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Short-term repeated-sprint training (straight sprint vs. changes of direction) in soccer players

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Abstract

Repeated-sprint training (RST) is considered a critical training method in team sports. It is well known that RST effects may depend on several variables such as the duration of the protocol and repeated-sprint methodology. Few studies have evaluated very short-term protocols and compared different RST modalities. The aim of this study was to compare the effectiveness of 2 week RST including straight sprints or changes of direction (CODs) on physical performance in a sample of soccer players. This study used a randomised pre-post parallel group trial design. The participants were assigned to either an RST group using straight sprints (RST-SS = 18 players) or an RST group using CODs (RST-COD = 18 players). The protocols were: 3 sets of 7 x 30 m sprints for the RST-SS and 7 x 20 + 20 m (one COD of 180°) for the RST-COD, with 20 s and 4 min recovery between sprints and sets, respectively. The following evaluations were performed: 10 and 20 m sprint, agility test, repeated sprint test (RSTbest and RSTmean), and Yo-Yo Recovery Level 1. After the training period, the RST-SS did not report any performance variation, while the RST-COD showed improvements in the 10 m sprint and RSTbest (effect size = 0.70 and 0.65, respectively). The between-group analysis did not report any statistical difference between the RST-SS and the RST-COD. In conclusion, this study did not support the utilisation of a very short-term RST protocol with soccer players, however, the RST-COD presented some additional benefits in sprint performance compared to the RST-SS.
Keywords: soccer, team sports, performance, training, changes of direction

Introduction

Soccer is characterised by an intermittent-activity profile with metabolic contributions from both the aerobic and anaerobic systems (Coratella et al., 2016; Rampinini et al., 2007). Players cover distances of 10–13 km during matches and perform approximately 1350 activities, such as sprints, accelerations/decelerations, and changes of direction (CODs), all of which are interspersed with short recovery periods (Beato and Jamil, 2017; Beato et al., 2018b; Mohr et al., 2005).

Repeated-sprint training (RST) is considered a critical component for team sports (Redkva et al., 2017; Taylor et al., 2015, 2016b), since it is a widely implemented methodology for enhancing functional performance in soccer at any level (Born et al., 2016; Impellizzeri et al., 2008). Many publications support the validity of this methodology and the association between repeated-sprint tests and physical performance during soccer games (Bishop et al., 2011; Impellizzeri et al., 2008). RST is based on replications of short maximal sprints interspersed with a brief recovery time (Ferrari Bravo et al., 2008). Furthermore, it is well known that RST effectiveness may depend on several variables such as frequency, volume and duration as well as a repeated-sprint methodology (exercise protocol) (Bishop et al., 2011; Buchheit et al., 2010). It is well known that the duration of training has critical importance for physical adaptations. Previous literature reported that protocols longer than 8 weeks showed meaningful changes in fitness and performance variables (Beato et al., 2018). Nevertheless, a recent publication reported large positive effects following 2 weeks of RST protocols (Taylor et al., 2016a). This study used a high frequency (e.g. 3 times per week) short duration protocol (e.g. 2 weeks), and found significant with-in improvements in sprint (5, 10, 20 m) performance. This argument is particularly interesting to investigate because soccer players (e.g. professional) have limited time to dedicate to specific physical development (e.g. congested match fixtures, travels, tactical and technical skills training) (Thorpe et al., 2015, 2017).

RST can be implemented using either straight sprints or CODs (Taylor et al., 2016a). It is already reported that the presence of CODs can be an important physiological and mechanical stimulus (Dellal et al., 2010; Nedrehagen et al., 2015; Zamparo et al., 2015), as it is well known that athletes accustomed to performing CODs and short shuttle runs can reduce the energy demand (economy) during such specific actions (Zamparo et al., 2014, 2015, 2016). Therefore, including specific COD exercises in a training program can elicit greater developments in fitness components associated with neuromuscular factors such as jump, sprint and repeated sprint performance (Beato et al., 2018; Bishop et al., 2011). The ability to repeatedly produce maximal activities of short duration with brief recovery periods is named repeated sprint ability. However, the only study analysing the difference between these two RST protocols (using short-term training), reported no additional benefits to performance when CODs were included (Taylor et al., 2016a), while previous scientific evidence (using a medium-term protocol) supported the contrary (Zamparo et al., 2014).

