

# Return to football training and competition after lockdown caused by the COVID-19 pandemic: medical recommendations

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**ABSTRACT:** The lockdown caused by the COVID-19 pandemic represents a great unknown regarding the physiological changes induced in elite football players. Although it will differ from country to country, the return to sport for professional football players will follow a forced lockdown never experienced and longer than the normal annual season break. Moreover, in addition to an obvious decrease in performance, the lockdown will possibly lead to an increase of the injury risk. In fact, preseason is always a period with a specific football injury epidemiology, with an increase in the incidence and prevalence of overuse injuries. Therefore, it seems appropriate to recommend that specific training and injury prevention programmes be developed, with careful load monitoring. Training sessions should include specific aerobic, resistance, speed and flexibility training programmes. The aerobic, resistance and speed training should respect some specific phases based on the progressiveness of the training load and the consequent physiological adaptation response. These different phases, based on the current evidence found in the literature, are described in their practical details. Moreover, injury prevention exercises should be incorporated, especially focusing on overuse injuries such as tendon and muscle lesions. The aim of this paper is to provide practical recommendations for the preparation of training sessions for professional footballers returning to sport after the lockdown.

**CITATION:** Bisciotti GN, Cristiano Eirale, Alessandro Corsini et al. Return to football training and competition after lockdown caused by the COVID-19 pandemic: medical recommendations. *Biol Sport*. 2020;37(3):313–319.

Received: 2020-05-13; Reviewed: 2020-06-08; Re-submitted: 2020-06-13; Accepted: 2020-06-25; Published: 2020-06-25.

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**Key words:**

Detraining

Aerobic training

Speed training

Resistance training

Neuromuscular training

Muscle-tendon injury prevention

## INTRODUCTION

In December of 2019, an outbreak of a severe acute respiratory syndrome caused by COVID 19, starting in the Chinese Hubei Province of Wuhan, quickly disseminated to the rest of world. This led to a quarantine enforced progressively by most affected countries. Therefore, from February 2020 onwards, all major sport events were cancelled or postponed, and leagues suspended. In most of the countries, athletes were confined and obliged to train at home, with all the consequent logistic restrictions but especially with the health uncertainty linked to the pandemic. During that period, sport medicine professionals were called to provide advice on the home confined sport activity [1,2] and on the activity restarting [3]. Due to the lack of knowledge about COVID-19, all the recommendations are for the moment difficult; therefore the principle of “maximal caution” has been evoked [3]. Although it will differ from country to country, the return to sport for professional football players will follow a forced lockdown never experienced and longer than the normal annual

season break. Moreover, the situation is different than in regular pre-season preparation as probably most teams will start to train in small groups and no friendly match will be initially allowed. For these reasons, the return to play should focus not only on the precaution related to COVID-19 but also on the preventive strategies for avoid-injuries and illness related to this unprecedented situation.

Recently, some authors have advanced the hypothesis that the sharing of information is more helpful than providing generic training recommendations on return to play after the COVID 19 confinement [4]. We feel that providing recommendations is important because, even if an individualized approach were the best solution, it should still be based on specific modifications of evidence-based general guidelines. Otherwise, all guidelines currently present in medicine would have no value. Also, the utmost attention must always be paid not to confuse anecdotes with evidence. For these reasons, the aim of this paper is to provide practical recommendations to

professional footballers returning to sport after the lockdown, without denying the importance of the individual approach.

#### *Effects of confinement on training*

Detraining is a physiological effect well known in the literature. The term detraining means the partial or complete loss of previous physiological adaptation to physical exertion caused by a period of training interruption [5]. In general, a few weeks of inactivity or lower level activity are sufficient for the decline of physiological capabilities, unless specific programmes of training are carried out [6]. Detraining causes changes of body mass and composition, a loss of efficiency of neuromuscular and cardiovascular systems and, consequently, a loss in strength, speed, flexibility and endurance and an increase of the risk of injury [7].

