

Effect of an eccentric overload and small-side games training in training accelerations and decelerations

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Abstract:

The aim of this study was to investigate the effects that two different training programs have on the characteristics of the accelerations (ACC) and decelerations (DCC) of the soccer players and their ability to maintain them over time in a training task. Twenty-three female soccer players from a Spanish professional club were split into three groups: a Small-sided game training (SGG), an eccentric overload training (EOG) and a control group (CG). The ACC and DCC variables were analysed in a training task before and after the training protocol using GPS devices. The SSG improved the total distance travelled [ES (CI) = 0.32 (0.04; 0.60)], the number of ACC >2 m/s² [ES (CI) = 0.60 (-0.16; 1.36)], distance travelling ACC between 2-3 m/s² [ES (CI) = 0.62 (-0.01; 1.25)], initial velocity ACC [ES (CI) = 0.88 (-0.10; 1.86)] and the percentage of repeated ACC [ES (CI) = 0.58 (-0.11; 1.28)] with respect to the CG. The EOG group improved distance travelling ACC [ES (CI) = 0.66 (-0.10; 1.41)] and DCC [ES (CI) = 1.21 (0.77; 1.64)] over 3 m/s², maximum ACC [ES (CI) = 0.92 (0.40; 1.44)] and DCC [ES (CI) = 1.16 (0.58; 1.74)], average ACC [ES (CI) = 1.07 (0.40; 1.74)] and DCC [ES (CI) = 0.91 (0.24; 1.54)] and the number of DCC >2 m/s² [ES (CI) = 0.54 (-0.18; 1.26)] with respect to the CG. In conclusion, the SSG obtained improvements in the ACC variables, while the EOG brought about improvements in the ACC and DCC variables.

Key Words: GPS device; football; female players; strength training; flywheel devices.

Introduction

Soccer is an intermittent sport, demanding high aerobic and anaerobic adaptation levels (Di Salvo et al., 2007) with a large number of short high-intensity actions, which are probably a determinant factor of performance (Mara et al., 2017). Based on this affirmation, different training methods have gained importance during recent years. In addition, the studies related to accelerations (ACC) and decelerations (DCC) in team sports has increased in the last years, owing to the approval by sport's governing bodies to use GPS devices in competitive match plays (Harper et al., 2019).

One example is eccentric-overload. Strength training through fly-wheel devices has gained prominence, due to the high degree of involvement of eccentric force in the deceleration phase, which is essential to improve the levels of re-acceleration when changing direction (de Hoyo et al., 2016).

Initially, eccentric-overload training (EOT) was used as a useful method to reduce the number of injuries in football players (Askling et al., 2003; de Hoyo et al., 2016). However, nowadays the majority of research works focus on the positive effects of this kind of training to improve change of direction (COD) variables in soccer players, as has been proved in different researches (Beato et al., 2019; de Hoyo et al., 2016; Tous-Fajardo et al., 2016).

Another type of current training is small-sided games training (SSGT), which is based on game situations played on a smaller area than an official game and with a reduced number of players (Halouani et al., 2014). The great advantage of these games is the capacity of reproducing a similar context to a real match but with a higher number of technical and tactical actions, owing to the reduced number of players and game dimensions, with demonstrated positive effects on the improvement of physical capabilities (Halouani et al., 2014; Hill-Haas et al., 2011).

SSGT has shown similar improvements to high interval intensity training (Dellal et al., 2012; Halouani et al., 2014; Hill-Haas et al., 2011) with better results after a SSGT periodisation in COD (Büjalance-Moreno et al., 2018; Dellal et al., 2012; Halouani et al., 2014), RSA (Büjalance-Moreno et al., 2018; Eniseler et al., 2017; Halouani et al., 2014; Owen et al., 2012), maximal oxygen intake (Halouani et al., 2014), and sprint test (Büjalance-Moreno et al., 2018; Halouani et al., 2014).

Despite finding much research studying the influence of both kinds of training in physical variables, no study has analysed the effects of them on a training task. With this goal, the aim of this study was to investigate

the impacts that the different training programmes have on the characteristics of the accelerations and decelerations of the players and their ability to maintain them over time.