Considering the limited evidence about the effects of relatively high frequency (sessions per week), short-term RST interventions, the aim of this study was to compare 2 weeks (3 sessions per week) of RST, using both straight sprint and COD protocols. The sprint, repeated sprint ability, and agility performance was assessed in a sample of amateur soccer players during the pre-season.

Methods

Participants

Forty healthy soccer players (amateur level, Italy) were considered during the enrolment process. A minimum training volume of two training sessions and a match per week was requested for each player (inclusive criteria). Only outfield players were taken into account (four goalkeepers were excluded), therefore, thirty-six participants were included in the current study (mean ± SD; age 21 ± 2.4 years, body mass 74.1 ± 7.3 kg, body height 179.4 ± 7.2 cm). All participants were informed about the potential risks and benefits of the study and signed an informed consent form. The Ethics Committee of the University of Suffolk (Ipswich, UK) approved the study. All procedures were conducted according to the Declaration of Helsinki for human studies.

Design and research question

This study used a randomised pre-post parallel group trial design. The randomisation was performed according to a computer-generated sequence. The participants were then assigned to either an RST group using straight sprint (RST-SS = 18 players) or an RST group using CODs (RST-COD = 18 players). Thirty-two participants completed the study, while two participants per group dropped out due to contact injuries during the training sessions (injuries not associated with the protocols) or because they did not perform the second test battery. The flow of participants according to CONSORT was respected (Moher et al., 2001). Thirty-six participants (also the drop out) were considered in the final statistical analysis.

Training protocols, as well as the baseline tests and post-training assessments, were performed before the beginning of the official season (August 2017). In this study, the design selected did not involve a control group. Authors considered the utilisation of a control group, in such circumstances, as an unethical approach because it could have decreased the players' performance and impacted the clubs' success in the wider fixture program. A more detailed description of this decision is reported in the following publication (Beato et al., 2018). This approach is largely used in clinical trials when an existing treatment that has already been demonstrated to have efficacy exists (Lesaffre, 2008). In such an instance, RST chosen for this study was previously utilised with success (Taylor et al., 2016a).

Tests

The participants replicated the same tests 3 times, with a recovery of 3 minutes between the trials and the best scores in every test were considered for further data analysis. The 10 and 20 m sprints were performed to evaluate improvements in sprint abilities. For this purpose, infrared timing gates (Microgate, Bolzano, Italy) were placed at the start and the end of each of the mentioned distances. The 505 COD test was utilised to evaluate improvements in agility (Paul et al., 2016; Stewart et al., 2014). The repeated-sprint test used the following protocol: 6 sprints of 20 + 20 m (with one COD of 180°) interspersed with a recovery period of 20 s (Impellizzeri et al., 2008). Repeated-sprint test best (RSTbest) and RSTmean (average of the 6 sprints time) were used for analysis (Impellizzeri et al., 2008). The Yo-Yo Recovery Level 1 was used to evaluate soccer specific aerobic fitness variations after the RST protocol (Krustrup et al., 2003).

Training

The two training methods proposed were previously analysed using a Global Positioning System (Taylor et al., 2016a). Maximum speed was higher in the RST-SS (27.7 $km \cdot h^{-1}$) compared to the RST-COD (19.8 $km \cdot h^{-1}$) based on the nature of the activity (straight sprint vs. short shuttle runs), while the heart rate peak resulted in 92.1% and 89.1%, respectively (non-significant difference). In this study, the players' internal load was monitored using the Rating of Perceived Exertion scale (RPE, Borg's CR10-scale) (Gaudino et al., 2015; Impellizzeri et al., 2004). Protocols were as follows: 3 sets of 7 x 30 m sprints for the RST-SS and 7 x 20 + 20 m (one COD of 180°) for the RST-COD, with 20 s and 4 min recovery between sprints and sets, respectively. The training volume was maintained constant during the 6 sessions of the protocol.

