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CURRENT OPINION

The Transition Period in Soccer: A Window of Opportunity

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Abstract The aim of this paper is to describe the physiological changes that occur during the transition period in soccer players. A secondary aim is to address the issue of utilizing the transition period to lay the foundation for the succeeding season. We reviewed published peer-reviewed studies if they met the following three selection criteria: (1) the studied population comprised adult soccer players (aged >18 years), (2) time points of physiological and performance assessments were provided, and (3) appropriate statistics for the calculation of effect sizes were reported. Following two selection phases, 12 scientific publications were considered, involving a total sample of 252 players. The transition period elicits small to moderate negative changes in body composition, a moderate decline in sprint performance with and without changes of direction, and small to moderate decrements in muscle power. Detraining effects are also evident for endurance-related physiological and performance outcomes: large decrements in maximal oxygen consumption ($\dot{V}O_{2max}$) and time to exhaustion, and moderate to very large impairments have been observed in intermittent-running performance. Off-season programs should be characterized by clear training objectives, a low frequency of training sessions, and simple training tools in order to facilitate compliance. The program suggested here may constitute the 'minimum effective dose' to maintain or at least attenuate the decay of endurance- and neuromuscular-related performance parameters, as well as restore an adequate strength profile (reduce muscle strength imbalances). This periodization strategy may improve the ability of players to cope with the elevated training demands of pre-season training and therefore reduce the risk of injury. Moreover, this strategy will favor a more efficient development of other relevant facets of performance during the pre-competition phase (e.g., tactical organization). We contend that the transition period needs to be perceived as a 'window of opportunity' for players to both recover and 'rebuild' for the following season.

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Key Points

The transition period should be viewed as a 'window of opportunity' for players to recover and to 'rebuild' for the following season.

Coaches should adopt a holistic view (e.g., social factors, training background) when defining the individual training variables (e.g., frequency, volume, intensity) and modality of the exercise intervention.

An individualized training program during the off season may represent an adequate methodological and physiological strategy favoring a more efficient periodization of the subsequent pre-season phase.

1 Introduction

The soccer season is commonly planned in three distinct periods: the pre-competition, competition, and transition periods. The duration of each period is influenced by intrinsic (e.g., environmental conditions) and extrinsic factors (e.g., international competitions). For instance, some leagues comprise two distinct cycles of pre-competition, competition, and transition periods. Nevertheless, the most frequent scenario is that after 10–11 months of training and competition [1], players undertake a period of rest typically lasting 4–6 weeks; the so-called transition or off-season period.

Despite the general increase of training and competition demands over time, the transition period is generally characterized by a complete cessation of, or substantial reduction in, training [2, 3]. In some cases, players might be involved in sport activities and/or voluntary non-periodized training. The duration of the cessation period, the magnitude of decrement in training impulses, and the players' fitness levels will modulate the kinetics of alterations to body composition and physiological functions; ultimately, this may lead to a partial or complete loss of some training-induced adaptations [2, 3].

According to Mujika et al. [2], detraining can be divided into short term (<4 weeks) and long term (>4 weeks). Importantly, detraining effects may influence how players prepare during pre-competition and potentially affect their performance levels in the first matches of the competition period [4]. In fact, pre-competition periodization is affected by players' physical performance and physiological status at the start of the season. For instance, following significant detraining during the transition period, additional physical training may be required, which may be detrimental to other dimensions of performance (e.g., team tactical organization). Furthermore, the pre-competition period is commonly characterized by a high frequency of training sessions. Players are typically exposed to friendly games after a short period of returning to training (7–10 days) and are subjected to more rapid increases in training load compared with other periods [5, 6]. Moreover, clubs' commercial obligations may see many players travelling and competing frequently within the pre-season, limiting structured training and recovery opportunities within this important period; all these factors contribute to substantially increasing the psychological and physiological stress of the pre-season period [7–9]. The development of fatigue during such intensified phases impacts players' responses to training demands (e.g., how players understand the tactical tasks within the global team organization). Moreover, excessive fatigue may also compromise the capacity of players to tolerate and recover from the typically higher training loads, and consequently affect the odds of injury. It should be noted that rapid increases in training load (e.g., training load = rating of perceived exertion × training duration), particularly during pre-season training, have been associated with increased risk of injury [10]. Moreover, training intensity [e.g., accumulated time spent >85 % of maximal heart rate (HR_{max})] and volume (accumulated training hours) are key variables in characterizing players' training load and have been recently associated with injury incidence in professional football players [6]. Assuming complete cessation of training during the transition period, the pre-season period represents a triad of risk factors: high training volumes, high training intensity, and a rapid increase in training load relative to recent exposure [6, 11].

