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ORIGINAL ARTICLE

Effects of a shock microcycle after COVID-19 lockdown period in elite soccer players

Effets d'un entraînement fractionné de haute intensité (HIIT) après une période de confinement due au COVID 19, chez des joueurs de football d'élite

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KEYWORDS
Soccer;
COVID-19;
Microcycle;
High intensity training;
Elite players

Summary
Objectives. — Decreases in physical fitness are inevitable after two to six week period of detraining in athletes. Lockdown period changed the characteristics of soccer players' training.
Aim of the study. — The aim of our study was to apply a HIIT shock-microcycle (SM) after return to training and assess its effect on players' performance.
Equipment and methods. — Nineteen elite professional soccer players during the lockdown period (LP) from March to May 2020 (8 weeks) performed 3-4 individual training sessions per week. The training sessions included running boots of anaerobic short and aerobic prolonged duration intervals. Intensity was determined according to lab ergospirometry test 2 weeks before LP. All the players followed an indoor program, 3—6 sessions per week consisted of core, balance and flexibility exercises (~45 minutes). SM training content was same for both groups and took place the first two weeks after LP, consisted by eight high intensity interval training sessions (HIIT), two technique, two tactical sessions and two days off.

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Results. — Repeated sprint ability mean time ($RSA_{MeanTime}$) and Repeated sprint ability performance—sprint no 4,5,6 ($RSA_{4,5,6S}$) improved after SM ($P = 0.025$, Effect size: $r^2 = 0.331$, $P = 0.010$, Effect size: $r^2 = 0.411$, $p = 0.009$, Effect size: $r^2 = 0.418$, $P = 0.037$, Effect size: $r^2 = 0.293$, respectively. Yo-Yo intermitted recovery test level 2 ($YYIR2_{TotalDistance}$) that covered by players during the 2nd measurement was 10.8% longer ($P = 0.004$, Effect size: $r^2 = 0.483$). Also, the $YYIR2_{HeartRateRecovery}$ percentage was lower during the 2nd measurement ($P = 0.014$, Effect size: $r^2 = 0.107$).
Conclusions. — These results indicate that SM can improve YYIR2 and RSA performance thus it is a useful tool to regain physical attributes in a short period.

MOTS CLÉS
Football ;
COVID-19 ;
Microcycle ;
Entraînement fractionné de haute intensité ;
Joueurs d'élite

Résumé
Objectifs. — L'altération des capacités physiques est inévitable après une période de deux à six semaines d'absence d'entraînement chez les athlètes. La période de confinement due au COVID19 a changé les caractéristiques de la préparation des joueurs de football.
But de l'étude. — Le but de notre étude était d'appliquer un microcycle d'entrainement fractionné de haute intensité (HIIT, ou microcycle de choc SM), après le retour à l'entraînement, et d'évaluer ses effets sur les performances des joueurs.
Matériel et méthodes. — Dix-neuf footballeurs professionnels d'élite ont effectué 3-4 séances d'entraînement individuel par semaine pendant la période de confinement de mars à mai 2020 (LP, 8 semaines). Les séances prévoyaient des exercices de courses à pied par intervalles, de courte et longue durée. L'intensité des exercices évaluée par des tests d'ergospirométrie en laboratoire deux semaines avant la LP. Tous les joueurs ont suivi le programme en salle close (3—6 séances par semaine) comprenant des exercices de base, d'équilibre et de flexibilité (~45 minutes). Le contenu du HIIT était le même pour les deux groupes et a débuté après la LP, pendant les deux semaines suivant l'entraînement et comprenant 8 sessions de HIIT, 2 sessions d'entrainement technique, 2 sessions de tactiques et 2 jours de congé.
Résultats. — RSAMeanTime et RSA4,5,6S testé après le HIIT ($p = 0.025$, $p = 0{,}010$, $p = 0{,}009$, $p = 0{,}037$ respectivement. YYIR2Total Distance: la distance totale parcourue par les joueurs durant la seconde évaluation était plus longue de 10,8 % ($p = 0{,}004$). De même, le pourcentage de YYIR2HeartRateRecovery était plus bat durant la seconde évaluation ($p = 0{,}014$).
Conclusions. — Les résultats de l'étude ont démontré que le SM peut améliorer les performances YYIR2 et RSA, et constitue une arme utile pour la régénération des aptitudes physiques dans un espace limité.