Material & methods

Participants

A convenience sample of 18 U-23 female soccer players was recruited, with the following characteristics: age (mean \pm SD, years) = 19.3 ± 1.7 ; range = 16–23; body mass (mean \pm SD, kg) = 53.9 ± 7.3 ; height (mean \pm SD, cm) = 161.1 ± 6.1 .

The players belonged to the second team of a professional Spanish club. This team has competed in the second national female football league for the last 9 seasons. Three weekly training sessions are performed during the competitive period. At the time of the study, no injuries were diagnosed and no player was in a recovery process.

All participants and their parents or guardians were informed in advance about the purpose of the study and the type of evidence to be submitted. Each of the players and their parents or guardians gave their signed informed assent following the recommendations of the Declaration of Helsinki. The study was approved by the ethics committee of the Autonomous University of Madrid.

Procedure

The study was based on a quasi-experimental design, establishing 3 groups: a control group (CG, $n = 7$), a first experimental group (EOT, $n = 8$) enrolled in 10 sessions of isoinertial-based additional strength training using flywheel devices, and a second experimental group (SSGT, $n = 8$) which carried out an additional programme of 10 SSGT sessions. Players with availability for performing two additional sessions per week were randomly assigned to the two experimental groups. The data were collected during the previous week and after the 5-week period during which the training programmes were carried out. Both experimental groups included two additional training sessions per week.

The first experimental group executed 10 EOT sessions. The training consisted of 5 exercises using flywheel devices, squat and lateral lunge (kBox 3, Exxentric AB TM®, Bromma, Sweden), lying glute kickback and split in Versa-Pulley (Heart Rate Inc.®, Costa Mesa, California, USA) and two-leg curl on a YoYo flywheel device (YoYo® Technology, Stockholm, Sweden). The unilateral exercises were performed twice, one with each leg. Following previous studies (de Hoyo et al., 2016; De Hoyo et al., 2015; Tous-Fajardo et al., 2016) the workload was increasing progressively, by a rate of 2 repetitions every two training sessions, starting with 1x6 (6 reps) and ending with 2x7 (14 reps). During training on the flywheel devices, the players were encouraged to perform the concentric phase as fast as possible, while delaying the braking action to the last third of the eccentric phase (Sabido et al., 2017; Tous-Fajardo et al., 2016).

On the other hand, 10 sessions of SSGT were performed by the second experimental group. The training consisted of ball possession exercises between two 4-player teams within a space of 18 x 18 m (40.5 m² / p) in size, split into 3 sets of 4 minutes, leaving 1:30 min of recovery between sets. This SSGT was done at the end of the training sessions.

All the players were familiarised with the exercises used in the EOG and in the SSG as part of the training during the season. The control group was limited to carrying out the usual training sessions programmed for the whole group.

Training task

Data were obtained during a training task. This was chosen to check the effects of the different programmes on the physical performance of the players in a context similar to competition and also to control contextual variables which cannot be granted in competition, such as the quality of the opponent, the score, the style of play or the frequency and duration of the interruptions (Lago-Peñas, 2012; Linke et al., 2018).

The task consisted in a 6-on-6, plus an additional player who participated only with the team that was in possession of the ball, in a pitch measuring 38 x 45 m (131 m²/p), without any structure or direction and during 3 sets of 4 min with 1:30 min of recovery. The objective was to maintain possession of the ball as long as possible. The task was performed twice in two training sessions, placing two players from each experimental group in each team.

Kinematic variables

During the training task, the following variables were measured:

- Total distance (TD).
- Work-rest ratio (WR Ratio): distance covered by the player at a speed >4 km/h (period of activity or work) divided by the distance covered at a speed of 0–3.9 km/h (period of recovery or rest) (David Casamichana et al., 2012).
- High intensity running (HIR): distance travelled at a speed $> 60\%$ of maximal velocity (Bradley & Vescovi, 2015). This was estimated individually by the maximal individual speed achieved during a previous speed test (Castellano et al., 2016).
- Total number of accelerations (N° ACC >2) and decelerations (N° DCC >2) >2 m/s² (David Casamichana et al., 2012).