Despite the consensus that 'optimal' fitness development requires variability in training stimuli, elite players may be persistently exposed to high training loads during pre-competition; internal and external load variables have been reported as being constant within the different pre-competition microcycles during pre-season periodization [12]. Notwithstanding these data, the transition period remains the least examined and understood phase of the soccer season. Here, we discuss the physical, physiological, biochemical, and performance alterations that occur during transition periods. We contend that the transition period should be viewed as a window of opportunity for players to recover and to 'rebuild' for the following season. A complete cessation or near absence of training stimuli might not be beneficial or appropriate for all players. We begin by examining the magnitude of decrements in physical performance and physiological parameters observed from pre- to post-transition. Following this, we present evidence-based guidelines for a periodized transition program.

2 Methods

2.1 Search Strategy: Databases and Inclusion Criteria

We selected studies in two consecutive screening phases. The first phase consisted of identifying articles through a systematic search using the US National Library of Medicine (PubMed), MEDLINE, and SPORTDiscus databases. Literature searches comprised scientific publications from April 2000 to January 2015. The following keywords were used in combination: 'elite soccer', 'professional soccer', 'highly trained players', 'seasonal alterations', 'performance analysis', 'soccer physiology', 'football', 'detraining', and 'training cessation'. We further searched the relevant literature using the 'related citations' function of

PubMed and by scanning reference lists. In the second phase, we reviewed published peer-reviewed studies if they met the following three selection criteria: (1) the studied population comprised adult soccer players (aged >18 years), (2) time points of physiological and performance assessments were provided, and (3) appropriate statistics for the calculation of effect sizes were reported. Following the two selection phases, 12 scientific publications (ten journal articles, one PhD thesis, and one conference communication) were considered, involving a total sample of 252 adult soccer players.

2.2 Data Extraction and Presentation

Data related to the players' physiological parameters (e.g., % body fat) and performance parameters (e.g., soccer-specific endurance tests and jump tests) were extracted and presented as the percentage of change (PC) = (post-test mean − pretest mean)/pretest mean × 100. We assessed the magnitude of the changes using effect sizes (ES) = (post-test mean − pretest mean)/pretest standard deviation [13]. We obtained 52 ESs, threshold values for which were 'trivial' (<0.2), 'small' (0.2–0.6), 'moderate' (0.6–1.2), 'large' (1.2–2.0), and 'very large' (>2.0) [14].

3 Physiological and Performance Changes

3.1 Body Composition

It is common that the off-season break negatively influences players' body composition. Trivial to small increases in the percentage of body fat (%BF) in professional (PC = 0.8–3.0 %; ES = 0.2–0.5; Fig. 1) [15–18] and in semi-professional (PC = 0.6 %; ES = 0.2) [19] players have been reported. Moreover, moderate decreases in lean body mass (LBM; PC = −3 %; ES = −0.5) [15] and large decrements in fat-free mass (FFM) were detected in professional players (PC = −6.6 %; ES = −1.3) [20]. However, the ability of off-season training programs to prevent these changes has received little attention. A 4-week off-season multi-component training program comprising 22 sessions of general strength training and gymnastic exercises, low-intensity running, and stretching routines might prevent negative changes in body composition compared with no structured training program [16]. Body mass increased from 78.1 ± 4.8 to 78.7 ± 5.0 kg (PC = 0.8 %; ES = 0.1) in the training group, but greater increases were detected in the control group (from 76.5 ± 2.7 to 77.9 ± 2.8 kg; PC = 1.9 %; ES = 0.5) [16]. Similarly, %BF increased by 0.3 % (ES = 0.2) in the training group and by 0.8 % (ES = 0.5) in the control group [16].