1. Introduction

Our society faced the biggest pandemic during the last century. Specifically, on January 30, 2020, the World Health Organization (WHO) announced that the new coronavirus outbreak is a public health emergency of international concern (www.who.int) [1]. Countries all over the world established measures to get through this situation. Part of that was the lockdown. During this period all non-essential movement restricted for the citizens. In Greece, the lockdown announced on the 22nd and started on 23rd March. All organized sports activities were suspended, soccer clubs stopped the training sessions and athletes had to stay home or train individually at outdoor cites (not organized facilities). Wearable devices were used by fitness coaches to guidance players and control their training volume. Tate, et al. (2015) [2] recommend that apps and wearable devices are useful tools to track and motivate individuals.

During the lockdown period all the official matches and training sessions were postponed, so fitness coaches were providing individual training instructions to maintain the players' competitive level. It is known that decreasing the volume, the intensity and the density of the training can lead to detraining. More specifically, it is noticed [3] that a prolonged period of rest after the competitive season causes the partial or complete loss of training-induced physiological and performance adaptations, in response to an insufficient training stimulus, which is defined as detraining. Decreases in physical fitness are inevitable after two to six week period of detraining in athletes [4—8]. The detraining can impair cardiovascular and neuromuscular performance [6]. When lockdown started, it was unclear how long the players would be out of organized team training sessions. Also, the fields for a long time were closed and the only places where an athlete could practice were the parks and the streets.

After the lockdown period (Spring 2020), the football federations, depending on the political decisions in relation to the management of the pandemic, provided a short period at the teams to prepare and return at a competitive level to complete the championships. High intensity training (HIIT) is a common practice to retain or regain performance in a short period. This type of training had shown that improves soccer players' fitness levels, such as sprints, and speed endurance

Table 1 COVID-19 intervention period (IP) training plan.

Session 1	Session 2	Session 3
10′ low intensity running 10′ dynamic warm up Intervallic running drill: 15′’—120% vVO_2max 15′’—walking Reps: 10 Sets: 3 (4 after 4th week) Recovery/set: 3′	10′ low intensity running 10′ dynamic warm up Aerobic running drill 10′—0.8 RER speed Recovery: 3′ Sets: 3 (4 after 4th week)	10′ low intensity running 10′ dynamic warm up Intervallic running drill: 4′—1 RER speed Recovery: 2′ 30′’ Sets: 4 (5 after 4th week)
Session 4 10′ low intensity running 10′ dynamic warm up	Session 5 10′ low intensity running 10′ dynamic warm up	
Intervallic running drill: 15′’—120% vVO_2max 15′’—walking Reps: 10 Sets: 3 (4 after 4th week) Recovery/set: 3′	Aerobic running drill 10′—0.8 RER speed Recovery: 3′ Sets: 3 (4 after 4th week)	

vVO_2max: velocity on VO_2max; RER: respiratory exchange ratio

[9] and is a more efficient method of inducing skeletal muscle adaptation in comparison to moderate-intensity training [10]. In recent years to improve endurance quickly, a new training method has been adopted, where in a short period of time (e.g., 2 weeks) many HIITs are taking place. This short period is called HIIT - Shock microcycle (SM) [11,12]. A recent review indicates the sustainability and effectiveness of high intensity interval training shock microcycle in different athletes to improve intermittent and continuous running performance [8]. Similar benefits also reported on soccer [11,13]. Interestingly, Joo (2018) [14] reported that the restoration of performance (YYIR2 and RSA) after a period of detraining requires an equal period of high intensity aerobic workouts Therefore, the limited preparation time that federations had provided, led the coaches to use the HIIT-Shock microcycle structure that according to the literature could have positive effects on players' physical condition in a short time.

However, studies investigating the effect of a SM on soccer players are limited [4,11,13] while none have been performed on high-level soccer players. Therefore, the aim of our study was to apply a shock-microcycle (SM) after the lockdown period and return to training and assess its effect on elite professional soccer players' performance.

The hypothesis of the study was that a SM can be an effective approach to improve motor performance of elite soccer players in a very short period.