- Distance travelled accelerating (ACC 2-3) and decelerating (DCC 2-3) between 2 and 3 m/s² and above 3 m/s² (ACC>3 and DCC>3) (Gaudino et al., 2014; Hodgson et al., 2014).
- Maximum accelerations and decelerations (ACC max/DCC max) (Gaudino et al., 2014; López-Fernández et al., 2019). The average of all the values was calculated as Average ACC/Average DCC.
- Initial velocity acceleration (Initial V ACC) and deceleration (Initial V DCC). This was defined as the running speed immediately before the start of acceleration and deceleration (Sonderegger et al., 2016).
- Percentage of repeated accelerations (% ACC rep) and decelerations (% DCC rep) defined as the percentage of accelerations and decelerations that were repeated with a maximum of 30 seconds after the last one (Buchheit et al., 2010).

Instruments

The physical data of the task were obtained with a GPS device (GPSports, SPI-Pro X, Canberra, Australia). These devices have been used in previous research to provide data on distances travelled at different speeds, accelerations, and decelerations (Gaudino et al., 2014). Regarding the research on the reliability of the device, it has been proved, in general, as a valid and reliable instrument (Vickery et al., 2014).

Each player wore a padded neoprene vest where the device was placed, with the GPS situated between the scapula near the upper thoracic spine (De Hoyo et al., 2018). All the devices were activated approximately 15 minutes before the data collection to allow acquisition of satellite signals (Gaudino et al., 2014). To avoid the error that can be caused by the use of different devices, each player always used the same equipment (Buchheit et al., 2010).

The Team AMS software (Team AMS, GPSports) was used to analyse the data related to accelerations, decelerations and distances travelled at different speeds obtained by the device.

Statistical analysis

For the statistical analyses, the IBM SPSS statistics 22 software was used.

Regarding the descriptive statistics, the mean and the standard deviation were calculated.

The confidence level of the measurements was estimated at a 90% confidence interval (CI) for the mean, using Cohen's effect size (ES). An approximation of magnitude-based interference was used to interpret the possible differences between groups in the different variables analysed (Hopkins et al., 2009). The criterion that was followed to categorise the magnitude of the effect size was: trivial (< 0.2), low (0.2-0.6), moderate (0.6-1.2), high (1.2-2.0), and very high (> 2.0). The probabilities were determined to establish if the real differences were higher, similar to or lower than the minimum appreciable change (0.2 x SD between participants (Hopkins et al., 2009). The probabilities of obtaining better or worse effects were evaluated in the following qualitative way: < 1%, almost certainly not; 1-5%, very unlikely; 5-25%, unlikely; 25-75%, unclear; 75-95%, possibly; 95-99%, very likely and > 99%, most likely. If the probabilities of obtaining a better or a worse effect were both > 5%, the real difference between the groups was classified as unclear.

Results

Table 1 shows the results of the variables analysed during the training task for the SGG. Improvements were obtained for TD [ES (CI) = 0.32 (0.04; 0.60)], N° ACC >2 [ES (CI) = 0.60 (-0.16; 1.36)], ACC 2-3 [ES (CI) = 0.62 (-0.01; 1.25)], Initial V ACC [ES (CI) = 0.88 (-0.10; 1.86)] and % ACC rep [ES (CI) = 0.58 (-0.11; 1.28)]. Only unclear changes were found in the deceleration variables.

Table 1. Pre – post differences in training task variables obtained with GPS between SSG and CG.