3.2 Neuromuscular Performance

In terms of long-term neuromuscular detraining, trivial to small changes in force production at low and moderate angular velocities occur after 4 weeks of detraining (30 min jogging at approximately 60 % HR_{max}, three times a week) in professional players [21]. Nevertheless, the deleterious effects may be more pronounced at higher shortening velocities (60° s^{-1} and 180° s^{-1}; PC = 0.1 % and ES = 0.01 vs. PC = –3.4 % and ES = −0.3, respectively) [21]. This position is further supported when considering other reports tracking seasonal alterations in force production capacity of professional players [22]. Trivial changes in jumping ability evaluated by the countermovement and squat jump tests have also been reported (PC = −0.3 % and ES = −0.03 vs. PC = 1 % and ES = 0.1, respectively) [21]. Nevertheless, 6–8 weeks of detraining was associated with moderate reductions in countermovement jump (PC = −4.6 to −6.3 %; ES = −0.5 to −0.8) and squat jump height (PC = −6.1 to −7.1 %; ES = −0.7 to −0.9) in professional players [17]. Short distance (10-m sprint time: PC = 2.9 %; ES = 0.7–0.8; 20-m sprint time: PC = 1.3–1.7 %, ES = 0.7–0.8) [17] and long-distance sprint performance (50-m sprint time: PC = 7.4 %, ES = 1.0) [18] seem to be moderately impaired after 3–6 weeks of detraining in professional players. Similar trends were also observed in semi-professional players after 8 weeks' detraining (15-m sprint time: PC = 3.3 %; ES = 0.9) [19]. Additionally, assessment of change of direction ability using the Illinois agility test revealed moderate performance declines in semi-professional players (PC = 1.6 %; ES = 0.7) [19].

3.3 Aerobic Fitness

Detraining during the off-season period is also detrimental to other physiological and performance measures (Fig. 1). The transition period leads to a decrease in maximal oxygen consumption ($\dot{V}O_{2max}$; PC = −3.5 to −6.1 %; ES = −0.5 to −3.0) [16, 17, 19, 23]. Sotiropoulos et al. [16] reported that a 4-week transition period training program undertaken by professional players did not prevent decreases in $\dot{V}O_{2max}$. However, players who did not perform any structured training during the transition period had a greater decline in $\dot{V}O_{2max}$ than those who followed the structured training (PC = −6.1 % and ES = −1.4 vs. PC = −1.4 % and ES = −0.3, respectively). In contrast, Slettalokken et al. [24] recently showed that the off-season decline in aerobic fitness can be prevented by adding a low-frequency high-intensity training stimulus (five bouts of 4 min at 87–97 % of peak heart rate) during a 6-week off-season period in semi-professional players. One