2. Materials and methods

2.1. Experimental design

The COVID-19 intervention period (C-19 IP) (Spring 2020) lasted eight weeks, during COVID-19 lockdown period for 10 weeks (March to May). The players performed 4-5 outdoor training sessions per week. The characteristics of the training program are presented in Table 1. All the players followed an indoor program of 4-6 sessions per week consisted of core, balance and flexibility exercises (∼45 minutes). The training intensity was determined according to the lab tests made two weeks before the lockdown period (treadmill protocol to assess the respiratory exchange ratio (RER) and lowest speed at VO_2max (vVO_2max). Training monitoring through this period was made using a mobile phone app (polar beat) and polar flow team web application. This method has some advantages: First no special equipment requirement and second coaches can review the data immediately after the session ends [15].

Following C-19 IP was allowed by the government to use official training ground facilities. On the first day a low intensity field training session took place (mobility, technique) and measure of the anthropometric characteristics. On the second day the players did RSA test (20—20 m, recovery 20 seconds, six repetitions) [16]. The YYIR2 test completed at fourth day (48 hours after the previous testing day). Between testing days, the players had done one recovery training session (flexibility, mobility) [17]. The study design presented in Fig. 1.

The SM took place the following two weeks, consisted of eight high intensity interval training sessions (HIIT), two technique, two tactical sessions and two days off. The HIIT sessions were divided into two different programs (program A and program B).

Training content:

- Plyometrics: 4 drills, 3 sets consisting of 24 two leg hurdle jumps 50 cm, 48 single leg hurdle jumps 30 cm, 12 accelerations 5 m;
- High intensity interval training: Program A—8 repetitions at 120% vVO_2max speed, duration 15′’, recovery 15′’ walking (20 m), sets: 3, recovery/sets: 2′. Program B—4 repetitions at 1.0 RER, duration 4′, recovery 2′;

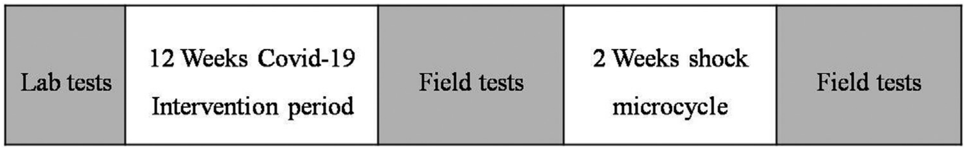

Figure 1 Study design.

Table 2 Structure of the shock microcycles and RPE values (average value ± SD).

Day	Type of training	RPE	RPE × Duration
Day 1	Plyometrics—$HIIT_{programA}$	6.9 ± 0.9	347 ± 46
Day 2	$HIIT_{programB}$	7.4 ± 1	405 ± 56
Day 3	Technique	4.8 ± 1	297 ± 61
Day 4	Plyometrics - RST	7.5 ± 1.1	383 ± 55
Day 5	Techniques	4.4 ± 1	243 ± 53
Day 6	$HIIT_{programB}$	7.4 ± 1	430 ± 83
Day 7	DAY OFF		
Day 8	Plyometrics - $HIIT_{programA}$	7.4 ± 1.2	479 ± 66
Day 9	SSG 4vs4	7.8 ± 1.2	491 ± 75
Day 10	Tactical Training	5.4 ± 1.2	293 ± 63
Day11	Plyometrics - RST	7.7 ± 1.4	433 ± 77
Day 12	Tactical Training	7.2 ± 1	432 ± 80
Day 13	SSG 4vs4	8.2 ± 1.2	473 ± 70
Day 14	DAY OFF		

Plyometrics: 4 drills, 3 sets jump exercises & 5 m acceleration. $HIIT_{programA}$: High intensity interval training, 15'' at 120% vVO_2max, 15'' recovery, 8 reps. $HIIT_{programB}$: High intensity interval training, 1.0 RER, 4 minutes, 4 reps. Technique: 20′ warm up, 20′ coordination—technique drills, 20′ passing drills. RST: 35 m sprint, 6 reps, recovery 20'', 2 sets. SGG: small side games, 4v4 + 2 GK, pitch area: $102m^2$/player, duration 4′, recovery 2′, sets: 4. Tactical training: 25′ warm up, 45′ tactical drills. OFF: day off. RPE: rate of perceived exertion