During the traditional season, the detraining experience occurs at the end of the league competition or because of an injury or illness. These detraining situations are common and are not comparable to the situation caused by the confinement due to the COVID-19 pandemic, despite the home training performed [1].

#### *Return to sport after inactivity*

Due to the inactivity during the season break, preseason is always a period with a specific football injury epidemiology, with an increase of overuse injuries' incidence and prevalence. [8]. Moreover, there is evidence of a preventive effect of training during preseason on in-season injuries [9].

The return to sport after a lockdown period can be even more impacting because of 3 main reasons:

- The lockdown does not correspond to the classic off-season period due to all the physiological and psychological constrictions related to confinement.
- The next preseason will probably differ from normal. Indeed, in some countries it will possibly correspond to a congested period, with a potential increase of injuries [10].
- In the case of a congested period, the acute versus chronic workload ratio, estimated to be a risk factor of injuries [11], will be elevated with a consequent increase of injury risk.

For these reasons, we may speculate that the incidence of injuries at the return to play may be impacting. Moreover, the lack of possibility of performing an adequate preseason-training programme, and the long period of detraining, may expose the footballers to more injuries during the regular season.

Therefore, it seems appropriate to recommend that specific training and injury prevention programmes be developed, with careful load monitoring.

#### *Aerobic training*

The reduction in aerobic performance occurs after stopping intense aerobic exercise for a few weeks [12]. A period of 2-4 weeks of detraining causes a quick initial decrease in  $VO_2max$  followed over the longer term by a decrease of blood volume together with a de-

crease in haemoglobin content. These physiological changes cause a decrease in muscle capillarization and a loss of efficiency of the body temperature regulation mechanisms [13, 14]. If the detraining period lasts longer than four weeks, in addition to a further decrease in  $VO_2max$ , a reduction in arterial-venous oxygen difference is observed, which, in turn, implies a change in maximal oxygen delivery to the skeletal muscles and a decrease in haemoglobin content [13,14]. Furthermore, after a detraining period longer than one month, a decrease in skeletal muscle oxidative enzyme activity is observed [13,14]. This important mismatch of the aerobic system, both from the central and the peripheral point of view, requires attention to some important points during the re-training phase. It has been recommended that the re-training could start only after the player has undergone the post-COVID-19 pre-competition medical assessment [3]. Based on these profound physiological changes, both central and peripheral, of the aerobic system, the training period should be based on a careful choice of intensity, volume and type of training. For this reason, we suggest that aerobic training be based on three different phases, characterized by a different type of work in order to stimulate the aerobic and anaerobic system with increasing intensity. The retraining period should start with a first phase based on interval training sessions based on 45-90 seconds of running at about 80-85% of the maximum aerobic speed (MAS, i.e. the minimum speed corresponding to the  $VO_2max$ ) interspersed with running phases performed at active recovery speed (50-60% of  $VO_2max$ ) [15]. The total duration of the training sessions should not be less than 20 minutes [16]. After this first period of basic adaptation, a second period based on intermittent training of increasing intensity (from 100 to 115% of the MAS) should follow. Therefore, in this second phase the physiological demand shifts from a purely aerobic mechanism to a mixed aerobic-anaerobic mechanism, with a greater progressive involvement of the lactic acid anaerobic system [17]. The recommended types of interval training are 30"/30", 20"/20" and 10"/10" (and related variations). The recommended intensity are from 100% of the MAS (for 30"/30") to 115% of the MAS (for 10"/10"). The total durations of the recommended series range from 10 minutes (for 30"/30") to 6 minutes (10"/10"). The total volume of the training should involve at least 3 sets of intermittent training per session. Furthermore, at the beginning the recovery should be passive, while in a second time the recovery should be active, i.e. carried out at a running speed equal to about 50-60% of the MAS [17,18]. Finally, high intensity ball exercises should only be performed in a third period following the first two adaptation periods mentioned above.