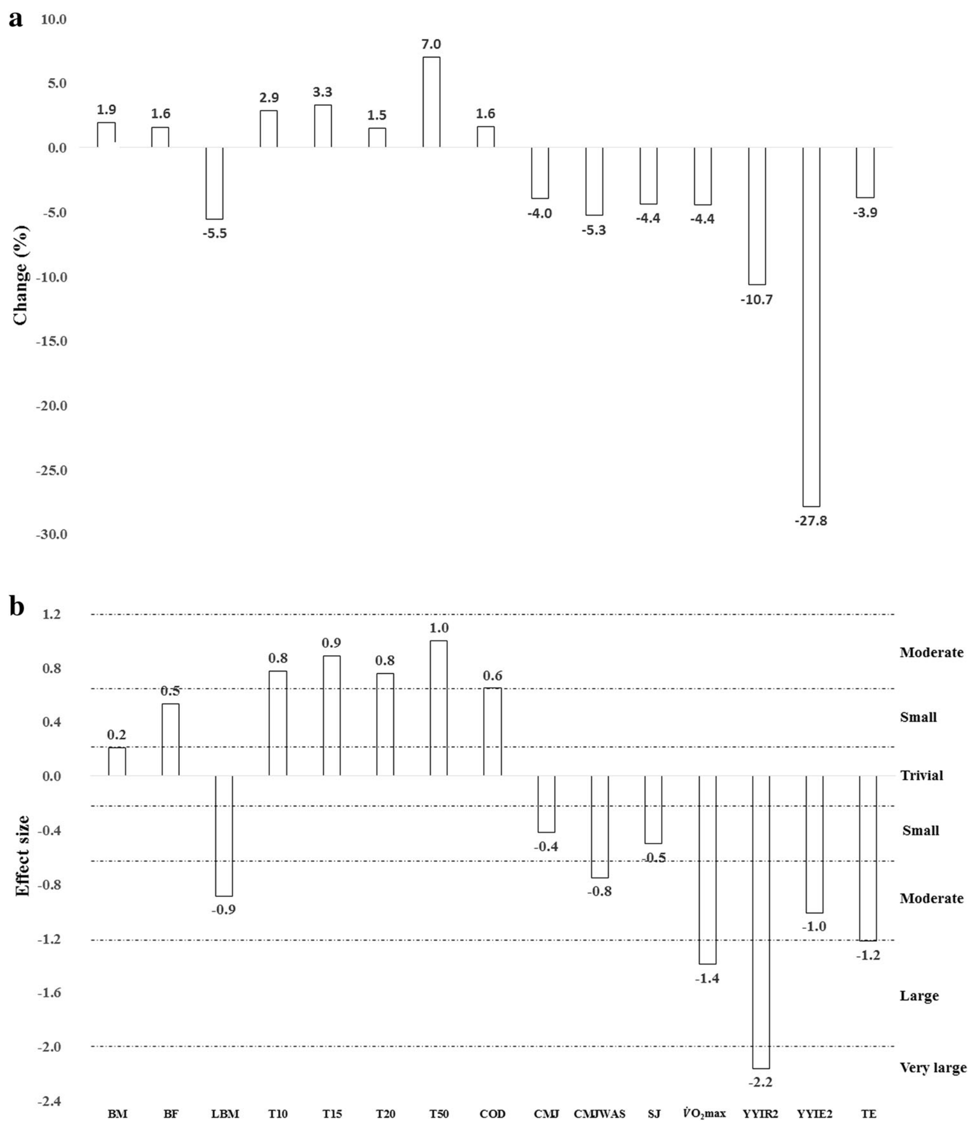

Fig. 1 **a** The effect of detraining (3–8 weeks) presented as mean percentage of change and/or average weighted mean percentage of change. **b** Overall effect sizes (mean) for body mass (BM) [15–17]; percentage body fat (%BF) [15–17, 19]; lean body mass (LBM) [15, 20]; 10-m [17], 15-m [19], 20-m [17], and 50-m sprint times (T10–T50) [18]; change of direction ability (COD) [19]; countermovement jump without (CMJ) [17, 21] and with arm-swing (CMJWAS) [19]; squat jump (SJ) [17, 21]; maximal oxygen consumption ($\dot{V}O_2$max) [16, 17, 19, 23]; time to exhaustion (TE) [23]; Yo–Yo Intermittent Recovery Test—level 2 (YYIR2) [28]; Yo–Yo Intermittent Endurance Test—Level 2 (YYIE2) [29]