Statistical analysis

Data were presented as mean ± standard deviation (SD). The Shapiro-Wilk test was used for checking the normality (assumption). Robust estimates of the 90% confidence interval (CI) and heteroscedasticity were calculated using bootstrapping technique (randomly 1000 bootstrap samples) (Haukoos and Lewis, 2005). Intention to treat analysis was adopted (every player was considered for the final analysis) (Beato et al., 2017; Moher et al., 2001). Analysis of variance (one-way ANOVA) was used to evaluate within-group differences (Baseline and Post). Analysis of covariance (ANCOVA), using baseline values as covariate, was employed to detect possible between-groups differences (Hopkins et al., 2009). When significant F-values were found, post hoc analysis was performed (Bonferroni). Significance was set at $p < 0.05$ and reported to indicate the strength of the evidence. Effect size (ES) based on the Cohen d principle was interpreted as trivial < 0.2, small 0.2-0.6, moderate 0.6-1.2, large 1.2-2.0, very large > 2.0 (Hopkins et al., 2009). Statistical analyses were completed using SPSS software version 20 for Windows 7 (Chicago, USA).

Results

No differences were found between the two groups at baseline: 10 m Sprint, 20 m Sprint, 505 COD, RSTbest, RSTmean, and Yo-Yo recovery Level 1 ($p > 0.05$). The RST-SS and RST-COD did not show any difference ($p = 0.77$) in the internal load recorded (RPE) 6.3 ± 0.5 AU and 6.4 ± 0.6 AU, respectively, during the short-term protocol. There were no changes in performance for the RST-SS, while the RST-COD showed meaningful improvements in the 10 m Sprint and RSTbest after the training period. Within-group variations for both the RST-SS and RST-COD are reported in Table 1. Between-group analysis did not show any statistical difference in the 10 m Sprint (F = 1.192, $p = 0.283$), 20 m Sprint (F = 1.403, $p = 0.283$), 505 COD test (F = 0.193, $p = 0.663$), RSTmean (F = 1.201, $p = 0.35$), RSTbest (F = 2.263, $p = 0.142$), and Yo-Yo recovery Level 1 (F = 1.031, $p = 0.738$).

Discussion

The aim of this study was to examine the effect of two short-term RST protocols in amateur soccer players during the pre-season. After 2 weeks of RST, few meaningful within-group differences were found, with positive effects exclusively for the RST-COD that showed moderate positive effects in the 10 m sprint and RSTbest (ES = 0.70 and 0.65, respectively). No group differences were found between the RST-SS and RST-COD. This study can have important implications because it does not support the utilisation of a very short-term (2 weeks) RST intervention in soccer. Moreover, this study reported a better within effect after the RST-COD protocol, which should be preferred to RST using straight sprints.

RST is a widely-implemented methodology for enhancing functional performance in soccer (Bishop et al., 2011). Previous studies presented positive effects on sprint and repeated sprint abilities after medium and long-term training (Bishop et al., 201; Ferrari Bravo et al., 2008; Serpiello et al., 2011). However, data on short-term training are scant (Taylor et al., 2015). The only previous study available on this topic reported large positive effects in 5 m, 10 m, 20 m sprint performance and moderate to large effects in Yo-Yo Recovery

Level 1 performance, while no clear differences were found in the countermovement jump and agility tests (Taylor et al., 2016a). The current study presented much smaller effects after 2 weeks of training (within-group analysis) (Table 1) than previously reported. The different effects found between Taylor et al. (2016a) and the current study could be explained by the different sample enrolled (semi-professional vs. amateurs) and the consequent different weekly training load of the two samples (higher in semi-professional than amateurs). The authors believe that the limited improvements obtained after both the RST protocols (in this study) could be explained because of the short-term training intervention. Existing literature suggests that fitness improvements are closely associated with the duration of the protocol and 8 weeks seems to be a suitable period to obtain some physiological adaptations (Bishop et al., 2001, 2011; Girard et al., 2011). Therefore, shorter protocols could fail to show meaningful effects, and the current study supports this statement.