#### *Resistance training*

The human muscle fibres are classified by several methods including histochemical methods, the speed of twitch contraction, the fatigability, the dominant fibre enzymatic pathway and the isoform expression of the myosin heavy chain (MyHC) [19-22]. The MyHC isoform expression it is the most used classification method. The

human skeletal muscle shows three different types MyHC: type I, type IIa and type IIx. The so-called “pure fibres” express a single MyHC isoform, while the so-called “hybrid fibres” show co-expression of multiple MyHC isoforms [22]. In agreement with this classification method, the human skeletal muscle fibres are subdivided into three different categories. The type I fibres (also called slow twitch fibres) have slow contraction and predominantly oxidative metabolism. The type IIb and IIx fibres (also called fast twitch fibres) have fast contraction and predominantly glycolytic metabolism. The human skeletal muscle fibres show high plasticity that is correlated with mechanical stimulation (i.e. training and de-training) [23,24], hormonal influence [25] and aging [26]. Physical exercise, and consequently the de-training phenomenon, may induce change in muscle fibres' transition. Indeed, chronic muscle stimulation causes an increase of cytosolic free  $Ca^{2+}$  [27]. PPP3CA (also called calcineurin), a protein with phosphatase activity controlled by intracellular calcium, has a main role in fibre type gene regulation. Calcitonin up-regulation increases type I fibre gene activity, whereas calcitonin inhibition increases type II fibre gene activity [28]. Resistance training involving high intensity contractions is able to increase muscle mass inducing hypertrophy. Since the long detraining period caused by lockdown due to the COVID-19 pandemic may have caused both a loss of muscle mass (atrophy) and a decrease or a loss of the fast fibres' particular characteristics, we suggest organizing the resistance training in two periods.

The first period, which should be composed of at least 10 training sessions, should be focused on the recovery of muscle hypertrophy. The external load adopted for the training in this period should be between 70 and 75% of the maximal load and the series should be composed of 8-10 repetitions. The rhythm of execution should be slow and controlled [29,30]. It is important to remember the relationship between strength and hypertrophy. Indeed a period of 8-12 weeks causes a loss of muscle mass (on average 0.6% per day starting from 15 days of inactivity) [31]. This loss of muscle mass is the cause of a contextual loss of muscle strength ranging between 7 and 12% [31]. For this reason, the recovery of muscle mass is the first important step on which to base the resistance training [32].

The second period should be based on selective stimulation of the fast twitch fibres. Indeed, several studies have shown a decrease in fast twitch fibres after a detraining period in footballers, swimmers and weightlifters [14,33]. During this second training period, the external load should be between 50 and 85% of the maximal load [34]. The executive rhythm should be at maximum speed (i.e. maximal power output) and the series must be stopped when the execution speed (or power production if the training is monitored) decreases over an established limit. It is possible to maintain this type of training also during the in-season period [35]. Furthermore, as a final but not least important recommendation, we suggest the inclusion (starting from the second period) of exercises based on eccentric contraction in the resistance training plan. Indeed, ec-

centric exercises are particularly effective both for the prevention of muscle injuries and for the increase in maximal strength [36].

### *Speed and explosive strength training*

There is evidence that 4 weeks of detraining in a soccer player population cause an increase in the time of 20 and 30 m sprint and in the performance of an agility test [37]. Considering both these data and that a long detraining period, such as that caused by the COVID-19 pandemic, can result in a decrease in the number of fast twitch fibres [14,33], it is reasonable to expect a noticeable loss of athletic speed skills. Since several studies have shown a close relationship between maximal speed values and muscle power values [38-40], we suggest structuring the speed training in three phases as follows:

The first phase should be focused on exercises allowing maximal power production of the lower limb. The exercises may be of general or specific type. The general exercises (leg press, squat, squat jump) should respect the same rules already specified for the second period of resistance training. The specific exercises consist of sprint with tow, uphill-sprint, etc; in the other term the specific exercises are based on different types of sprint. It is important to underline that this training period should be preceded by an initial period of resistance training focused on the recovery of muscle hypertrophy [41].

