

Respiratory Health of the Ultra-Endurance Cyclists and Runners—A Perspective

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ABSTRACT

High intensity sustained aerobic physical activities like ultra-endurance running and cycling may induce higher intensities of inflammatory and oxidative stress in the body and may cause disturbances in the general immunity and more specifically respiratory immunity temporarily and may also cause some health implications. Also, the chronic high intensity training of these athletes is another aspect that needs much attention. Respiratory tract gets affected severely during these high intensity sustained aerobic activities and may lead to the compromise in the bronchial epithelial integrity, leading to respiratory tract infections, which in turn could induce palpable reductions in the performances of these endurance athletes. Hence, health and performance are the two important factors that are to be considered during the training and competition of these ultra-endurance athletes. The training protocols of these athletes should consider the methods of tackling these inflammatory and oxidative stress both during practice and during competitions. A major recovery method for these athletes may be the proper nutrition program that can provide these ultra-endurance runners and cyclists with proper micronutrients. Special diets consisting of ample anti-oxidant and anti-inflammatory nutrients would certainly help these athletes in this regard. Enough quality protein and energy substrates may also help in the proper synthesis of the cell signaling cytokines and hormones that may protect the immune function of the body. Proper rest periods and proper consolidation of the anti-inflammatory and anti-oxidative capacities through sufficiently long duration training before taking part in such high intensity aerobic activities is highly recommended.

Keywords: Inflammatory stress, Oxidative stress, Respiratory Immunity, Respiratory tract infections, Ultra-endurance running.

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I. INTRODUCTION AND BACKGROUND

It is scientifically proven and accepted that regular exercise seems highly beneficial for the health of individuals. Because of this reason, it seems the individuals are encouraged to participate in sporting events including running and cycling. Though there are several other social outcomes of participation in sports, the main expectation from exercise is certainly the elevated health of the individuals who participate in regular exercise regimens. Participation in sporting events has risen to a different level at present and the competitors are highly motivated and taking a very high risk to win the sports competitions. The money and prestige involved in the sports events at present make the sportsmen undergo severe training protocols and participate in high intensity sporting events. Though there are several studies that indicate that moderate intensity and moderate duration exercises are always beneficial for enhanced immunity and functional health, people are taking up high intensity sustained physical activities for the sake of fitness. There seems some predicament with respect to the effects of high intensity and long sustained duration exercise protocols.

Physical exercise per se is physical stress to the body and would induce physiological stress which may disturb the homeostasis of the body. Physical exercise stress may cause inflammatory stress and oxidative stress upon the tissues of the body. Although controlled or optimal inflammatory and oxidative stress could bring positive changes in the immune metabolism of the body and would cause enhanced immunity among the exercising individuals (Scharhag *et al.*, 2005). Certainly, uncontrolled and/or excessive amounts of inflammatory and oxidative stress may prove fatal to individuals, but there seems no conspicuous quantitative tool at present to understand and measure the levels of inflammatory and oxidative stress happening due to exercise at a particular time. Moreover, the tolerable limits of these stresses by individuals differ significantly due to different issues which may include genetic make-up, lifestyle issues like nutrition

(Pingitore *et al.*, 2015), rest, sleep, emotional stress factors, etc. High intensity sustained aerobic activities like marathon running and ultra-endurance cycling efforts seem to induce higher intensity of inflammatory and oxidative stress upon the tissues of the body (Morici *et al.*, 2016), which may contribute to either suppressed immunity temporarily or could lead to other ROS (Reactive Oxygen Species) prone health issues (Mrakic-Spota *et al.*, 2015). Several studies are supporting the concept that the uncontrolled and very excessive and continuous bouts of inflammation and oxidative stress are to be tackled through the progressive enhancement in the endogenous anti-inflammatory and anti-oxidative capacities through proper and scientific adaptation to such extreme events.

The foremost affected tissue during such activities is respiratory tract tissues as they are exposed to high intensity respiratory processes and thereby causing them to experience higher amounts of inflammation and oxidative stress of the bronchial epithelial tissue in particular (Glen *et al.*, 2018), which might disintegrate the epithelial tissue of the respiratory tract, leading to the disintegration of the mucous layer, which makes the epithelial tissue of the respiratory tract to be prone for pathogen attacks easily, more particularly the upper respiratory tract among such athletes. Additionally, the high intensity of sustained aerobic activities may also cause the suppression of the synthesis of mucosal immune proteins like immunoglobulins (IgA, IgG, etc.), which may also further precipitate respiratory tract health issues.

