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Effects of different repeated sprint-training frequencies in youth soccer players

AUTHORS: Ezequiel Rey[1], Alexis Padrón-Cabo[1], Pablo B. Costa[2], Carlos Lago-Fuentes[1]

[1] Faculty of Education and Sport Sciences, University of Vigo, Pontevedra, Spain
[2] Human Performance Laboratory, Center for Sport Performance, Department of Kinesiology, California State University, Fullerton, CA, USA

Corresponding author:
Ezequiel Rey
Faculty of Education and Sports Sciences, University of Vigo-Campus A Xunqueira s/n
Pontevedra 36005, Spain
Telephone: 986801700
Fax: 986801701
E-mail: zequirey@uvigo.es

ABSTRACT: The aim of this study was to determine the effects of 2 different repeated-sprint ability (RSA) training frequencies (2 RSA sessions per week [RSA2D] or 1 RSA session [RSA1D]) under volume-equated conditions on sprint and RSA performance in under-15 (U15) soccer players. Twenty-seven youth male soccer players (age: 12.29±0.47 years; height: 158.35±10.86 cm; weight: 45.08±8.05 kg) were randomly assigned to RSA2D (n=14) or RSA1D (n=13) groups. The players performed the same RSA training for 6 weeks, and only the training frequency differed between the groups. Before and after the training period, 5 m sprint, 10 m sprint, 20 m sprint and the RSA test were assessed. No significant time × group interactions were observed ($p>0.05$). Within-group analysis showed significant improvements in 20 m sprint ($p=0.046$, partial eta squared [η_p^2] = 0.150, large) and RSA average time ($p=0.001$, $\eta_p^2=0.438$, large), fastest time ($p=0.012$, $\eta_p^2=0.229$, large), and total time ($p=0.001$, $\eta_p^2=0.438$, large) from pre-test to post-test in RSA1D and RSA2D groups. However, no significant pre-post changes ($p>0.05$) were found in 5 m and 10 m sprint tests. In the between-group analysis, there were no significant differences between RSA1D and RSA2D groups in any variable. In conclusion, the current findings suggest that 6 weeks of RSA training 1 or 2 times per week in addition to typical soccer training produced significant and similar improvements in sprint and RSA performances. This information could be useful for coaches when planning training sessions during congested fixtures of soccer competitions or in periods when the emphasis should be placed on other physical qualities.

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INTRODUCTION

Contemporary soccer has been characterized as an intermittent high-intensity strenuous sport that intersperses brief bouts of very intense activity with low-intensity movements [1–3]. Although soccer players only sprint between 100 and 1,320 m per match, match analysis studies demonstrated that work:rest ratios between high-intensity actions bouts increased from 1:12 for the match average to 1:2 during the most intense period [4]. Consequently, the ability to repeat multiple high-speed sprints of short duration with brief recovery periods is widely accepted as a crucial component of physical performance in soccer [5,6]. Thus, it can be argued that repeated-sprint ability (RSA) is essential in competitive soccer, and accordingly, the improvement of different training strategies to increase RSA performance in youth soccer players should be of significant interest to coaches as well as strength and conditioning professionals.

Several scientific studies support the effectiveness of RSA training methodology to induce changes in power, speed, high intensity running and RSA performance in youth soccer players [7–12]. To optimize training adaptations with RSA, different variables may be manipulated, such as intensity, volume, rest, or weekly frequency [13]. Of these variables, training frequency, defined as the number of training sessions performed per microcycle [14], has not received attention in the literature, and despite the large body of scientific evidence of RSA training in team sports, the effect of manipulating training frequency under volume-equated conditions remains unknown [13].

To the best of our knowledge, only three studies have analysed the effects of different training frequencies while controlling for total weekly volume on measures of athletic performance in team sports players [15–17]. Yanci et al. [15] examined the effects of two equated plyometric training weekly volume routines using different frequencies (i.e. 1 vs. 2 sessions per week). The findings showed that both training frequencies were effective in improving sprint, change of direction, and jump performance in amateur male futsal players. In addition, under volume-equated conditions, Ramirez-Campillo et al. [16] reported that one and two plyometric training sessions per week were equally effective to improve vertical jump performance, kicking velocity, sprint, and change of direction in amateur female soccer players. Finally, Bouguezzi et al. [17] studied the effects of one vs. two sessions of equal-weekly volume plyometric training on sprint, change of direction, jump performance, and muscle strength in prepubertal male soccer players. The authors concluded that, when an equal volume is performed, both training frequencies are equally effective to improve measures of athletic performance.