A second phase based on plyometric training [42,43]. In soccer the ability to perform sprinting, kicking, changing of direction, jumping and in general rapid action is paramount to optimize the performance [44]. A large number of soccer specific movements are constituted by a rapid stretch-shortening cycle (i.e. a succession of quick eccentric and concentric phases) [45]. Plyometric training is able to improve exercise performance involving the stretch-shortening cycle of a muscle-tendon unit [45]. For this reason, plyometric training may be considered a correct and useful method to develop explosive strength [42,43,46].

A third phase based on repeated sprint ability training [47]. Soccer performance is characterized by short duration sprints interspersed by short recovery [48]. The repeated sprint ability is the capability to perform the best possible sprint performance during a series of short sprints, whose duration is 10 seconds, separated by a short period ( 60 seconds) of recovery [49]. Therefore, repeated sprint ability requires a “physiological mix” between power production (i.e. the sprint speed) and endurance (i.e. the recovery between the sprints) [50]. More precisely, repeated sprint ability is based on a complex relationship between metabolic aspects, such as oxidative capacity, phosphocreatine recovery and  $H^+$  buffering, and neural factors such as muscle activation and a neuromuscular recruitment strategy [47]. To date, in the literature several studies have reported the importance of a specific training programme focused on repeated sprint ability improvement in soccer [47-51].

### *Flexibility*

Flexibility is the capacity to reach an optimal joint range of motion. It depends on several factors linked to different anatomical structures such as bone, the muscle-tendon unit and connective tissue [52]. Some authors report a decrease in flexibility after 8 weeks of detraining [52]. Stretching is a hotly debated topic in the literature. Many studies have highlighted the possible negative effect of static stretching on dynamic performance [53,54]. However, there are also some studies that show no negative effects of static stretching on dynamic performance. It is likely that stretching of short duration (lasting up to 30 seconds) inserted in a warm-up session may not have a negative effect on the subsequent dynamic performance, especially in a highly trained population [55]. On the other hand, dynamic stretching does not show a negative effect on dynamic performance. Indeed, dynamic stretching seems to have a positive effect on the neuromuscular system, providing a performance enhancement [55]. However, it should be stressed that static and dynamic stretching probably have two different application rationales. Regular practice of static stretching is able to increase the joint range of motion (ROM). To have an optimal ROM is an important factor for acquisition of the benefits associated with flexibility in particular sport activities [56]. On the other hand, dynamic stretching shows its optimal application in the warm-up [57]. Indeed, an optimal warm-up should be structured by sub-maximal aerobic activity, dynamic stretching and sport specific dynamic exercises [55]. For these reasons, we suggest early introduction in the training plan of stretching exercises involving the major muscle groups, performed both in static and dynamic conditions [56].

### *Prevention of muscle injuries*

There is evidence that muscle performance is maintained for up to 4 weeks of inactivity, but in elite athletes the eccentric strength and sport-specific power may decrease remarkably [58]. Hwang *et al.* [59] stated that the period is even shorter (2 weeks). Inactivity leads to a reduction of fibres' cross sectional area (atrophy) [60] but also to a change of their composition [61]. Indeed, fast type fibres (type II) may undergo a transformation into slow type fibres (type I). This modification further affects muscle performance especially in terms of strength [61] and speed. This importantly impacts footballers, due to the physiological demands of the game that requires fast accelerations and high speed. For this reason, at the return to play, muscle testing should be performed, especially focusing on the research of eventual atrophy and loss of strength and speed. In the case of atrophy, we recommend complementing the training programme with specific exercises. Finally, it is important to remember that the so-called "multicomponent prevention programmes" seem more effective than the "single-component prevention programmes" especially in joint injury prevention [62-64]