high-intensity training (HIT) session every second week (PC = 1 %, ES = 0.1) or one HIT session per week (PC = −2 %, ES = −0.6) effectively prevented a significant decrease in $\dot{V}O_{2max}$ in soccer players [24]. Off-season deconditioning is also reflected in decreased time to exhaustion during incremental tests (PC = −3.9 %; ES = −1.2) [23], as well as a reduced ability to perform at sub-maximal intensity. Christensen et al. [25] observed that only 2 weeks of inactivity during the off-season period resulted in lower $\dot{V}O_2$ kinetics (at 75 % maximal aerobic speed) as evidenced by an increased time constant (τ) (PC = 10.7 %; ES = 0.9). This general attenuation of the $\dot{V}O_2$ response dynamic reduces the contribution of oxidative phosphorylation for adenosine triphosphate (ATP) resynthesis [26] and increases the accumulation of fatigue-related metabolites (H^+ and P_i) [27]. In addition, Mohr et al. [23] observed that the off-season resulted in an increased heart rate at running speeds of 10, 14, and 17 km·h^{-1} (PC = 6.1 % and ES = 2.0; PC = 4.4 % and ES = 1.4; and PC = 2.8 % and ES = 1.7, respectively). Therefore, coaches should expect an altered external: internal load ratio when players return to training, which has obvious consequences in the high-loading phase of pre-competition (e.g., reduced economy, increased fatigue and psychophysiological responses to a given training load).

For this purpose, HIT impulses during the off-season period might be needed to counteract decrements in soccer-specific fitness. Long-term detraining impairs performance during soccer-specific endurance tests such as the Yo–Yo Intermittent Recovery Test—level 2 (YYIR2, PC = 10.7 %; ES = −2.2) [28] and the Yo–Yo Intermittent Endurance Test—level 2 (YYIE2, PC = 28 %; ES = −1.0) [29]. In fact, a short-term 2-week detraining period significantly impaired YYIR2 performance (PC = −23 %, ES = −1.2) and total time to perform a repeated sprint (RS) test (10×20 m/15-s recovery; PC = 2.1 %; ES = 0.7) [25]. This decreased ability to perform high- to very high-intensity exercise (e.g., RS) may result from the aforementioned impairments in some neuromuscular (e.g., sprint speed) and endurance determinants of high-intensity exercise (e.g., $\dot{V}O_2$ kinetics) [30]. Given the established associations between physical match performance and Yo–Yo tests, it is assumed that the reduction in Yo–Yo test performance translates into lower match running performance [31].

The benefits of performing an off-season organized training plan is indirectly supported by a study by Boullosa et al. [32]. During the final 5 weeks of the transition period, after 18 days' rest, players performed 21 individualized conditioning sessions (strength, endurance, and proprioceptive-based exercises). After 8 weeks of pre-season training, no pre- to post-preseason improvements were observed in either specific (YYIR1: 2475 vs. 2600 m; PC = 5.1 %; ES = 0.3) and non-soccer-specific [maximal aerobic speed (MAS); 18.1 vs. 18.2 km·h^{-1}; PC = 0.6 %; ES = 0.1) endurance performance. Therefore, it can be concluded that organized, individualized conditioning sessions were as key to enabling players to maintain their ability to perform intermittent endurance exercise as their physiological determinants (e.g., $\dot{V}O_{2max}$ and running economy). In fact, players started the season with high levels of soccer-specific endurance (YYIR1, 2475 ± 421 m); pre-season values of professional players have been reported to range from 1510 to 2000 m [33–35] and from 15.9 to 16.1 km·h^{-1} [35, 36] for YYIR1 and MAS, respectively.