- Repeated sprint training: 35 m sprint with change of direction, recovery 20′', repetitions 6, sets 2, recovery/sets 3′;
- Small side games: 4v4 + 2 GK, pitch area: $102m^2$/player, duration 4′, recovery 2′, sets: 4. Before main part of the above sessions the players made a standardized warm up (20′ with mobility, flexibility and technique drills);
- Technique training: 20′ general and specific warm up, 20′ coordination & technique drills, 20′ specific position passing drills;
- Tactical training: 25′ general and specific warm up, 45′ low intensity team tactics

Shock microcycle structure presented in Table 2.

According the COVID-19 safety instructions during the first week after C-19 IP the players trained in small groups (4—6 players) and at the second they allowed to participate in full squad training. During this period players' load monitoring was made using GPS units (Apex 18 Hz, STATSports, Northern Ireland) placed on a vest in a pocket on their scapulae. The following parameters used for analysis: total distance (TOTD), high metabolic load distance (HMLD), high speed running distance (HSR), accelerations > 2 m/s^2 (AC2), accelerations > 3 m/s^2 (AC3), decelerations < −2 ms/^{2} (DC2), decelerations < −3 m/s^2 (DC3).

The HMLD is a metabolic variable defined as the distance, expressed in meters, covered by a player when the metabolic power exceeds 25.5Wkg-1. HMLD variables include all high-speed running, accelerations and decelerations above 3 m/s^2 [18]. The intensity thresholds used (for HSR) have been established based on previous studies [19].

After SM anthropometric characteristics and the field-testing procedure repeated similar to the previous protocol (two testing days with one rehabilitation day between).

During the lockdown period, the players received a personalized nutritional program from the team's dietitian tailored to the individual energy needs of the players as they spent much of the day at home. After the end of the lockdown, the nutritional program was adjusted to the new requirements of the players as they participated again in the team's training sessions.

2.2. Subjects

Power analysis was performed before the study by setting an effect size 0.6, a probability error of 0.05, and a power of 0.9 for 1 group and 2 measurements points (pre and post). Power analysis estimations were based on studies that examined the effects of training protocols on performance of soccer players [11,14]. The analysis indicated that 17 subjects were the smallest acceptable number of participants. Nineteen soccer player members of a Super league Greece team (finished at the first six positions on the table and participated at play offs). All of them were in field players (three central defenders, five side defenders, three midfielders, four wingers and four strikers). Six players who didn't wish to take outdoor training sessions during lockdown were excluded. One more player was excluded because he missed three training sessions during SM due to pain on his Achilles tendon.

All testing procedures were fully explained in detail to participants, prior to the start of the study. A consent form for participation in the study was read and then signed by the participants. Moreover, the study was approved by the ethical committee of the Aristotle University of Thessaloniki, in accordance with the ethical standards in sport and exercise research.

2.3. Anthropometric measurements

An electronic digital scale and Seca height-measurement (Seca 220e, Seca, Hamburg, Germany) were used to measure the body mass and height of the players. These two measurements had an accuracy of 0.1 kg and 0.1 cm in the respective evaluations. The participants, during the measurements, were barefoot, wearing only their underwear. To assess body fat, a Lafayette skinfold caliber (Lafayette, Ins. Co., Indiana) was used to measure the thickness of the soccer players' hypodermic fat in four of their skinfolds (biceps, triceps, suprailiac, subscapular). All skinfold measurements were taken on the right side of the body, as described by Slaughter et al. (1988) [20]. Finally, the body density was calculated according to the Durnin and Rahaman equation (1967) [21] for people over 16 years of age, and body fat percentage was calculated with the use of Siri equation (1956) [22].

2.4. Yo-Yo intermitted recovery test level 2

The YYIR2 consists of repeated 20-m runs back and forth between the starting, turning, and finish lines at a progressively increased speed, which is controlled by audio beeps from a CD-player. When the subject failed twice to reach the finish line in time, the athlete stopped the test and the distance covered was recorded as the test result. The coefficient of variation for test-retest trials was 5.5%. In combination with this test, two measurements of heart rate were used. The first measurement concerned the percentage of the maximum heart rate during the 6th minute of the test ($YYIR2_{6HR}$) and the second measurement the heart rate one minute after the end of the test ($YYIR2_{HRR}$).