Variables	SGG		CG		ES 90% IC	%	Qualitative Inference
	Pre	Post	Pre	Post			
TD (m)	452.8 ± 59.6	465.7 ± 59.9	454.8 ± 69.6	445.5 ± 54.9	0.32 (0.04; 0.60)	77/23/0	Likely
WR Ratio	10.01 ± 4.08	10.83 ± 5.37	7.69 ± 3.08	7.96 ± 2.43	0.13 (-0.41; 0.67)	41/44/15	Unclear
HIR (m)	43.04 ± 17.30	48.38 ± 25.64	53.10 ± 24.73	54.33 ± 18.79	0.17 (-0.51; 0.86)	47/35/17	Unclear
N° ACC >2	8.79 ± 2.32	9.71 ± 2.36	9.05 ± 1.88	8.57 ± 2.34	0.60 (-0.16; 1.36)	82/14/4	Likely
ACC 2-3 (m)	17.92 ± 5.11	21.84 ± 6.19	16.23 ± 6.60	16.1 ± 8.45	0.62 (-0.01; 1.25)	87/11/2	Likely
ACC >3 (m)	3.27 ± 2.53	2.53 ± 1.61	4.30 ± 3.17	3.12 ± 2.59	0.12 (-0.69; 0.94)	44/32/25	Unclear
ACC Max. (m/s ²)	3.23 ± 0.39	3.23 ± 0.29	3.38 ± 0.48	3.22 ± 0.32	0.32 (-0.36 0.99)	62/28/10	Unclear
Average ACC (m/s ²)	2.51 ± 0.14	2.55 ± 0.19	2.57 ± 0.13	2.59 ± 0.07	0.16 (-0.60; 0.92)	46/33/21	Unclear

Initial V. ACC (km/h)	3.67 ± 0.71	4.26 ± 0.83	3.82 ± 0.43	3.86 ± 0.48	0.88 (-0.10; 1.86)	88/8/4	Likely
% ACC Rep	59.6 ± 13.3	67.1 ± 6	57.6 ± 8.31	57.8 ± 11.4	0.58 (-0.11; 1.28)	83/14/3	Likely
N° DCC >2	12.71 ± 2.39	12.21 ± 2.71	10.14 ± 2.86	8.67 ± 1.66	0.30 (-0.45; 1.05)	59/28/13	Unclear
DCC 2-3 (m)	19.36 ± 3.86	19.89 ± 5.92	17.71 ± 4.28	17.39 ± 3.54	0.19 (-0.74; 1.13)	49/28/23	Unclear
DCC >3 (m)	6.95 ± 3.67	5.41 ± 3.22	6.98 ± 2.59	4.77 ± 1.69	0.19 (-0.43; 0.81)	49/37/14	Unclear
DCC Max (m/s ²)	3.74 ± 0.21	3.44 ± 0.41	3.79 ± 0.25	3.59 ± 0.21	- 0.39 (-1.33; 0.55)	14/22/64	Unclear
Average DCC A (m/s ²)	2.75 ± 0.15	2.79 ± 0.14	2.80 ± 0.12	2.82 ± 0.1	0.11 (-0.64; 0.86)	42/34/24	Unclear
Initial V. DCC (km/h)	11.79 ± 0.65	11.86 ± 0.69	11.42 ± 0.80	11.67 ± 0.55	-0.22 (-1.00; 0.77)	18/30/51	Unclear
% DCC Rep	58.9 ± 10.3	63.9 ± 6.2	56.6 ± 7.9	58.7 ± 7.6	0.28 (-0.16; 0.72)	63/33/4	Possibly

Table 2 shows the results of the variables analysed during the training task for the EOG. Improvements were obtained for ACC>3 [ES (CI) = 0.66 (-0.10; 1.41)], ACC max [ES (CI) = 0.92 (0.40; 1.44)] Average ACC [ES (CI) = 1.07 (0.40; 1.74)], N° DCC >2 [ES (CI) = 0.54 (-0.18; 1.26)], DCC>3 [ES (CI) = 1.21 (0.77; 1.64)], DCC max [ES (CI) = 1.16 (0.58; 1.74)] and Average DCC [ES (CI) = 0.91 (0.24; 1.54)]. The WR Ratio shows a negative change with respect to the control group [ES (CI) = - 0.38 (-0.71; -0.05)].

Table 2. Pre-post differences in training task variables obtained with GPS between EOG and CG.