To date, no studies have examined the effects of manipulating RSA training frequency on youth soccer players' physical fitness. Such information would be of great interest for coaches as well as strength and conditioning professionals due to the fact that throughout the competitive season most of the youth soccer players have limited time available for improving their physical performance [18], combining their sport with school. In addition, professional soccer players are frequently exposed to congested fixture periods [19], so coaches and physical trainers have limited time available for conditioning training. Thus, the aim of this research was to determine the effects of 2 different RSA frequencies (2 RSA sessions per week [RSA2D] vs. 1 RSA sessions [RSA1D]) under volume-equated conditions on sprint and RSA performance in U15 young soccer players. Based on previous findings in team sports athletes [15–17], it was hypothesized that 1 RSA training session per week would have similar performance enhancements compared with 2 RSA sessions per week.

MATERIALS AND METHODS

Design

This study used a 2–group, randomized controlled trial design to compare the effects of RSA training programmes with different frequency each week (RSA1D vs. RSA2D). The intervention programme of each group was added to its daily training routine. The study was conducted during 6 weeks of the competitive period (February–April) during the 2017–18 season. To determine the effects of RSA training, the following tests were selected: (a) 5 m sprint test, (b) 10 m sprint, (c) 20 m sprint, and (d) the RSA test. To reduce the influence of external variables, all subjects were instructed to maintain their usual lifestyle and normal dietary intake before and during the study.

Subjects

Based on the study of Chtara et al. [9], a priori power analysis [20] (G*Power, version 3.1.9.2, Universität Kiel, Düsseldorf, Germany) with an assumed type I error of 0.05 and a type II error rate of 0.20 (80% statistical power) was conducted for RSA performance. It revealed that 9 persons per group would be sufficient to observe medium group × time interaction effects. Twenty-seven U15 male soccer players were recruited in the current study. Exclusion criteria were injuries resulting in the loss of one or more soccer matches/training sessions in the 3 months prior to study initiation. The participants in systematic soccer training had a mean experience of 8.79 ± 1.63 years. The players regularly performed 3 weekly soccer sessions with their team on average exercising 7.2 ± 1.4 $h \cdot wk^{-1}$ in their normal training cycle. Likewise, the team usually competed one official match per week. The players had never participated in regular/systematic RSA training. Players were randomly assigned by an investigator not directly involved in testing or the training intervention into 1 of 2 groups, RSA1D (n = 14) or RSA2D (n = 13). The intervention programme was added to the usual training routines. In all other respects, all subjects completed identical training activities. Only players who participated in at least 80% of all training sessions were included in the statistical analysis. Written informed consent indicating their voluntary participation was obtained from participants and legal representatives after explanation of the experimental protocol and its potential benefits and harms. The local Investigation Review Committee of the Department of Physical Education and Sport Sciences approved the study. The physical characteristics of the players are shown in Table 1.

TABLE 1. Physical characteristics (mean SD) of the players participating in the study.

Group	N	Age (y±SD)	Weight (kg±SD)	Height (cm±SD)
RSA1D	14	14.5 ± 0.5	63.9 ± 6.8	178.0 ± 13.3
RSA2D	13	14.3 ± 0.3	62.6 ± 6.1	177.1 ± 8.1

Note: RSA1D = One day per week RSA training group; RSA2D = Two days per week RSA training group.

Intervention Programmes

The intervention period consisted of 6 weeks of performing 1 (RSA1D group) or 2 (RSA2D group) weekly sessions of RSA training. RSA training consisted of 2–6 sets of 4–6 x 15 to 30 m of maximal straight-line sprints (interspersed with 20 seconds of passive recovery). Only the RSA training frequency during the competition period differed between the groups. Because of the greater training volume per session, the training sessions for RSA1D were two times longer than for RSA2D (Table 2). In every session, prior to the intervention programme, all participants performed a 15–minute standardized warm-up (low-intensity running, athletic drills, 5 short bursts of progressive accelerations and 3 x 30 m maximal straight line run). All training sessions were executed on the same surface. The RSA2D group subjects performed their training sessions with at least 48 h recovery to avoid fatigue effects. A certified strength and conditioning specialist supervised all training sessions to ensure that all warm-up activities and RSA training were completed with correct technique and maximum effort. All players were instructed and motivated to complete all sprints as fast as possible and verbal encouragement was provided to each player. No other endurance training was completed during the study period. The RSA training programme used in the present study was adapted from previously published programmes [7–13].

Rating of Perceived Exertion

After each training session, players were asked to rate their perceived exertion (RPE) using Foster's 0–10 scale [21]. All players had regularly used this scale.

