiratory illness, it would be advisable not to discontinue training abruptly. After home quarantine, several athletes are striving to restore rigorous training routines to maintain high fitness for further championships. However, research has helped to establish that there is a need to be careful when engaging in exercise after a break occasioned by the COVID-19 pandemic while noting the complex relationship between stress, anxiety, and athletes' decision-making on the right intensity level to train (Haan et al., 2021). Perhaps the biggest challenge that elite athletes face when trying to resume intensive training after a COVID-19 infection is the post-synaptic viral syndrome. It has also been shown that the stress and anxiety levels from the infection can lead to athletes making incorrect decisions regarding the right intensities to incorporate back into their training when they are back to sporting activities. This study aimed to establish the contribution of NA and other dependent variables toward the total amount of global social media traffic (Muriel et al., 2020). Such complex interactions between the immune system, physical exercise, and threats posed by pandemics call for a better understanding of those relationships and the bi-product, high-stakes management that is required to protect the health and performance of elite athletes.

Analysis Procedure

Search Strategies

We conducted a thorough literature search across various databases, including Scopus, Web of Science, ISC (Islamic World Science Citation Center), PubMed, and Google Scholar, spanning the years from 1988 to 2021. Our search involved using a variety of keywords to find articles relevant to topics such as the effects of exercise intensity on the immune system, athlete recovery related to exercise intensity, athlete stress and its impact on the immune system, athlete sleep and its connection to immune function, as well as the vaccination considerations specific to elite athletes.

Criteria Regarding Inclusion and Exclusion

This study investigated the search key databases such as Google Scholar, Scopus, Pub Med, Web of Science, and ISC for publications in the last three decades from 1988 to 2022. Some of the keywords that we used include: the effect of exercise intensity on the immune system, athlete recovery regarding exercise intensity, stress in athletes and its influence on the immune system, athlete sleeping and link with the immune system, and COVID-19 vaccination concerns for elite athletes.

Results and Discussion

An examination of low-intensity exercise and how this affects the immune systems of athletes. Comparatively few studies have looked at the effects of low-intensity training on the immunity of athletes to infection. Training at an intensity that results below the first ventilatory threshold, blood lactate level remains stable, and the concentration does not exceed 2 mM, or at an intensity level that is below 37-45% of VO2max exercise is known as low-intensity endurance training or LLD or zone-1 exercise.

In this study, elevations in the circulation of both interleukin-6 (IL-6) and interleukin-10 (IL-10) were noted after three hours and twenty-six minutes of low-intensity exercise (Steensberg et al., 2003). In addition, studies have found that when exercising at a low intensity below 60% of VO2 max, the effect on inflammation and immune function is improved if the session is less than 60 minutes (Rose et al., 2021). Taken in aggregate, current literature on the subject indicates that low-intensity exercise can serve as an effective method of helping elite athletes recover as well as reducing stress levels after competition (Stöggl & Sperlich, 2019). Taken together, these findings suggest that exercise training at a lower intensity can also elicit beneficial adaptations at the cellular level within the immunological system (see Table 1).

Table 1. A Retrospective Analysis of Low-Intensity Exercise on the Immune System

Intensity	Results	Source
Low	Improves immune system function	(Tenório et al., 2018)
Low	Improved immune system function	(Petersen & Pedersen, 2005)
Low	Immune system function	(Steensberg et al., 2003)

Moderate Exercise and its Effects on Immune Systems of Athletes

Moderate type of intensity exercise is exercised in the first and second lactate or ventilatory thresholds termed as the ‘zone-2’. This causes lactate accumulation in the body preferentially performed at an exercise intensity of 45-65 % VO2 max. (Goodwin et al., 2007). Several other studies that were undertaken provided further information on the effects of moderate-intensity exercise training. They also pointed out that this form of exercise decreases inflammation, while at the same time raising IL-10 levels and improving T-cell immunity. Importantly, other studies have also found that while moderate-intensity exercise reduces inflammation for durations of up to sixty minutes, exercise exceeding an hour leads to an inflammation increase. (Stöggl & Sperlich, 2019). IL-10, a well-known anti-inflammatory cytokine, has also been noted to upregulate in response to both HIIE and moderate exercise (Suzuki et al., 2002). Moderate exercise has also been shown to alleviate cytokine storms, at the same time as enhancing WBCs, lymphocytes, and T cells. (Suzuki & Hayashida, 2021). In conclusion, incorporating all these studies, one gets a clear stand that moderate-intensity exercises function as a protective measure against suppression of immunity (see Table 2).