Variables	EOG		CG		ES 90% IC	%	Qualitative Inference
	Pre	Post	Pre	Post			
TD (m)	471.5 ± 40.7	454.9 ± 37.5	454.8 ± 69.6	445.5 ± 54.9	- 0.11 (-0.39; 0.17)	3/68/29	Unclear
WR Ratio	13.05 ± 6.06	10.96 ± 4.66	7.69 ± 3.08	7.96 ± 2.43	- 0.38 (-0.71; -0.05)	0/17/82	Likely
HIR (m)	39.71 ± 17.60	43.63 ± 19.17	53.10 ± 24.73	54.33 ± 18.79	0.11 (-0.39; 0.61)	38/48/15	Unclear
N° ACC >2	7.79 ± 2.82	7.88 ± 2.23	9.05 ± 1.88	8.57 ± 2.34	0.20 (-0.39; 0.80)	50/37/12	Unclear
ACC 2-3 (m)	15.89 ± 6.54	16.34 ± 5.08	16.23 ± 6.60	16.1 ± 8.45	0.08 (-0.47; 0.63)	35/46/19	Unclear
ACC >3 (m)	2.35 ± 1.89	3.37 ± 2.52	4.30 ± 3.17	3.12 ± 2.59	0.66 (-0.10; 1.41)	85/12/3	Likely
ACC Max. (m/s ²)	3.10 ± 0.42	3.43 ± 0.39	3.38 ± 0.48	3.22 ± 0.32	0.92 (0.40; 1.44)	99/1/0	Very Likely
Average ACC (m/s ²)	2.41 ± 0.10	2.59 ± 0.11	2.57 ± 0.13	2.59 ± 0.07	1.07 (0.40; 1.74)	98/2/0	Very Likely
Initial V. ACC (km/h)	4.30 ± 0.60	4.15 ± 0.70	3.82 ± 0.43	3.89 ± 0.47	-0.34 (-1.44; 0.77)	20/22/59	Unclear
% ACC Rep	52.3 ± 15.9	51.9 ± 12.9	57.6 ± 8.31	57.8 ± 11.4	- 0.05 (-0.73; 0.64)	26/39/34	Unclear
N° DCC >2	9.92 ± 2.42	10.01 ± 2.77	10.14 ± 2.86	8.67 ± 1.66	0.54 (-0.18; 1.26)	79/16/5	Likely
DCC 2-3 (m)	16.83 ± 5.30	16.70 ± 6.16	17.71 ± 4.28	17.39 ± 3.54	0.04 (-0.37; 0.45)	25/59/16	Unclear
DCC >3 (m)	5.51 ± 3.68	7.68 ± 3.95	6.98 ± 2.59	4.77 ± 1.69	1.21 (0.77; 1.64)	100/0/0	Most Likely
DCC Max. (m/s ²)	3.55 ± 0.43	3.84 ± 0.44	3.79 ± 0.25	3.59 ± 0.21	1.16 (0.58; 1.74)	99/1/0	Very Likely
Average DCC A (m/s ²)	2.56 ± 0.09	2.74 ± 0.15	2.80 ± 0.12	2.82 ± 0.1	0.91 (0.24; 1.54)	96/3/1	Very Likely
Initial V. DCC (km/h)	11.75 ± 0.96	11.95 ± 0.75	11.42 ± 0.80	11.67 ± 0.55	-0.04 (-0.57; 0.49)	22/48/30	Unclear
% DCC Rep	54.3 ± 13.5	58.1 ± 8.1	56.6 ± 7.9	58.7 ± 7.6	0.14 (-0.48; 0.77)	43/40/17	Unclear

Figures 1 and 2 represent the difference between the distances travelled when accelerating and decelerating, respectively, at different intensities in the first and third series, and in the pre- and post-test. Improvements were

observed in the distance deficit between the first and the third series, accelerating at intensities between 2-3 m/s² [ES (CI) = -0.79 (-1.77, 0.18)] and decelerating at intensities >3 m/s² [ES (CI) = -0.59 (-1.12; 0.37)] between the SGG and the CG. The EOG presented unclear changes, in comparison with the CG, in the deficit of distances travelled when accelerating and decelerating.