4 Biochemical Changes

Detraining can lead to changes in the cellular and blood biochemical milieu. Short-term detraining (2 weeks) decreased muscle oxidative capacity, via reduced muscle pyruvate dehydrogenase activity (17 %), and maximal activities of citrate synthase (12 %) and 3-hydroxyacyl-CoA (18 %) [25]. A decrease in muscle oxidative capacity may have a detrimental effect on players' ability to perform and recover from intense exercise via reduction in phosphocreatine (PCr) resynthesis rate and increasing the contribution from anaerobic sources [25–27, 30]. Alterations in blood redox states indicative of a decrease in antioxidant status capacity have also been observed; a decrease in the first line of antioxidant enzymatic defense against superoxide radicals (superoxide dismutase activity) has also been reported after a 6-week off-season period [37].

Biochemical monitoring has shown that long-term detraining resulted in lower concentrations of biomarkers of tissue damage (e.g., creatine kinase, malondialdehyde) [37]. This may not be surprising given that the kinetics of these bio-markers have been associated with the metabolic and mechanical demands associated with eccentric muscle contractions, ischemia-reperfusion events during power-related actions, excessive trauma (e.g., contact actions), and increased $\dot{V}O_2$, which are all typical of soccer activities. No changes in C-reactive protein have been reported [15, 37], but increases in creatinine, granulocytes, total interleukin-8, serum nitrate, ferritin, and bilirubin have been reported during the off-season phase [15]. This apparent increase in catabolism observed after long-term detraining periods [15] is also partially supported by an increase in cortisol levels and a decrease in testosterone/cortisol ratio during the off-season [37]. Accordingly, Reinke et al. [15] observed that the transition period induced significant decrements in tissue-level stress, but that periods longer than 4 weeks may be required before full recovery is achieved. Nevertheless, training exposure throughout the off-season was not recorded, particularly during the final weeks of the transition period. Thus, a stress reaction related to physical loads before the start of pre-season cannot be excluded as a factor that may have influenced results [37]. However, players with higher match exposure during the season (starters vs. non-starters) may be prone to higher catabolic states as evidenced by the kinetics of hormonal-related parameters (increased cortisol) and their association with match exposure [4, 37]. Being so, this further reinforces the need for a holistic approach when defining the individual training variables of the exercise intervention (e.g., frequency and intensity).

Long-term detraining did not affect sex steroid levels at rest. Non-significant changes have been reported in sex steroid concentration, as total testosterone [17, 37], free testosterone, dehydroepiandrosterone-sulfate, *D*4-androstenedione, estradiol, luteinizing hormone, follicle-stimulating hormone, and prolactin [17]. However, it is clear that the scarcity of studies examining the multi-factorial nature of physiology and performance hamper extensive conclusions on the biochemical changes observed during transition periods. Moreover, difficulties interpreting the meaningfulness of alterations in biological markers due to the complexity of the network of biological interactions (e.g., spontaneous oscillations) and the lack of clear control of the activity of players during transition periods all increase the complexity of drawing precise conclusions.

5 How to Alleviate the Changes Due to Reduced Training

As previously discussed, the transition period is commonly devoted to recovery from the physiological and psychological stress of the competitive season [37, 38]. Therefore, off-season programs should be characterized by clear training objectives, a low frequency of training sessions, and simple training tools in order to increase compliance. The practitioner should adopt a holistic view (e.g., social factors, family obligations, a need for mental regeneration) when defining the individual training variables (e.g., frequency, volume, intensity) and modalities of the exercise intervention. Player training background, accumulated training and match exposure, injury history, player's personality and preferences, and off-season length, among others, are all factors that must be carefully considered during training prescription. The best exercise intervention is one that fits a player's specific needs. At the end of the season, individual members within a squad will likely occupy a broad range of different physical and physiological states (e.g., from detraining to over-reaching) [4, 38–44]. Therefore, individualized training programs may be warranted, with consideration of the aforementioned factors. As a practical guideline, to avoid a substantial decrement in endurance- and neuromuscular-related performance, we believe that off-season structured training programs should involve a minimum of two sessions per week, separated by 48–72 h [16, 24, 45, 46]. We believe that the design presented here constitutes a 'minimal effective dose' to allow maintenance, or a reduced decay of physical and physiological features relevant to football performance [16, 24, 45, 46].