Procedures

During testing sessions, the participants were required to wear the same athletic equipment and measurements were conducted at the same time of the day to minimize the effect of diurnal variations on the selected parameters during two experimental sessions. All data collection and test sessions were performed in an indoor court where ambient temperature ranged from 18 to 21 degrees Celsius. Each player was instructed and verbally encouraged to make a maximal effort during all tests. All tests were performed after 72 h of rest and at the same venue under identical conditions and supervised by the same investigators. The players complied with the following pre-test guidelines: (a) not to consume any energy/performance-enhancing drinks or supplements 48 h prior to testing; (b) not to consume food at least 2 hours prior to testing. Before testing, all participants performed 10 min of standardized warm-up involving 2 min of light dynamic stretching (10 repetitions for hamstrings, quadriceps, and calf muscles) and 5 min jogging, followed by short distance accelerations (3 submaximal sprints, progressing to 90% of their maximal velocity for the shuttle distance [30 + 30 m]). This routine was supervised by the team's coach before the tests. During testing session, players performed the 4 following tests:

5 m, 10 m and 20 m Sprint Test. Sprint time was measured by means of a dual infrared reflex photoelectric cell system (DSD Laser System, León, Spain). The photoelectric cells were attached to tripods, raised to a height of 0.9 m and placed in pairs 1 m apart. All players began with a standing start, with the front foot positioned 0.5 m from the first timing gate. They were instructed to perform all the sprints with a maximal effort. Players were allowed 2 trials, with a 2 min recovery period between. The intraclass correlation coefficient values [$ICC_{2,1}$] [22] for test-retest trials were 0.96 (95% CI 0.87–0.99), 0.97 (95% CI 0.91–0.99) and 0.96 (95% CI 0.89–0.98) for 5 m, 10 m, and 20 m, respectively.

Repeated Sprint Ability Test. Photoelectric cells (DSD Laser System, León, Spain) were used to measure RSA performance. The RSA protocol consisted of six maximal 25 m sprints. Following each sprint,

TABLE 2. Summary of training load progression.

Week	Group	Session	Distance (m)	Sets	Repetition	Distance per Session (m)	Distance per Week (m)	Recovery between Repetitions (s)	Recovery between Sets (s)	Intensity
	RSA1D	1	15	4	5	300				
1	RSA2D	1	15	2	5	150	300	20	240	100%
		2	15	2	5	150				
	RSA1D	2	15	4	6	360				
2	RSA2D	3	15	2	6	180	360	20	240	100%
		4	15	2	6	180				
	RSA1D	3	20	4	5	400				
3	RSA2D	5	20	2	5	200	400	20	240	100%
		6	20	2	5	200				
	RSA1D	4	20	6	4	480				
4	RSA2D	7	20	3	4	240	480	20	240	100%
		8	20	3	4	240				
	RSA1D	5	30	4	5	600				
5	RSA2D	9	30	2	5	300	600	20	240	100%
		10	30	2	5	300				
	RSA1D	6	30	4	6	720				
6	RSA2D	11	30	2	6	360	720	20	240	100%
		12	30	2	6	360				

Note: RSA1D = One day per week RSA training group; RSA2D = Two days per week RSA training group.

there was a period of active recovery (25 seconds), while athletes positioned themselves for a new start [23]. Recovery was measured with a stopwatch to ensure that subjects returned to the starting point between the 23rd and 24th second. Verbal feedback was given at 5, 10, 15, and 20 seconds of the recovery. The average time (AT), fastest time (FT), and total time (TT) were recorded during the RSA test according to previous studies [24]. The percentage of decrement score (%Dec) was then calculated using the following formula proposed by Fitzsimons et al. [25], which has been demonstrated to be the most valid and reliable method of quantifying fatigue in the multiple sprint test [26]:

$$(100 \times [\text{TT/ideal sprint time}]) \text{ -}100,$$
$$\text{where ideal sprint time} = 6 \times \text{FT}$$

For each sprint and RSA variable the percentage difference in the change of scores between RSA1D and RSA2D from pre- to post-test was calculated.

Statistical Analyses

All variables were normally distributed (Shapiro-Wilk test). Data are presented as means with standard deviation (*SD*). All statistical analyses were conducted using the statistical package SPSS for Macintosh (version 21.0, Chicago, IL, USA). A 2 (group: RSA1D and RSA2D) × 2 (time: pre, post) repeated-measures analysis of variance (ANOVA) was calculated for each parameter. Partial eta squared (η_p^2) effect sizes for the time × group interaction effects were calculated. An effect of $\eta_p^2 \geq 0.01$ indicates a small, ≥ 0.059 a medium, and ≥ 0.138 a large effect [27]. Additionally, Cohen's d was computed for comparing effect sizes (ES). ES were classified as trivial (0.0–0.2), small (0.2–0.5), moderate (0.5–0.8), and large (>0.8) [27]. Significance was established at the $P \leq 0.05$ level.