Effects of Intense Exercise Training on the Human Immune System and Athletes

Exercising at higher intensity involves exercising in a zone greater than 70% VO2max. (Laursen & Jenkins, 2002). When one engages in long-term, intense endurance physical exercise, this precipitates changes in some aspects of immune function within days. Sialic acid-binding protein 1 (Sgpa) has shown that neutrophils, natural killer cell function CF, salivary immunoglobulin A, and specific sorts of inflammatory or provocative macrophages are negatively affected by this type of exercise training. (Campbell & Turner, 2018). Further, the open window hypothesis posits that after 3-72 hours of engaging in high-intensity exercise, the host's immune system can become more vulnerable to invasions by pathogens resulting in opportunistic infections. (Pedersen & Bruunsgaard, 1995).

Table 2. Impact of Varying Levels of Activity on the Body's Immune Response Mechanism

Types of Exercise	Intensity of Exercise	Results (outcome)	References
Resistance	Light is used in warm-ups and dwells more on the proper form of exercise (45% 1RM), moderate is used in exercises aiming at building strength and muscles (75% 1RM), and heavy is used in exercises with maximal strength and intensity (95% 1RM).	Interleukin-6 levels increase at moderate and high intensity, specifically at 75% 1 RM and 95% 1 RM respectively, while no change is observed at low intensity, 45% 1 RM.	(Raines et al., 2020)
Resistance and Aerobics	Increase in IL-6 at 75% and 95% 1RM. No change in 45% 1RM	High-intensity resistance training: Rises IL-1 and TNF-α and C-reactive protein. Increased walking IL-10	(Xiao et al., 2020)
Higher intensity	Review study	Physical activity level 46-63% VO2max: Stimulates immune suppressors such as Interleukin-10, Interleukin-6, and Interleukin-7. Vigorous exercise at 64-100% VO2max evokes the production of pro-inflammatory cytokines such as Interleukin-1 beta, Interleukin-6, Tumor Necrosis Factor-alpha, Interleukin-17A, and Interleukin-15.	(da Luz Scheffer & Latini, 2020)
Aerobics	Review study	Moderate exercise at 45-60% of VO2 maximum results in improving immune system status by increasing antipathogen factors, increasing immune suppressors and T-cells specific, and the activation of white blood cells, killer	(Dixit, 2020)

		Lymphocytes, and developed B-cells.	
Aerobics	Walking at a minimum of 60-70% VO2peak.	Raises neutrophil and monocyte	(Highton et al., 2020)
Moderate intensity	Review study	Increases T cells of the immune system, natural killer lymphocytes, neutrophils, monocytes, and B cells	(Sitlinger et al., 2020)
Aerobic	Running on a treadmill at a speed of 3.0 km/h in increments of 1.0 km/h every minute until voluntary over the first 12 weeks of the intervention, then walking or jogging on a treadmill at 45–55% of their VO2max (25–30 min/day, 3–4 days/week), and then exercising at an intensity of 56–69% of VO2max (40–45 min/day, 4–6 days/week) over the final 12 weeks exhaustion. Running at moderate intensity for 20 min at 65–75% of HRpeak Jogging at a level of incline on a treadmill at a speed of 3. 0 km per hour in steps of 1km/h. During the first 12 weeks of the intervention, the patient either walked or jogged on a treadmill at 45 – 55% of VO2max: 25 – 30 mins/day, later exercising 3 – 4 days of the week in the following 12 weeks, the patient was exercised at an intensity of 56 – 69 % VO2max: 40 – 45 mins/day, exercising 4 – 6 days/week. Aerobic exercise: 20 minutes of moderate-intensity continuous running at 65–75% of HRpeak	Raises levels of IL-6, IL-4, and interferon γ. Reduce the level of Interleukin-6, Interleukin-4, and Interferon-y.	(de Souza et al., 2018)
Aerobic	O	Reduced levels of IL-1β, IL-8, TNF-α whilst increased levels of IL-10	(Tartibian et al., 2017)