Our proposal includes one HIT session per week (e.g., 5 × 4 mins at 87–97 % peak heart rate) [24]. Distinct HIT formats have been shown as a time-efficient stimulus; positive effects on cardiopulmonary and neuromuscular function can be achieved with a low volume of training [47–50]. Moreover, evidence suggest that a lower volume of high-intensity exercise is required to maintain key physiological features ($\dot{V}O_{2max}$) [51]. In addition, the hormonal responses associated with low-volume HIT (e.g., testosterone, androstanediol glucuronide, growth hormone) favors the anabolic processes to a greater degree than high-volume protocols [52–56] and so may at least partly counteract the negative changes in body composition profile that occur during the transition period (e.g., increased %BF and decreased LBM).

The selection of the off-season HIT session should consider an acute physiological response/strain effect [49]. Overall, the physical and physiological changes observed during the transition period (Fig. 1) recommend HIT sessions that combine high metabolic requirements from the O_2 transport and utilization systems with a substantial anaerobic glycolytic contribution whilst also considering the desired neuromuscular load. Individualized HIT sessions should be prioritized, and these sessions should take into account the physiological and neuromuscular profile of each player since the acute impact of HIT is highly variable and population dependent (age, sex, training status, and background) [49]. Moreover, the practitioner should consider that manipulation of the different HIT variables (e.g., bout duration and intensity and duration of recovery, number of intervals) will affect the acute physiological responses and so model the short- to long-term training adaptations [57].

The second training session should focus on muscle strength and power. A combination of resistance exercises, plyometric, and sport-specific strength exercises (e.g., accelerations and deceleration drills) is recommended to target a broad range of the force–velocity spectrum [58]. The aim is to maintain the essential aspects of intra- and inter-muscular coordination during soccer-specific motor tasks where force production is a key factor. As an example, the injury-prevention training program proposed by the Fédération Internationale de Football Association (FIFA) Medical Assessment and Research Centre, the '11+', may represent a practical and feasible strategy [59, 60]. It is easy to implement, requiring only simple tools and few resources. The program is focused on injury prevention, but we believe the '11+' has the necessary components to also serve as a detraining prevention program. We recommend adding a multi-joint exercise such as the squat [e.g., >80–95 % 1 repetition maximum (1RM), 3–4 sets, 4–8 reps] to the '11+' training program to address the basic requirements of the high-force low-velocity relationship of the neuromuscular system. The plyometric section of the '11+' will provide a complementary stimulus to address other parts of the force–velocity spectrum (low-force high-velocity relationship). This training structure may partially counteract the reported negative effects that long-term detraining (4 weeks) has on some morphological (muscle cross-sectional area) and mechanical factors (tendon stiffness), which are important in force production and application [61]. We believe this design may reduce the observed detraining effect in important muscle power abilities (e.g., sprint ability). Interestingly, one strength training session per week involving squats (3 × 4RM) during the competition period may be sufficient to maintain strength, jump, and sprint performance in professional players [45]. However, a lower training stimulus (single set vs. multiple sets) may also be effective for maintaining strength levels during the initial stage of the transition period [62, 63]. Again, the practitioner must consider each player (e.g., single set programs prescribed for players exposed to high training loads at the end of the season). Nevertheless, we believe the relatively high neuromuscular stress imposed during training sessions and games throughout the competitive season also provides a meaningful stimulus and contributes to preserving a player's neuromuscular performance [39, 64]. This supports our proposal of combining HIT sessions with strength/power training as a strategy to maintain high neuromuscular involvement during the transition period.