2.5. Repeated sprint ability test

For the assessment of RSA was used a test consisting of six 40 m (20 + 20 m) shuttle sprints separated by 20 s of passive recovery [16]. The athletes started from a line, sprinted for 20 m, touched a line with a foot, and came back to the starting line as fast as possible. After 20 s of passive recovery, the athletes started again. A photocell system was used to measure sprint time of each sprint (Microgate, Bolzano, Italia).The indicators we used for the RSA assessment were the best time in a single trial (RSA_{BS}), the time of each of the six sprints (e.g. RSA_{4S}—time on 4th sprint) and the mean time of the six sprints (RSA_{MT}). The coefficient of variation for test-retest trials was 4.9%.

2.6. Internal load

Borg Rating Perceived Exertion Scale (RPE, CR10) and RPE * training duration was used to record internal load. At the end of training players were asked to rate RPE. Examinees were familiarized with the use of RPE many years ago.

2.7. Statistical analysis

All the statistical analyses were conducted using SPSS (version 25.0; SPSS Inc., Chicago, IL, USA) and the results are reported as mean ± *SD*. Data were analyzed by a paired sample *T*-test. The level of significance was set at $P < 0.05$. Before analysis, Shapiro-Wilks test was used to detect any deviation from all departures from normality. Furthermore, the effect size ''$r^2 = t^2/(t^2 + df)$'' for paired samples T-test was calculated. The thresholds for small, medium, and large effects were defined as 0.01, 0.09, and 0.25 respectively.

3. Results

No differences were observed between pre and post measurements of anthropometric characteristics. However, as we can see the effect size of the changes were medium in weight and body fat. Results are presented in Table 3. The internal load of the players is presented in Table 2.

For RSA_{MT}, T-test analysis revealed that time significantly decreased from pre to post measurement ($t = 2.540$, $P = 0.025$, $r^2 = 0.331$, ES = large). For RSA_{BS} analysis showed no significant changes over time ($t = 0.065$, $P = 0.949$, $r^2 = 0.0003$, ES = small). For the first three sprints of RSA test no differences observed between pre and post measurements (RSA_{s1}: $t = 0.119$, $P = 0.907$, $r^2 = 0.001$, ES = small; RSA_{s2}: $t = 1.471$, $P = 0.165$, $r^2 = 0.142$, ES = medium; RSA_{s3}: $t = 1.487$, $p = 0.161$, $r^2 = 0.145$, ES = medium). However, for the last 3 sprints of the RSA test soccer players improved their performance (RSA_{s4}: $t = 3.016$, $p = 0.010$, $r^2 = 0.411$, ES = large; RSA_{s5}: $t = 3.053$, $P = 0.009$, $r^2 = 0.418$, ES = large; RSA_{s6}: $t = 2.323$, $P = 0.037$, $r^2 = 0.293$, ES = large). RSA results are presented in Fig. 2.

For $YYIR2_{TD}$ T-test analysis revealed that the distance covered was significantly increased at post measurement ($t = -3.486$, $p = 0.004$, $r^2 = 0.483$, ES = large). For $YYIR2_{HR6}$ the results showed a decrement at post measurement ($t = 2.852$, $P = 0.014$, $r^2 = 0.385$, ES = large). No differences between the measurements were observed for $YYIR2_{HRR}$ ($t = 1.245$, $p = 0.245$, $r^2 = 0.107$, ES = medium). YYIR2 results are presented in Table 4.

The mean values of TOTDS, HMLD, HRS, AC2, AC3, DC2, and DC3 during 2 weeks of shock microcycle are presented in Fig. 3.

4. Discussion

The results showed that the SM improved performance in the RSA test and more specifically the average time and time on $RSA_{s4,5,6}$. Also, the distance covered in YYIR2 during the 2nd measurement was 10.8% greater, the $YYIR2_{HR6}$ was reduced and the heart rate of the players after YYYR2 returned faster to the resting pulses.

Table 3 Participants' anthropometric characteristics.