### *Prevention of tendon injuries*

Some authors have reported an increase in Achilles tendon injuries

following the National Football League lockdown (March 11th to July 25th, 2011) [65]. There is evidence of the deleterious effect of detraining on the lower limb tendon biological characteristics [66]. Indeed, the rate of tendon collagen synthesis decreases over time during a period of disuse or detraining [66]. Some authors showed that, after a period of 23 days of unilateral lower leg suspension at the patellar tendon level, it is possible to observe a fall in the rates of myofibrillar protein synthesis, a decrease in tendon collagen synthesis and a decrease in focal adhesion kinase (FAK) phosphorylation [66]. Other studies show that a period of detraining causes important modification in collagen type I and III synthesis, collagen organization, tendon vascularity and proteoglycan content [67-70]. This sequence of biological and structural alterations causes a decrease in the tendon mechanical resistance that is particularly evident at the Achilles and patellar tendon level. For these reasons, we suggest that the sport activity should be restarted with caution after a long detraining period, to avoid an increase of tendon pathology and/or tendon injuries caused by the modification in tendon metabolism induced by detraining [68,69]. Another important point to underline is that in the literature there exists evidence on the increasing risk of development of Achilles tendinopathies or rupture for subjects belonging to blood group O [71-74]. Indeed, subjects belonging to blood group O show much higher N-acetylgalactosamine transferase activity than in subjects belonging to groups A and B [71]. This increased N-acetylgalactosamine transferase activity would result in an increase in type III collagen and in a consequent imbalance in the ratio type I collagen / type III collagen. Since type III collagen shows less resistance to mechanical stress compared to type I collagen [75], its abnormal collagen III proliferation may expose subjects to tendinopathy or spontaneous tendon rupture [73,76-78]. For this reason, players belonging to blood group O may have increased injury risk.

### *Neuromuscular prevention*

Insufficient neuromuscular control during dynamic movements may be a major injury risk factor [79-81]. Poor neuromuscular control may cause motion asymmetry and inefficient movement strategies following muscle or joint injuries [82]. Indeed, especially during the rehabilitation period following muscle or joint injury a symmetrical lower limb motion and an appropriate movement pattern are necessary both to reduce re-injury risk and to improve the athletic performance. Furthermore, even in a healthy athlete, a loss of neuromuscular control may expose the subject to deleterious load that he is not able to control [83,84].

The drop in muscle strength during immobilisation is more important than the loss of muscle volume; moreover, it occurs faster. For this reason, muscle strength is influenced not only by the cross sectional area and the characteristics of the muscle itself but also by neural mechanisms, especially during the first phase of immobilisation [60].

To our knowledge, in the literature there are no studies focused on the loss of efficiency of the neuromuscular system after a long



detraining period such as that imposed by the COVID-19 pandemic. It is however reasonable to suppose that a lack of specific stimuli for such a prolonged period may have deleterious effects on the neuromuscular system, exposing the players both to a greater injury risk and a decrease in performance. Therefore, we recommend executing single-leg exercises in dynamic movements, reaction to unforeseen functional circumstances, proper landing, leg and foot positioning, as well as improving resistance to neuromuscular fatigue, proprioception, muscle activation, and inter-joint coordination [85].

### CONCLUSIONS

The lockdown caused by the COVID-19 pandemic represents an unknown factor regarding the physiological changes induced in elite athletes. Indeed, except for the National Football League lockdown, to find a similar suspension of sporting activity we have to go back

to the times of the Second World War. Therefore, there are no evidence-based strategies for the return to sport activity. For this reason, without denying the importance of serious and correct sharing of information, the latter must be carefully checked before being put into practice. It is therefore obvious that further studies are warranted on the subject. The problems we will have to face are manifold: the loss of performance, the increase of injury risk and the consequences of important systemic changes. All this will also be further complicated by the fact that we will have an extreme need for a return to normality in an extremely short time. For all these reasons, to date, the only certainty is that it will be a very demanding challenge for everyone.

### Conflict of interest

All authors declare having no conflict of interest.

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