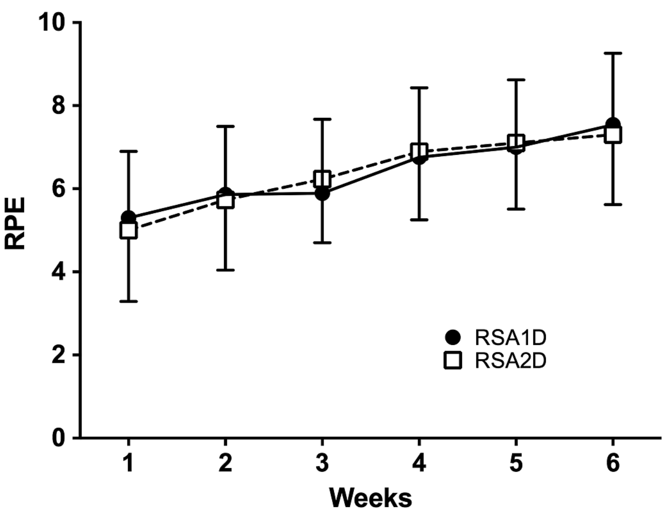

FIG. 1. Rating of perceived exertion (RPE) after each training session.

Note: RSA1D = One day per week RSA training group; RSA2D = Two days per week RSA training group.

RESULTS

Player RPE was reported throughout the intervention period with a median between 5 and 8 (Figure 1). There were no significant differences in RPE between groups during the training period. In addition, in the within-group analysis, no significant time effect was found in RPE.

Mean values and SD, percentage changes from pre-training to post-training for 5 m sprint, 10 m sprint, 20 m sprint, and RSA performance indices are reported in Table 3.

Sprint Performance

A significant time effect was found in the 20 m sprint test for RSA1D (ES= 0.531, moderate) and RSA2D (ES= 0.321, small). However, no significant time effects were found in the 5 m sprint or 10 m sprint test. Likewise, no significant main effects for group were obtained in 5 m sprint, 10 m sprint or 20 m sprint. No significant time × group interactions were observed in 5 m sprint, 10 m sprint or 20 m sprint.

RSA Performance Indices

A significant time effect was found in AT, FT, and TT for RSA1D (ES= 0.409–0.438, moderate) and RSA2D (ES= 0.512–0.615, moderate). No statistically significant effects for time in %Dec were observed. No significant main effects for group were detected in AT, FT, TT or %Dec. No significant time × group interactions were observed ($P > 0.05$).

DISCUSSION

To the author's knowledge, this is the first study to investigate the effects of different RSA training frequencies (one versus two sessions per week) in combination with regular training on sprint and repeated-sprint performance in youth male soccer players. The main findings of this study were that (a) both RSA training interventions during an in-season period were equally effective in developing 20 m sprint, RSA-FT, RSA-AT, and RSA-TT; (b) both RSA1D and RSA2D resulted in an insufficient training stimulus to increase 5 and 10 m sprint and %Dec performances.

Sprinting speed is an essential fitness component for playing soccer [28]. Moreover, sprint ability is able to discriminate youth players from different standards of play [29]. Therefore, training interventions aimed at improving sprinting speed may be a priority for soccer coaches. The present data showed a significant training effect on 20–m sprint performance for RSA1D and RSA2D training from pre-test to post-test. This result was in accordance with scientific literature [8,9,11,12] that showed a positive effect of RSA training on long distance sprint tests. The mechanisms underpinning improvements in 20 m sprint time could be closely related to different metabolic adaptations, such as increases in muscle metabolites (e.g. phosphocreatine and glycogen) and neuromuscular changes, such as changes in contractile properties and increments in muscle fibre recruitment, firing frequency, and motor unit synchronization [13].

The present results also showed that both RSA training frequencies failed to promote significant improvements in 5 and 10 m sprint performance. These findings are in agreement with those reported previously by Buchheit et al. [8] and Bravo et al. [7], who found no effects of RSA training on 10 m sprint time, and might suggest that more specific training strategies (e.g., plyometric training, resisted sprint training) than those used in this study may be required to improve acceleration capacity in youth soccer players. The lack of significant improvements in short distance sprints in both training groups could be related to the different kinematic and kinetic responses observed at different phases of the sprint acceleration during RSA training. Girard et al. [30] analysed the effects of 12 sets of 40 m sprints interspersed with 30 s of passive recovery on sprint kinematic and kinetics over different sections (5–10 m and 30–35 m). They found that during the initial acceleration phase (5–10 m) of each repeated sprint most of the ground reaction force-related parameters were significantly lower compared to the second interval (30–35 m). These different stimuli and the accumulative fatigue induced by RSA training could explain the physiological adaptations related to acceleration (5 and 10 m) and speed (20 m) observed in the present study.