The transition period also represents a window of opportunity to intervene on modifiable risk factors associated with injury occurrence. In terms of injury prevention, off-season training should focus on reducing the risk of the most common injuries (e.g., hamstring strains). Players with untreated strength imbalances may be four- to fivefold more susceptible to sustaining a hamstring injury than players showing normal strength profiles [65], therefore off-season interventions should target the restoration of normal strength profiles. Eccentric muscle loading has been recommended for the prevention of hamstring injuries [66, 67]. Training interventions might have a time-dependent effect on promoting eccentric strength and reducing the negative influence of fatigue observed during matches [68]. Although scarcely investigated [69], we believe that variation is key: strength exercises and proprioception exercises should be performed at both the start and the end of training sessions to expose players to non-fatigued and fatigued conditions, respectively. This might help condition players to cope with high-intensity periods in the final stages of the training sessions and/or friendly matches during pre-season. Similarly, although the mechanisms of adaptation are currently not fully understood, eccentric exercise elicits a protective adaptation often referred to as the 'repeated-bout effect'. Inducing this protective effect via eccentric exercise might reduce the magnitude of subsequent muscle soreness that is frequently reported during the pre-competition period. As well as the clear physiological benefits, this approach may also provide psychological benefits such as a reduced perception of effort and increased perceived tolerance and so favor players' commitment during training practices [70, 71].

An appropriate off-season training program may constitute, at least in part, a superior methodological and physiological strategy favoring a more efficient periodization of the subsequent pre-season phase. For instance, given the detrimental effect of high endurance loading on power development, a periodized program during the transition period may avoid or reduce the interference effect between power and endurance adaptations during pre-season in professional players, allowing practitioners to focus more on a certain component of a player's performance (e.g., muscle power) due to a greater 'baseline' of aerobic fitness [72]. Indeed, the role of the different training variables in the interference effect should be considered [73]. The frequency, duration, and volume of endurance training are key determinants of the development and maintenance of strength and power [74, 75]. This provides support for the adoption of an HIT format for the purposes of maintaining endurance qualities due to the low frequency and volume of training required. Moreover, strength, power, and HIT are characterized by brief and intense muscle contractions [58] and provide synergistic contributions to the overall training stimulus [74].

We recommend that the scientific community engage in active collaboration with applied practitioners and coaches to examine in detail the periodization during the transition period. For instance, which assessments of pre- and post-transition adaptation are the most useful: physical, physiological, psychological, or a combination [76–78]? Moreover, examining the effect of different off-season periodization programs on subsequent injury incidence, match performance, physical fitness, and psychometric markers throughout the season is warranted. We believe that addressing these questions may help practitioners develop more effective periodization models in the future, and ultimately result in tangible benefits for players and teams.

6 Conclusion

Overall, detraining during the transition period results in meaningful performance impairments in a range of physiological and performance measures. Both short- and long-term detraining leads to small-to-moderate negative changes in body composition profile and moderate changes in sprint ability. In addition, small-to-moderate decrements in muscle power might occur. The effect of detraining may be more evident in the ability to produce force at high angular velocities. Dynamic, multi-joint actions can be affected, primarily those requiring high levels of motor coordination. The detraining effects are also extended to endurance-related physiological and performance outcomes. Large reductions in $\dot{V}O_{2max}$ and time to exhaustion, and moderate to very large impairments in soccer-specific endurance, have been described. The resultant reductions in training status may negatively affect periodization during the pre-season, compromising performance levels during the initial stages of the competition phase.

We believe that the transition period needs to be perceived as a window of opportunity for players to recover and 'rebuild' for the start of the following season. This does not necessarily imply a complete or near cessation of training. On the contrary, cessation of training may negatively impact performance and increase susceptibility to injury when restarting structured training. We recommend that clubs, coaches, and clinical departments should consider the points discussed when prescribing individualized training programs for the transition period.

Compliance with Ethical Standards

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Conflicts of interest Joao Renato Silva, Joao Brito, Richard Akenhead, and George P. Nassis declare that they have no conflicts of interest relevant to the content of this review.

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