II. IMPLICATIONS OF HIGH INTENSITY ULTRA-ENDURANCE PHYSICAL ACTIVITIES

Commencement of physical exercise stress induces two metabolic stresses upon the body, inflammatory stress and oxidative stress. These two major stress conditions influence the physiological homeostasis of the being. Inflammation is a natural metabolic consequence in response to the physical stress induced on the tissues of the body, as it is an essential process that would in fact cause the initiation of tissue repair, regeneration and higher adaptations for such epigenetic effects. Human organism can tolerate the inflammatory bouts occurring in the body with its anti-inflammatory mechanisms which are endogenous and can respond to the inflammatory cytokines with optimal anti-inflammatory cytokines. Exercise endocrinology studies indicated that the myokines which are released through the skeletal muscle contraction during exercise have several potential anti-inflammatory responses. Studies in exercise endocrinology also indicate that the anti-inflammatory myokines secreted by the skeletal muscle in fact work even as an autocrine model thereby taking care of the tissues which are under direct stress due to the ultra-endurance physical activity. Myokines also work in the endocrine, paracrine model and hence help in tackling the inflammatory stress of the whole body in general during high intensity sustained aerobic exercises like marathon running and ultra-cycling. Exercise metabolism studies are indicating that sustained high intensity aerobic activities like marathon running and ultra-cycling would cause high amounts of free fatty acids as substrate for energy metabolism, leading to mitochondrial distress and oxidative stress (Vargas-Mendoza *et al.*, 2021). Higher oxidative stress could cause the release of higher amounts of oxidants and free radicals (Lewis *et al.*, 2016) that might make more circulating ROS (Reactive Oxygen Species), which if not properly neutralised through the endogenous anti-oxidative mechanism, could pose a serious threat to the tissue integrity of the body. It is important that oxidative stress need to be under control during physical activity, with proper nutritional support (Stander *et al.*, 2021). Prolonged and high-intensity aerobic activities may cause higher oxidative stress and need more scientific monitoring both during training and during competitions.

III. COMBINED EFFECT OF INFLAMMATORY AND OXIDATIVE STRESS–HEALTH AND PERFORMANCE CONSEQUENCES OF ULTRA-ENDURANCE RUNNERS AND CYCLISTS

Some of the exercise immunology studies are indicating a negative impact on functional health through disturbances in metabolic pathways due to the high intensity sustained exercise programs (Pugh *et al.*, 2021). More particularly the high intensity sustained aerobic exercise activities like ultra-endurance running and ultra-endurance cycling activities and including ultra-endurance swimming. With the increase in passion for participating in marathon running including ultra-endurance marathon running and cycling, it is important to take note of these negative consequences on the health of such competitors (Alena Zekovska *et al.*, 2017). It is also important to note that these highly competitive runners and cyclists are also involved in very high intensity training routines, which may also make them susceptible to immune-related issues thereby causing suppressed immunity and leading to reduced functional health. There have been several scientific explanations for this reduced functional health of ultra-endurance athletes, especially ultra-endurance runners and cyclists (Sadowska-Krępa *et al.*, 2021). One of such explanations has come from the classical open window theory of immunity of ultra-endurance activities, which envisaged that there may be a temporary compromise in the immune levels of the persons who engaged in ultra-endurance sustained high intensity aerobic activities like marathon running. According to this the individuals who are involved

in high intensity aerobic endurance activities like marathon running are prone to easier infection from pathogens like viruses and bacteria immediately post their participation at least temporarily. It indicates that these individuals may be more likely to show pathogen infection symptoms than compared to individuals who do not exercise or who exercise moderately (Scharhag & Kindermann *et al.*, 2005).

The combined effect of inflammatory and oxidative stress due to the high intensity sustained aerobic activities like marathon running and ultra-endurance cycling etc. might cause damage to the various tissues, especially the bronchial tissues of the respiratory tract since the respiratory tract is severely prone to the stress during the high intensity sustained exercises (Elkhatib *et al.*, 2021). Uncontrolled or excessive inflammatory stress due to the high intensity of sustained aerobic activities might cause epithelial tissue damage to the respiratory tracts, especially the upper respiratory tract and exposure to easier infection from pathogens causing respiratory tract infections. Generally, elite marathon runners and long-distance cyclists tend to get involved in rigorous high intensity training sessions quite regularly, exposing themselves to high levels of inflammatory and oxidative stress (Beat Kneschtle *et al.*, 2018). Frequent and excessive exposure to high levels of inflammatory and oxidative stress could induce several negative issues in terms of compromised immunity and functional health of the lungs and the bronchial muscles (Tiller, 2019). There may be several strategies that are existing to either control or to mitigate the negative effects of excessive amounts of inflammatory and oxidative stress, but it would be ideal to monitor properly the symptomatic manifestations of the functional health during the high intensity training and competitions.