	Pre	Post	t	*p*	r^2
Age (y)	27.4 ± 5.1	27.4 ± 5.1			
Height (m)	177.3 ± 6.8	177.3 ± 6.8			
Weight (kg)	76.4 ± 6.3	76.0 ± 6.1	t = 1.668	$p = 0.113$	$r^2 = 0.134$
Body fat (%)	6.27 ± 1.94	6.12 ± 1.85	t = 2.013	$p = 0.059$	$r^2 = 0.184$

Data are presented as mean ± SD.

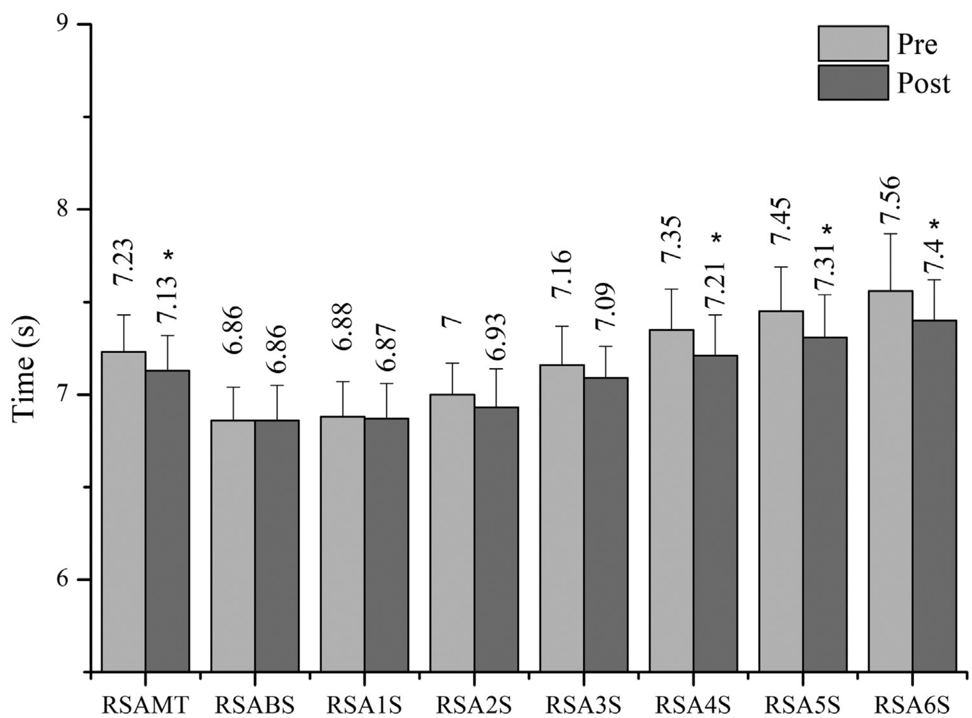

Figure 2 Repeated sprint ability (RSA) results.

Table 4 Results of the Yo-Yo intermittent recovery test level 2 (distance, heart rate) (average value ± SD).

	Measurement	
	Pre	Post
$YYIR2_{TD}$ (m)	1519 ± 463	1683 ± 402[a]
$YYIR2_{6HR}$ (%)	97.00 ± 2.18	95.64 ± 1.95[a]
$YYIR2_{HRR}$ (%)	82.3 ± 4.62	81.1 ± 4.63

TD: total distance; 6HR: 6th minute heart rate percentage; HRR: heart rate recovery.
[a] denotes significant difference between measurements.

In this study, we used YYIR2, an intermittent test to assess the aerobic capacity of players and we observed a significant improvement. Our findings are in line with those of previous research which found that the HIIT application improves performance in intermittent tests until exhaustion (YYIR2, 30-15 intermittent fitness test) [11,13]. More specifically, the players during the 2nd measurement covered 10.8% more distance compared to the 1st measurement. The players' level participated in previous studies was lower in comparison to ours, and researchers used the YYIR1 test. The improvement percentage in these studies is greater than 20%. However, one study reported an improvement of 0.75% [4]. One possible explanation given by the researchers for this slight improvement is that the interventional program was implemented just after the end of the season and the aerobic level of the players was at high level. Also, the re-evaluation in the study was applied 36 h after the end of the interventional program and there probably wasn't enough time to accommodate adaptation after an intense period of training. Higher percentage of improvement reported by the other studies are likely due to the lower physical level of the participants, which means that they have greater margins for improvement. Also, these studies before the 2nd measurement had greater time to recover (4 to 7 days). The main difference in the present study is that it was carried out in high-level soccer players and the 2nd measurement was carried out immediately after the end of the interventional program. It should be noted here that of the existing studies only one [13] has used a control group. This makes us wary of the magnitude of the effect of this training method.