A sport specific RST protocol involving linear sprints and specific COD angles could replicate power-type demands (biomechanical and physiological) required during a soccer match (Jeong et al., 2015; Serpiello et al., 2011; Zamparo et al., 2016). This study does not show any between-group differences after the protocol, therefore based on this evidence, it is not possible to state with certainty that one RST method is more effective to improve soccer relevant physical performance than the other. However, from a theoretical point of view, and based on previous evidence analysing longer protocols (> 8 weeks), it seems that the inclusion of CODs could offer additional benefits to sports specific performance (Born et al., 2016; Ferrari Bravo et al., 2008; Zamparo et al., 2014). Existing evidence suggests that CODs and short shuttle runs are more demanding than straight running and, therefore, produce higher central (e.g. O_2 consumption) and peripheral (e.g. lactate) stimuli (Taylor et al., 2015; Zamparo et al., 2014, 2015). Zamparo et al. (2014) reported in a previous study that shuttle runs (with a COD of 180°) resulted in higher cardiorespiratory and blood lactate accumulation data compared with linear sprints, therefore, CODs could offer a critical adaptation for soccer players (and other teams sports athletes). However, such metabolic factors cannot explain improvements found in sprint tests. The RST-COD showed increments in the 10 m sprint and RSTbest (moderate effects), while the RST-SS did not show any variation. These improvements could be associated with neuromuscular adaptations (e.g. increased muscle power) obtained by the repetition of CODs and accelerations, as well as the higher total sprint distance covered during the protocol. This could result in a potential higher mechanical load. These physiological explanations could support the slight superiority (with-in analysis) of the RST-COD protocol after two weeks of intervention. Therefore, the RST protocol using CODs could offer some advantages compared to RST-SS, however, future studies should verify these findings.

This study presents some limitations: firstly, the design of this study is not a randomised controlled trial. Authors considered the utilisation of a control group, in such circumstances, as a criticisable approach because it could have decreased the future players' performance in the wider fixture program. This approach is largely used in clinical trials when an existing treatment that has already been demonstrated to have efficacy exists (Lesaffre, 2008). In such an instance, RST chosen for this study was previously tested with success (Taylor et al., 2016a). Secondly, a gender-related generalisation of the results cannot be inferred and, therefore, the results could not be extended to other specific populations (e.g. female players or elite athletes). This study could be replicated enrolling amateur and elite female soccer players. The last limitation is associated with the total distance covered in the two protocols, where the RST-COD covered a longer sprint distance than the RST-SS. These discrepancies in the total sprint volume could have helped to find larger effects (e.g. sprint tests).

Conclusions

In conclusion, this study does not support the utilisation of very short-term RST, but it recommends protocols of longer duration as reported in the literature (generally >8 weeks). The results presented in this study disagree with the only previous evidence published on this topic (Taylor et al., 2016a), since both RST-SS and RST-COD were not effective training modalities when utilised for very short time (2-week short-term protocol). The results reported in this study can have a very important impact on fitness periodisation and training in soccer. Fitness coaches and sports scientists could integrate their training plans with the protocols described in this study, yet the authors suggest using longer training duration.

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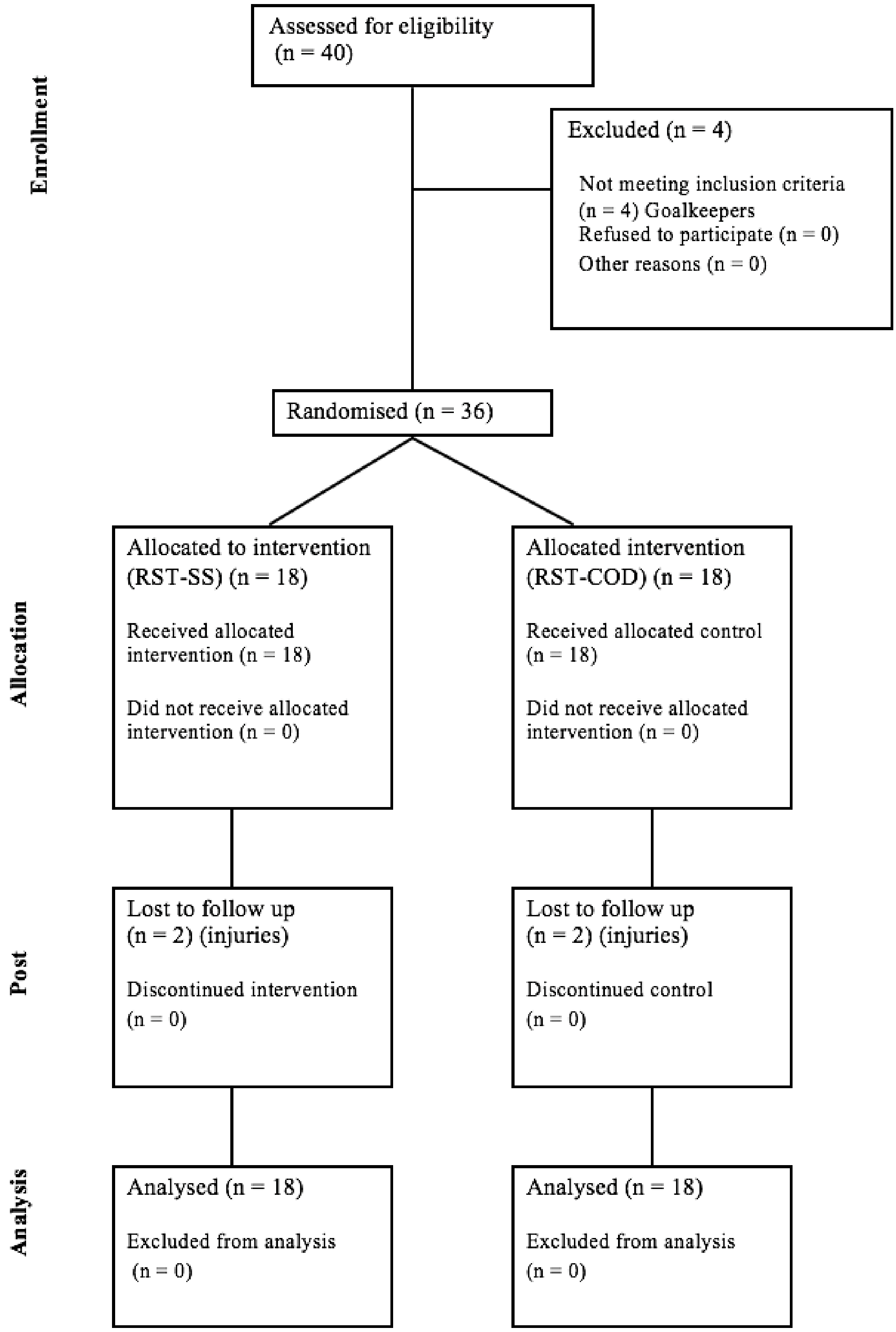