The main concerns for the elite ultra endurance athletes, whether it may be during their high intensity extensive training or during the high intensity sustained aerobic activities need to be examined in terms of both health and performance. Excessive or uncontrolled inflammatory and oxidative stress could induce considerable negative effects even on the performances of the elite athletes during their competition. Triggers of uncontrolled and excessive inflammatory and oxidative stress during the training may impair the recovery process and may lead to the plateau in performance. Faulty training programs that might induce excessive stress could cause disturbances in the recovery process of the sportspersons. Consistency in performances may not be achieved due to the severe inflammatory stress of sustained aerobic activities. Long distance runners and cyclists need to be very much cautious about their training and participation programs as the competition performances may get affected due to uncontrolled physiological stress (Scheer *et al.*, 2022).

IV. STRATEGIES FOR COUNTERING THE INFLAMMATORY AND OXIDATIVE STRESS AMONG ULTRA-ENDURANCE RUNNERS AND CYCLISTS

There are several strategies that may help either to reduce or control the negative effects of the high inflammatory and oxidative stress consequent the high intensity training, like proper rest and recovery methods. During the present day hectic scenario of marathon and cycling events, where the events are conducted very frequently or with insufficient time gap that may not give opportunity for full recovery of the ultra-endurance runner or cyclist, it is essential to plan for the comprehensive adaptation of the physiology of the athlete for such high intensity sustained physical efforts. Longer foundation in training might cause sufficient endogenous anti-inflammatory and anti-oxidative capacity in such athletes, which is certainly necessary to tackle the high loads of inflammation and oxidative stress during such aerobic events (Scheer *et al.*, 2021). It is scientific that ultra-endurance athletes like marathon runners and long-distance cyclists need a greater number of years of scientific training before they start participating in such high intensity competitive activities. This caution is more appropriate for recreational marathon runners and recreational endurance cyclists, who are participating in mass events across the globe in quite large numbers. The passion for participation in marathons is picking up globally and these recreational runners need proper monitoring of their training, rest, and recovery methods. Even during the training, it is necessary to have rest and recovery periods properly planned to avoid overtraining and consequent possible immune suppression state of the body. This immune suppression state of the body not only causes several health issues, especially respiratory tract health issues but also may lead to reductions in performance. The chances of the performance reduction of marathon runners or ultra-endurance cyclists may be due to respiratory symptoms consequent from heavy inflammatory and oxidative stress and suppressed respiratory immunity (Pacque & Booth *et al.*, 2007). The possibility is, that though there may be no respiratory infection symptoms, the endurance athletes may still have respiratory capacity problems in their successive endurance activities if no proper recovery is not done.

The recovery methods include support from the sport's nutritional science apart from enough sleep, emotional happiness, free from other stress factors including the negative ambient weather, etc. Proper nutrition management seems a very effective strategy for securing the safety and integrity of tissues that are exposed to high inflammation due to high intensity training (Devrim-Lanpir *et al.*, 2020). Though protection and enhancement of the endogenous anti-inflammatory and anti-oxidative capacities are essential for endurance athletes, many a time, supplementation of these anti-inflammatory and anti-

oxidative nutrients could help in protecting their health as well the performances (Antonioni *et al.*, 2019). Some of the nutraceuticals may be beneficial in this regard. Apart from these anti-inflammatory and anti-oxidative nutrients-containing foods, endurance athletes need enough quantities of carbohydrates and first-class proteins for synthesis and supply of hormones and other metabolic cytokines which are mostly synthesised from the proteins (Gao *et al.*, 2021). Along with the macronutrients, the endurance athletes may need perfect monitoring of their micronutrient needs, especially the metabolism of the minerals like calcium, phosphorous, zinc, etc. as they influence muscle, bone, and nervous system metabolism, which are very much concerned with the overall metabolic signals of the body. Several of the micronutrients are highly responsible for influencing the cell signaling of the body and hence may also influence the anti-inflammatory and anti-oxidative mechanisms in the body (Bester *et al.*, 2021). The possibility of protecting the endurance athlete's health and performances can be greatly increased if a proper nutrition program is adapted by these ultra-endurance runners and cyclists.

V. CONCLUSIONS AND RECOMMENDATIONS

High intensity sustained aerobic physical activities like marathon running, ultra-distance cycling, etc. may induce excessive and/or uncontrolled inflammatory and oxidative stress upon the various tissues of the body that may cause the suppression of immunity, which may cause disturbances in the health of the endurance athletes, especially the respiratory tract health. Disturbances in the bronchial epithelial tissue may also cause reductions in the respiratory capacities temporarily of these athletes and could cause palpable reductions in their performances in their subsequent ultra-endurance physical efforts.

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