The physiological mechanisms that probably improved after the effect of the intervention program and improved

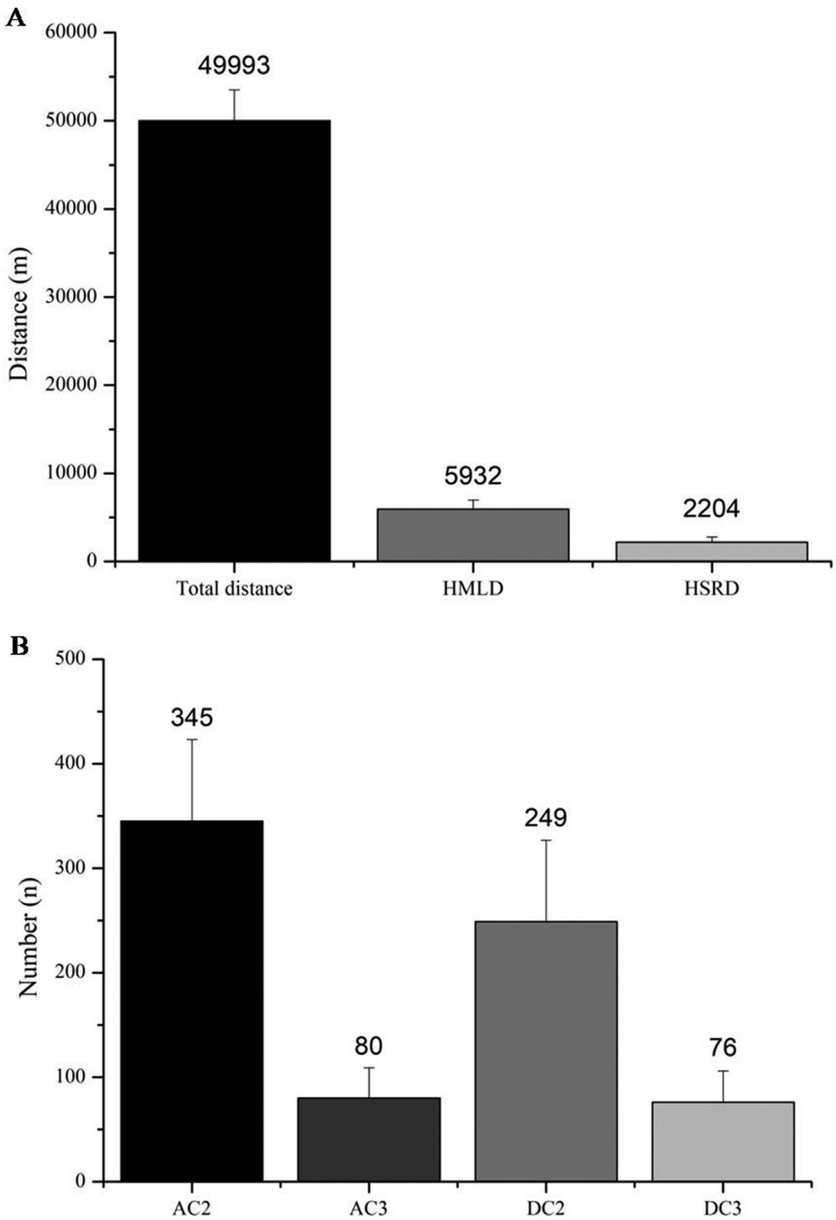

Figure 3 A. Distances covered during the 2 weeks of shock microcycle: Total distance, High metabolic load distance, High-speed running distance. B. Presented the accelerations and decelerations that performed by players during training.

performance are an increase of mitochondrial content and the improvement of motor unit recruitment. More specifically, an earlier study has reported that mitochondria can increase in a short period of time if the volume of training increases [23]. However, this study did not perform a histochemical examination to confirm this increase. This increase in mitochondria and enzymes also causes metabolic adjustments helping athletes use lipids to produce energy at higher movement intensities [24—26]. Martinez-Valdes, et al. (2017) [27] reported that the implementation of a HIIT program for a short period of time can induce an increase in discharge rate of high-threshold motor units improving the efficiency of movement.

