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REVIEW

Evaluating the probable effects of the COVID-19 epidemic detraining on athletes' physiological traits and performance

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Abstract The existing Coronavirus disease (COVID-19 outbreak has become the chief health concern all over the world. This universal epidemic with high morbidity and mortality rate affected the sports world as well as other fields of human life. In this situation, the routine and professional training of soccer players has been canceled. alterations in the training features including frequency, volume, and intensity might result in fitness detraining which will definitely have unpleasant effects on their professional life, including alterations in their physiological traits and performance.

The purpose of the current study is to shed light on the probable effects of the COVID-19 epidemic detraining on athletes, in order to persuade coaches and athletes pay more attention to detraining unpleasant effects and make appropriate decisions, and employ effective strategies to reduce and prevent these effects and return to full fitness.

Introduction

Coronavirus, also known as COVID-19 turned into a public health crisis and a global epidemic with a high rate of morbidity and mortality in December 2019 in Wuhan, China.[1,2] Therefore, quarantine is inevitable to prevent the spread of COVID-19, to decelerate the pandemic, and to protect people at higher risk.[3] As a result, not only the major tournaments and sports leagues have been suspended since March 2020 but also most of the training sessions have been canceled. Hence, alterations in the training features including frequency, volume, and intensity might result in fitness detraining.[4]

Detraining is characterized as a complete or restricted loss of training that triggers physiological, anatomical, as well as performance adaptations.[5,6] Since most of the physiological adjustments occur by persistent training, the maintenance of the accomplished level and further improvements need intensive training stimuli. When these stimuli are discontinued, an athlete becomes vulnerable to

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functional and psychic troubles which could be named the syndrome of detraining.[7]

The goal of this brief review is to introduce and reinforce the unfavorable effect of the long-time COVID-19 epidemic detraining period on athletes' physiological traits, performance, and vulnerability that can help coaches and athletes to adopt effective strategies to decrease the possible harmful effects of the detraining duration.

Effect of detraining on athletes' physiological features

Cardiovascular system

Routine dynamic endurance exercise triggers various alterations in the structure and function of the cardiovascular system and increases the blood volume simultaneously. Particularly, the procedure of exercise-induced cardiac remodeling is described by elevated or preserved diastolic function, slight to moderate biventricular eccentric hypertrophy, biatrial dilation, as well as blood volume expansion. Exercise-induced cardiac remodeling has been documented amongst elite athletes[8] and recreational exercisers who perform relatively lower intensities and volumes of exercise.[9] Likewise, it was reported that endurance exercise training in novice exercisers caused a rapid increase in plasma volume precedes a gradual enhancement in red blood cell volume. It was also claimed that elevations in red blood cell volume of 4% could be predictable after 15 weeks of endurance training in exercisers.[10]

Some investigations stated that reductions in chamber size and left ventricular wall thickness observed after periods of detraining among elite athletes.[11,12] Another study that was carried out on recreational marathon runners disclosed that an abrupt and sustained reduction in exercise volume for 8 weeks induces regression in exercise-induced cardiac remodeling and attenuates plasma volume. This regression occurs after distinct structure-specific time courses (early and late) described by early reductions in the thickness and mass of left ventricle wall right ventricle chamber size.[13]

Additionally, it was reported that maximal heart rate increased by 5% over 84 days detraining in endurance-trained athletes.[14] It was also suggested that improved submaximal heart rates, accompanied by a reduced length of the isovolumetric contraction phase time at rest, might be due to an amplified sympatho-adrenergic tone in the detraining period.[15]

Respiratory system

It has been shown that detraining of two weeks or more reduces maximal oxygen uptake ($\dot{V}_{O2\ max}$).[16] This initial rapid decline in $\dot{V}O_2max$ is likely related to a corresponding fall in maximal cardiac output which, in turn, appears to be mediated by a reduced stroke volume with little or no change in maximal heart rate. A loss in blood volume appears to, at least partially, account for the decline in stroke volume and $\dot{V}O_{2max}$ during the initial weeks of detraining, although changes in cardiac hypertrophy, total hemoglobin content, skeletal muscle capillarization, and temperature regulation have been suggested as possible mediating factors.[17] Moreover, an investigation illustrated that detraining for six weeks altered inspiratory flow but it did not influence the inspiratory time, total respiratory cycle, and the overall ventilatory efficiency of the respiratory system.[18]