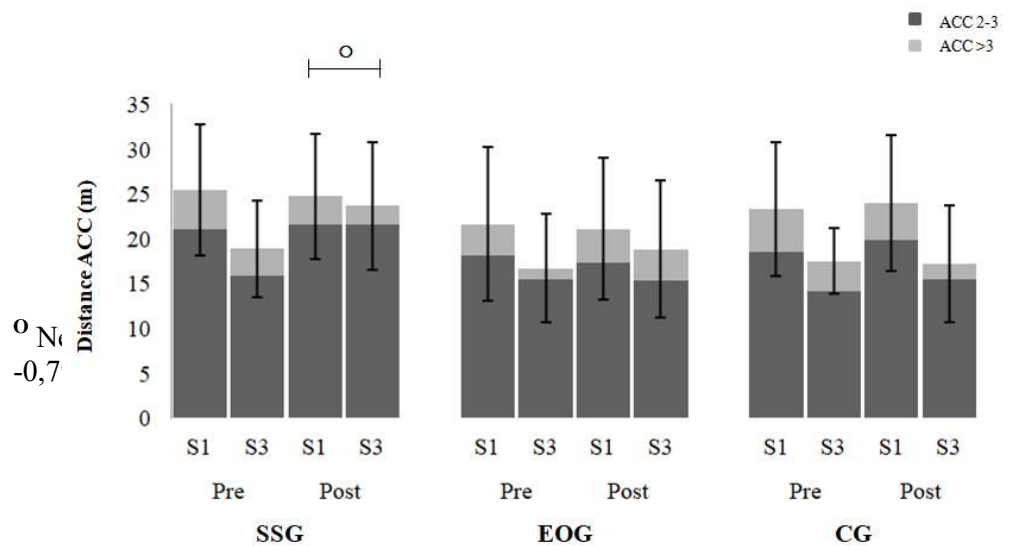


Figure I. Distance travelled accelerating in the first and third series (m).

* Negative effects on SGG compared with CG; low magnitude of change (ES = -0,59), (5/

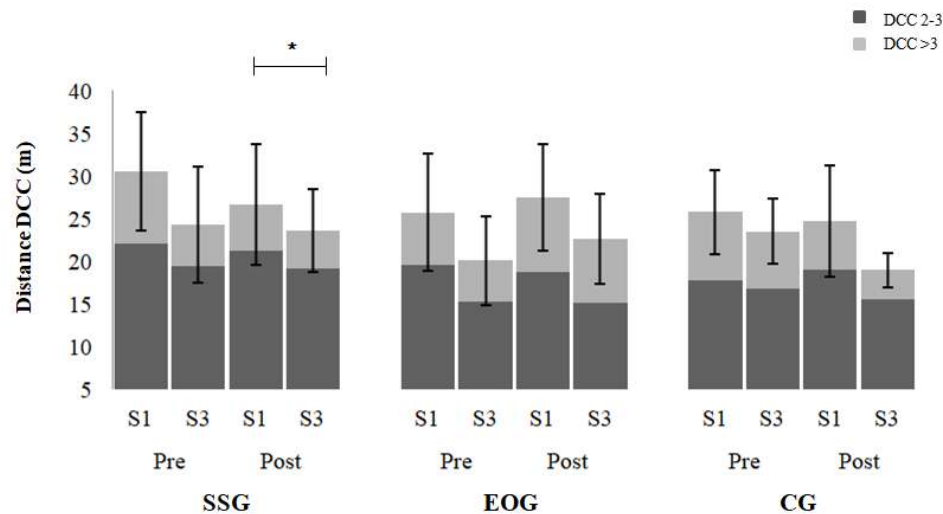


Figure II. Distance travelled decelerating in the first and third series (m).

Discussion

The aim of this research was to investigate the effects that the different training programmes have on the characteristics of the accelerations and decelerations of the players and their ability to maintain them over time.

Table 1 shows SSGT group improvements in ACC variables with respect to CG, including, TD, N° ACC >2, ACC 2-3, Initial V ACC and % ACC rep. The players also maintain the ability to accelerate between the first and third series of the task (Figure 1 and 2).

In the opinion of the authors, there are no studies which have evaluated an additional programme based on training through small-sided games that assess the effects during a model task. However, we could find different links with other studies for explaining the different improvements achieved.