The SM didn't affect the percentage heart rate recovery [28]. More recent studies demonstrate that HR decline is a useful tool to detect the shape and fatigue of the players after specific soccer training [29] and athletes engaged in intermittent sports are likely to have faster heart rate recovery during the first 20s after maximal exercise than their counterparts trained for continuous performance [30]. It is possible that the rapid decrease in heart rate after a maximum test depends more on body adjustments that do not occur after short HIIT programs (maximum stroke volume, total hemoglobin mass, capillary density). These changes seem to require more exercise time to occur [31,32].

The players improved their performance at RSA_{MT} (1.38%) and their performance at $RSA_{4,5,6S}$ (1.90%, 1.88%, 2.12%, respectively). RSA is positively associated with relative VO_2max and the ability to perform intermittent high-intensity efforts during soccer matches [16]. In the same study [16] observed that HIIT identified significant relationships between RSA, VO_{2max} and $VO_{2\text{-kinetics}}$ in soccer players. The improvement of YYIR2 performance probably indicates an improvement of VO_{2max} and this could explain the increased RSA performance. Our results are in line with previous studies [4,11,33] and demonstrate that SM can improve RSA performance. The improvement on the RSAtest was shown at the last sprints of the test, where the aerobic ability of the players has a crucial role in their performance

Regarding the adaptations it is known from previous studies that training at high intensities (VO_{2max}) causes peripheral adjustments, such as increase of muscle mitochondrial and capillary density and central adjustments and increase of stroke volume and cardiac output [34]. A recent study [35] showed that intermittent exercise caused a greater increase in the number of mitochondria than long-term exercise with stable pace. Similar findings are reported by Franson et al. (2018) [36] enhances to a greater extent the oxidative capacity of muscles compared to continuous endurance training. The two main adaptational mechanisms benefits from HIIT are a) the hypoxic effect of reducing the level of O_2 in the muscles and the enhanced aerobic metabolism by increasing the expression of PGC-1a mRNA which increases the biogenesis of mitochondria [37,38] and b) improving the buffering capacity of the muscles [39].

The players improved RSAmean after the intervention program. The training likely improved a) the performance of glycolysis and the ATP-PC energy system [40], b) the ability to homeostasis muscles and manages lactic acid [39] and c) the percentage of FT oxidative fibers [40]. However, the above are hypothesis since the study did not carry out measurements that prove them and confirm the factor that is responsible for the improvement in performance.

This study shows some limitations. Initially the sample is limited, so we are wary of generalizing the conclusions. Also, in the study, no control group was used. Further research is needed to identify how many HIIT workouts have to be applied on a SM to obtain the best results on improving fitness.

5. Conclusions

The present study showed that a two-week shock microcycle can improve the RSA performance and YYIR2 performance of elite professional soccer players. This study shows that in well-trained soccer players, for a short period of two weeks, it is possible to apply 4 HIIT workouts per week. In the model we used in this study, high-intensity workouts included running exercises (HIIT, RSA) and small-sided games. The application of this SM should be considered together with the overall training load of the players to reduce injury risk and to gain the maximum possible physical adjustments. Also, after increased load training block (SM), appropriate recovery should be given to display supercompensation and increase performance.

6. Practical Applications

The above SM potentially can be applied in case that increase of performance in limited time is needed. Such cases could be the winter holidays, the interruptions during the season due to national team matches or the preparation for early pre-season European cup games. Another condition we could have benefits from applying a SM, is during return to play after a player's injury. However, during periods of significant acute increase in players' load, monitoring should be applied in detail (on internal and external load) to recognize fatigue and overreaching symptoms to ensure the health and the best performance of the players.

Disclosure of interest

The authors declare that they have no competing interest.

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