Figure 1. CONSORT diagram showing the flow of participants through each stage of a randomised trial

Table 1. Summary of baseline and post-training data for RST (RST-SS, n = 18, and RST-COD, n = 18). Data are presented as mean ± SD.

Variable	Baseline Mean ± SD	Post-training Mean ± SD	Delta difference (90% CI)	*p*	ES (interpretation)
RST-SS					
10 m Sprint (s)	1.75 ± 0.11	1.74 ± 0.11	-0.01 (-0.05; 0.05)	0.985	0.09 (trivial)
20 m Sprint (s)	2.94 ± 0.11	2.92 ± 0.11	-0.02 (-0.06; 0.06)	0.965	0.18 (trivial)
505 COD test (s)	4.77 ± 0.22	4.76 ± 0.19	-0.01 (-0.07; 0.06)	0.967	0.04 (trivial)
RSTmean (s)	7.46 ± 0.19	7.40 ± 0.20	-0.06 (-0.14; 0.03)	0.231	0.3 (small)
RSTbest (s)	7.13 ± 0.17	7.09 ± 0.18	-0.04 (-0.15; 0.07)	0.479	0.2 (small)
Yo-Yo 1 (m)	1642 ± 365	1822 ± 461	180 (-87; 447)	0.258	0.49 (small)
RST-COD					
10 m Sprint (s)	1.78 ± 0.11	1.70 ± 0.12	-0.08 (-0.13; -0.07)	0.040	0.72 (moderate)
20 m Sprint (s)	2.96 ± 0.12	2.90 ± 0.10	-0.06 (-0.10; 0.01)	0.222	0.52 (moderate)
505 COD test (s)	4.70 ± 0.21	4.73 ± 0.16	0.03 (-0.08; 0.14)	0.667	0.15 (trivial)
RSTmean (s)	7.50 ± 0.21	7.48 ± 0.21	-0.02 (-0.06; 0.03)	0.475	0.1 (trivial)
RSTbest (s)	7.14 ± 0.18	7.01 ± 0.18	-0.13 (-0.23; -0.03)	0.037	0.65 (moderate)
Yo-Yo 1 (m)	1686 ± 359	1811 ± 260	124 (-24; 273)	0.164	0.46 (small)

SD = standard deviations; CI = confidence intervals; ES = effect size; m = meters; s = seconds, SS = straight sprints; COD = change of directions; RST = repeated sprint test; Yo-Yo 1 = Yo-Yo recovery Level 1