Respiratory Infections and their Relationship with Exercise

Thus, based on the available evidence, it can be concluded that chronic exercise might increase the vulnerability to upper respiratory tract infections in athletes (Gałązka-Franta et al., 2016). The continuous experience of recurrent infections in athletes is a major challenge, particularly regarding the coronavirus breakout (Hull et al., 2020). Based on these findings, several qualitative and quantitative research studies have re-confirmed that exercise of high intensity, which lasts over 60 to 90 minutes, can negatively impact the immune function (Hekmatikar et al., 2021; Khoramipour et al., 2021). In addition, due to the physical demands of their training for professional sports, other elite athletes who take part in strenuous exercise to prepare for competitions could potentially have increased vulnerability to infections (Monks et al., 2017). One study revealed that shorter, high-intensity training programs over four weeks in swimmers resulted in restlessness in 33% of the total athletes, while 42% of the athletes complained of symptoms of at least URTI. It has become apparent that the functions of the lymphatic system that can force the system of immune may become compromised during periods of vigorous exercise (Born et al., 2017). This cross-sectional study established that allergic rhinitis is common among athletes; especially those who exercise intensively. Elite athletes training for competition exposure expose their bodies to high-intensity exercise which leads to frequent incidences of allergic rhinitis (Katelaris et al., 2000) Therefore, a study done among 216 Olympic athletes found that 56% of them had a history of pink eye, and inflammation of the nose called rhinitis. Asthmatic rhinitis can also reduce the physical capabilities of specialist athletes through slumber disturbances, poor concentration, and decreased fitness (Katelaris et al., 2000). In addition, allergens can induce the airway epithelium to produce other cytokines such as IL-33, IL-25, and TSLP. These cytokines excite the innate submucosal lymphocytes including ILC2 that release interleukin 4 (IL-4), interleukin 5 (IL-5), interleukin 9 (IL-9), and interleukin 13 (IL-13) (Suzuki et al., 2004). Taking these observations into consideration, in association with the so-called "open window" hypothesis, it is quite clear that elite athletes are at a higher risk of developing COVID-19. This further extrapolates the relevance of taking vaccines and providing healthcare assistance during cases of an infection.

Management of Athlete's Infections

High altitude training among high-performing athletes has been linked with vulnerability to viral infections thus leading to a dip in aerobic and anaerobic capacity in such athletes. It is important to note that this vulnerability is even more prominent for people who have been infected with COVID-19 (Grimby, 1962). Efficient management of infections in athletes revolves around a twofold approach, catering to two distinct categories of athletes: the severe infection cases and the mild case ones. For individuals in the first category, who are struggling with viral infections that result from intense exercise and developing severe physiological conditions, a significant first step recommended is the concept of active rest, which entails low levels of exercise (Suzuki et al., 2004). Therefore, a modest resistance training intervention and protein supplementation suggest that such a strategy, which is associated with minimal risks, should be implemented (Gade et al., 2019). On the other hand, traditional training can be considered appropriate for athletes who belong to the second category, and who have only minor symptoms. To avoid worsening the disease, athletes should not stop exercising immediately once they come down with URTI or COVID-19. Discontinuation of exercise during illness also has the likelihood of aggravating the immune system further when one ceases exercising.

Administering Vaccinations to Athletes in Conjunction with Training

The role of vaccination is emphasized in the case of elite athletes throughout the preceding sections of this report. However, one of the common issues that crop up around athlete vaccination is the possibility of the occurrence of complications that are usually linked to the first dose of the vaccine. These side effects can be related to the extent of the vaccine used as well as the kind of vaccine used. (Gleeson & Williams, 2013). The facts reveal that close to 94 percent of athletes suffer from fever, general fatigue, and arm pain lasting for 2 days after the vaccine in currency. (Hull et al., 2022). Therefore, during this duration, it is recommended that the levels of training be reduced for any athletes involved in high-intensity training. After these symptoms have resolved, it is then possible to gradually increase the training intensity. Strength training at moderate to high intensity may be performed up to the day before the second vaccine dose after which, the intensity of training should be reduced. Headaches, chills, fever, and muscle aches are some of the symptoms that elite athletes have been reported to develop when they run a fever for 1- 3 days after the second jab. (Hull et al., 2022). Therefore, exercise intensity needs to be kept moderate until the fourth day after the second dose, though intensity needs to be gradually built up after this time. (Gleeson & Williams, 2013).

Conclusion

The current COVID-19 situation shows that to sustain the physical and athletic performance of elite athletes, it is paramount to balance the exercise load with the immune response. Based on this review, it is apparent that high-intensity training can lead to lower immunity and increased vulnerability to URTI and COVID-19 but switching between training intensities can help in reducing such risks. Primarily, elite athletes should adjust their training, including limiting their workload during times of infection and vaccination. Moderate and mild exercises have been found to enhance immune function and help recovery while the athletes continue with their exercise to enhance their immune strength. Moreover, vaccine side effects should also be considered alongside athletic training schedules for effective vaccination with minimal side effects and shortest recovery time back to peak performance. In conclusion, it can be noted that moderate-intensity training, while taking the health state of the athlete and various external factors, including vaccination, into consideration, plays a key role in achieving higher levels of protection against infections while maintaining the performance capability of the environment.

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