On the other hand, recent research has illustrated that using masks through a short exercise with an intensity of about 6–8 METS, augments the CO_2 (20%) and attenuates O_2 (3.7%) concentrations and causes hypercapnic and hypoxic breathing in athletes.[19]

Muscular system

Skeletal muscle is able to adapt to inconstant intensities of functional demands. Muscular detraining occurs following inadequate training stimulus period which is characterized by the declined capillary density that might happen within after 2 or 3 weeks of inactivity.[20] A research conducted on semiprofessional soccer players showed that the number of capillaries around slow-twitch fibers reduced significantly after 3 weeks of detraining.[21] It is supposed that muscle capillarization return to pre-training point after training cessation for four weeks, but still above that estimated in sedentary people. Furthermore, after long-term detraining, muscle cross-sectional area reduced and fiber-type returned to genotype, and the population of oxidative fibers in comparison to glycolytic fibers increased in bodybuilders and elite powerlifters. In addition, detraining caused a large conversion from fast-twitch IIa to IIb in cyclists and endurance runners.[15]

Muscle unloading and detraining reduce electromyographic activity and lead to muscle atrophy, which is correlated with a reduction in muscle strength and power.[22] Muscular endurance declines after only 2 weeks of detraining which might be because of declined blood supply to the muscles, muscle glycogen storage and oxidative enzyme activities, as well as disturbed acid-base balance. The detraining effect on agility and speed is small, but the flexibility is lost quickly.[20] Thus the risk of vulnerability increases. To escape injury, athletes must participate in year-round flexibility training.

Besides, training cessation in highly trained athletes affects mitochondrial adenosine triphosphate (ATP) production rate. In this regard, a study examined the influence of detraining on mitochondrial ATP production in human skeletal muscle. The obtained data revealed that a 6-week endurance training followed by a 3-week training cessation protocol caused a 12–28% reduction in mitochondrial ATP production and a 4–17% decrease in mitochondrial enzyme functions[23].

Hormones

It has been reported that detraining for twelve weeks results in a less effective catecholamine response, that means an augmented noradrenaline and adrenaline concentration through sub-maximal exercise at the same relative intensity. To explain in simple words, the same exercise is more stressful after a period of inactivity.[24] Conversely, an investigation on strength-trained athletes indicated some positive hormonal modifications after 2 weeks of detraining, with improved testosterone and growth hormone and reduced cortisol amount in the serum[25] which could be a compensatory response to restrict muscle atrophy.

Metabolic rate

The respiratory exchange ratio is estimated by the consumed amount of oxygen versus the produced amount of CO_2 during exercise and provides a clue of which fuels predominate, carbohydrate, fat, or protein.[26] After detraining, a comparative reduction is seen in energy derived from fat, and an increase in the carbohydrate amount used as fuel during sub-maximal and maximal exercise. In addition, just after a few days of inactivity, detraining resulted in higher blood-lactate concentrations at a lower percentage of $\dot{V}O_{2max}$ in cyclists, swimmers, and in endurance-trained runners.[27]

Detraining effects on performance

Detraining affects endurance performance. For instance, swimmers' performance declines after the off-season training. Detraining in soccer players decreased the time to exhaustion by 24% in five weeks. In addition, long-term inactivity might reduce or even completely reverse training-induced performance advances. Though, a fairly short break is usually not too bad and, in case the preceding training adaptations were reached with long-term training (6−12 weeks), two weeks of inactivity does not seem to cause a remarkable change in time to exhaustion.[28]

Suggestions to avoid detraining adverse effects

It has been claimed that reduced training strategies delay the onset of cardiorespiratory, muscular, hormonal, and metabolic detraining. It seems that maintaining training intensity is an important element for preserving the training-induced performance and physiological adaptations. In order to retain cardiorespiratory endurance, athletes have to train at least three times a week, and the training intensity must be at least 70% of the usual training intensity. In addition, the reduction of training frequency must be more moderate (not more than 20−30%). Performing alternate training types such as cross-training could delay detraining in athletes if similar-mode exercises are performed. However, dissimilar-mode cross-training might also be advantageous to the moderately trained individual.

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