RSA has been recognized as one of the most relevant physical components in soccer [31]. Several scientific studies have shown positive effects of repeated-sprint training on soccer players' RSA achieved through one- [8,32] or two-weekly sessions [7,9,11]. The results of this study showed a large training effect on TT, AT and FT for RSA1D and RSA2D training. Furthermore, a non-significant greater improvement in the RSA2D group than in the RSA1D group was observed. Taking into account that %Dec remained unchanged after both RSA training protocols, the improvements observed in TT, AT, and FT were likely related to alterations in glycolytic enzymes, ionic regulation, and muscle buffering (i.e. central metabolic factors), which suggests an improvement in the overall anaerobic performance but not in the ability to recover between sprints [7,33,34].

The present findings lend support to previous scientific evidence in team-sport athletes regarding the effects of different plyometric training frequencies [15–17] on specific performance, which generally showed that one session per week would be enough to improve specific performance in team-sport athletes. It seems that under volume-equated conditions and with a progressive overload prescription (from 300 to 720 m per week), a higher weekly RSA training frequency during 6 weeks has no additional effects on physical performance in youth soccer players. However, taking into account the observed non-significant greater improvements in the RSA2D group than in the RSA1D group, it is possible to argue that training frequency would be a more important training variable over longer time periods (> 6 weeks). Nevertheless, this remains speculative and future investigations are warranted.

TABLE 3. Physical performance between and within groups from pre- to post-test.

	RSA1D (n=14)			RSA2D (n=13)			ANOVA P values (η_p^2)		
	Pre	Post	Δ (%)	Pre	Post	Δ (%)	Time	Group	Time x Group
5 m sprint (s)	1.05 ± 0.53	1.05 ± 0.91	0.54	1.04 ± 0.52	1.04 ± 0.54	-0.30	0.978 (0.001)	0.669 (0.007)	0.765 (0.004)
10 m sprint (s)	1.87 ± 0.99	1.85 ± 0.11	-0.85	1.84 ± 0.09	1.81 ± 0.11	-1.67	0.089 (0.111)	0.369 (0.032)	0.603 (0.011)
20 m sprint (s)	3.31 ± 0.15	3.23 ± 0.21	-2.15	3.28 ± 0.15	3.23 ± 0.22	-1.46	0.046 (0.150)	0.788 (0.003)	0.700 (0.006)
RSA									
AT (s)	4.20 ± 0.17	4.12 ± 0.20	-1.83	4.20 ± 0.20	4.08 ± 0.19	-2.83	0.001 (0.438)	0.771 (0.003)	0.349 (0.035)
FT (s)	4.08 ± 0.16	4.02 ± 0.21	-1.41	4.06 ± 0.19	3.97 ± 0.16+	-2.14	0.012 (0.229)	0.590 (0.012)	0.583 (0.012)
TT (s)	25.17 ± 1.03	24.71 ± 1.21	-1.83	25.18 ± 1.23	24.46 ± 1.13	-2.83	0.001 (0.438)	0.771 (0.003)	0.349 (0.035)
% Dec	2.95 ± 1.88	2.53 ± 1.16	2.53	3.46 ± 1.77	2.73 ± 1.14	2.73	0.153 (0.080)	0.425 (0.026)	0.688 (0.007)

Note: RSA1D = One day per week RSA training group; RSA2D = Two days per week RSA training group; AT = average time; FT = fastest time; TT = total time; %Dec = percentage of decrement score.

η_p^2= Partial eta squared.

CONCLUSIONS

For coaches and strength and conditioning professionals, it is necessary to know the optimal weekly frequency of RSA training required to improve or maintain physical performance in soccer players. Our data suggest that RSA training once per week during the in-season period may provide a sufficient training stimulus to increase 20 m sprint performance and RSA in youth soccer players, assuming a sufficient training volume. The present results have important practical implications and provide further evidence that exposure to only 1 weekly RSA training session can induce important physical performance changes in youth soccer players and can be practically implemented during congested fixtures of soccer competitions, which imply limited training sessions, or in periods when the emphasis needs to be placed on other qualities (e.g. tactical).

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