The differences between the SGG group and the CG in TD, N° ACC >2, ACC 2-3 could be linked with the the improvement in the ability to repeat efforts (Owen et al., 2012), the reduction in the average time in an RSA test (Büjalance-Moreno et al., 2018) or the best time recorded during the RSA (Eniseler et al., 2017;

Rodríguez-Fernández et al., 2017) in previous studies that have used SGG as a training method. In addition, players are able to maintain the capacity of repeating accelerations over the time.

These effects are explained by a higher number of high intensity actions and a higher participation in SSG than in bigger situations (Hill-Haas et al., 2011) linked with the intermittent nature of the game (Gaudino et al., 2014; Nevado-Garrosa & Suárez-Arrones, 2015), which make a faster recovery possible between efforts in the player, being able to perform high intensity actions with a higher frequency (López-Segovia et al., 2014) by an improvement of the aerobic metabolism (Rodríguez-Fernández et al., 2017).

With respect to the improvement in % ACC rep in the SSGT, only one study has used this variable previously, taking measures in a real competition instead of a training task (Recuenco Serrano, 2016), concluding that despite of the influence of neuromuscular performance in this variable, the aerobic performance and the capacity of repeated efforts play an important role. So, the previously reported improvement in the aerobic metabolism could explain the improvement in % ACC rep for the SSGT.

However, it appears that there are not enough stimuli to achieve adaptations at the DCC level. This could be due to the fact that the ACC evaluated in the 6x6 started at 3-4 km/h, while the DCC have an average of 11-12 km/h, velocities which are difficult to achieve in the small-sided game (18x18 m) used in the SGG (D. Casamichana et al., 2011; Nevado-Garrosa & Suárez-Arrones, 2015).

Table 2 shows EOG group improvements in the ACC variables with respect to the CG, including ACC>3, ACC max, Average ACC, N° DCC >2, DCC>3, DCC max and Average DCC. The WR Ratio shows a negative tendency.

Similar to the SSGT, no previous research has used a model task to evaluate the effect of an eccentric overload training in football players. However, we could establish a relation between our study results and the improvement in change direction performance after an EOT in football players found in other studies (de Hoyo et al., 2016; Tous-Fajardo et al., 2016). Both authors seem to agree that training with eccentric overload improves the ability to change direction due to producing higher levels of strength when braking and re-accelerating and reducing contact times in both the braking phase and the phase of re-acceleration.

The improvement in DCC variables, which are not found in the SSGT, respond to the ability to produce greater eccentric strength during the braking phase, making a faster transition to the propulsive phase, improving the application of strength. A possible explanation, found in previous studies, is that a more intense braking phase allows storing and reusing elastic energy, increasing the production of strength in the re-acceleration phase (Spiteri et al., 2013).

Contrary to the SSGT, the improvement in ACC and DCC variables cannot be explained by an improvement in the capacity of repeating efforts, which is confirmed by previous studies (Tous-Fajardo et al., 2016). The negatives effects on the W-R Ratio, not being able to maintain the capacity of accelerating and decelerating between the first and third series (Figure 2) and not finding an increment in N° ACC >2 or N° DCC >2 ensure that a better result in some variables in the EOG could be not related with an improvement in the aerobic performance of the players. So, in this case, improvements in the ACC and DCC variables are related with an increment in the capacity of producing and applying strength.

The main limitation of the present study was the sample size, which could be increased to a higher number of players, teams or player levels. Another possible limitation is the accuracy of the instrumentation when recording data in sports characterized by intermittent actions with changes in speed and direction. In addition, it was not possible to have an encoder in each fly-wheel device to control the intensity during the eccentric-overload training in our study.

As future lines of research, it will be necessary to develop more precise tools which follow the capacity to incorporate evaluation methods of a more open nature, closer to the real game.

Conclusions

In conclusion, the SSGT performed on this research seem to be a good method for inducing slight adaptations related to the capacity of acceleration, but, in this case, not with the capacity of deceleration. Besides, players were able to maintain performance related to repeat short efforts as well as maintaining them in time, ratifying the capacity of small-sided games to induce adaptations in the aerobic metabolism. On the other hand, EOG group improved the ability to accelerate and decelerate in the training task, meaning more intense actions due to an improvement in the capacity to produce strength. However, this kind of training was not able to avoid the usual decrement in the ACC and DCC during the first and third series of the training task.

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