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Research article

Physical Demands of Ball Possession Games in Relation to the Most Demanding Passages of a Competitive Match

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Abstract

The main aim of this study was to determine the physical demands of different small-sided ball possession games (SSBPGs) according to player field position and compare these demands in relation to the most demanding passages of play (MDP) in competitive matches. Global positioning system data were obtained from 25 football players (20.4 ± 2.1 yrs, 1.78 ± 0.66 m, 69.7 ± 6.1 kg) belonging to the reserve squad of a Spanish La Liga Club. Players were categorized according to positional groups; full back (FB), central defender (CD), midfielder (MF), wide midfielder (WMF) and forwards (FW). The variables analyzed were relativized to metres per minute ($m \cdot min^{-1}$): total distance covered (TD), TD at high speed (HSR; >19.8 $km \cdot h^{-1}$), TD at sprint (SPR; >25.2 $km \cdot h^{-1}$), the number of accelerations (ACC) and decelerations (DEC) at high intensity (> +/-3 $m \cdot s^{-2}$), the average metabolic power (AMP; $W \cdot kg^{-1}$) and the high metabolic load distance (HMLD; >25.5 $W \cdot kg^{-1}$). The MDP were analyzed using a rolling average method, where maximal values were calculated for 3 and 5 minutes to compare with SSBPGs using AMP as a criterion variable. The results were obtained from the SSBPGs relative to the MDP (expressed in %) for each player position. FB showed the greatest magnitude of overload in ACC/DEC according to the MDP in the two smaller SSBPGs formats (201-217%), whereas MF showed lower values (105-140%). The load expressed in relation to the MDP can be different depending on the format of the SSBPGs and the characteristics of playing position. These factors should be considered by the coaches when planning training.

Key words: Small-sided games, GPS, peak intensity, football.

Introduction

Small-sided games (SSGs) are extensively used in football training with the aim of concurrently simulating a variety of technical and physical aspects of the sport (Hill-Haas et al., 2009). In this regard, the implementation of SSGs has been shown to be effective in developing aerobic and anaerobic endurance, agility and strength in players at different standards of play (Los Arcos et al., 2015; Owen et al., 2012).

Among the vast array of football-specific tasks (e.g., SSGs, modified games, conditioned games, etc.) currently available, small-sided ball possession games (SSBPGs) are extensively used to develop combinative playing skills. In these drills, the generic aim is to conserve ball possession with no goals or goalkeepers involved, while the four moments of the game (i.e., offensive organization, defensive organization and both offensive and defensive transitions) are present (Winter and Pfeiffer, 2016). Moreover, the spatial structure of the team and tactical tasks associated with the different playing positions, although simplified in comparison to an 11 vs. 11 game, can be maintained.

The idea that the physical demands of competition present large inter-player and intra-player variability is not new (Carling 2013; Di Salvo et al., 2007). One of the variables that can greatly influence a player's physical activity during a competitive match is the position they occupy on the pitch (Castellano et al., 2014; Di Salvo et al., 2007). Thus, it would appear desirable that training drills aiming to improve game-related physical performance effectively address these positional-specific demands observed during matches. In overall terms, SSGs typically present lower demands relating to high-speed running (HSR) and sprint actions, and greater acceleration-deceleration demands than competitive matches (Beenham et al., 2017; Casamichana et al., 2012; Dellal et al., 2012; Giménez et al., 2018). The magnitude of these differences increases when the number of players and/or pitch dimensions are reduced (Casamichana and Castellano, 2010; Hill-Haas et al., 2009).

Recently, Lacome et al. (2017) compared competitive match demands with those imposed by different SSGs and modified games, considering the playing position of players in the competition. The main findings revealed that, when compared with the most demanding passages (MDP) of the competitive matches, there were substantial differences depending on positional role, with central defenders and midfielders being the most over-stimulated and under-stimulated during the SSGs compared to competition respectively. Despite the study by Lacome et al. (2017), the possible differences that SSGs might impose on the different playing positions remain largely unexplored.

To date no comprehensive evaluation of the physical demands of SSBPGs in comparison with game demands and specific to each playing position has been conducted. Therefore, the aim of this study was to quantify the external training load that the different positions are

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exposed to during different SSBPGs when compared with the MDP of competitive matches.

Methods

Study design

Global Positioning System (GPS) data were collected during the 2015-2016 competitive season to establish the position-specific demands of the competitive matches and the different SSBPGs. Demands were expressed in values relative to practice time ($m \cdot min^{-1}$ for example) and values relative to the most demanding passages of play (% of the MDP) in competitive football matches over a similar duration (3 or 5 minutes).

Participants

Data were collected from 25 football players (20.4 ± 2.1 yrs, 1.78 ± 0.66 m, 69.7 ± 6.1 kg) belonging to the reserve squad of a Spanish La Liga Club. At the time of writing, the first team squad has been ranked among the top six in the last 10 seasons and ranked as the top team in the last three seasons according to official UEFA rankings. Players were grouped according to their playing position as central defenders (CD, n = 4), full backs (FB, n = 6), midfielders (MF, n = 3), wide midfielders (WMF, n = 5) and forwards (FW, n = 7). Data arose as a condition of the players' employment whereby they were assessed daily and thus no authorization was required from an institutional ethics committee (Carling et al., 2016; Lacome et al., 2017). Nevertheless, this study conformed to the Declaration of Helsinki and players provided informed consent before participating.

Competitive matches

Thirty-seven competitive matches in the 2015-2016 season were included in the analysis (13 wins, 15 losses, 9 draws, final league position 11th). The team systematically played in a 1-4-3-3 formation with a goalkeeper, four defenders (two FBs and two CDs), three midfielders (a MF and two WMFs) and three FWs. Goalkeepers and players with fewer than six records were not included in the analysis. Only data from players who completed the full match were analyzed. A total of 227 individual GPS files from match data on reserve team players belonging to a professional male football team were collected, with this distribution per position: CD = 42, FB = 60, MF= 40, WMF = 34, and FW = 51 GPS files.

Small-sided ball possession games

The SSBPGs were structured according to the position of the player in the game system (wide players occupied the positions closest to the narrow side line and MF and WMF occupied the inner positions). The main offensive objective of the positional games was to maintain possession of the ball in superiority with three jokers (Jk). Quick pressure after losing ball possession was the main defensive tactical concept. The characteristics of each of the SSBPGs analyzed in the current study were as follows (Figure 1):

1. *4v4+3: four against four players plus three Jks. Duration: 02:48±00:37 min. Dimensions: 13 x 17 m, surface area per player: 21.0 m^2; one of the Jks is located inside and the other two Jks on the sides of the playing area, which creates an overload of 7 vs. 4 in the possession phase.*
2. *5v5+3: five against five plus three Jks. Duration: 03:48±00:43 min. Dimensions: 25 x 20 m, surface area per player: 38.5 m^2; one of the Jks is located inside and the other two Jks on the sides of the playing area, which creates an overload of 8 vs. 5 in the possession phase.*
3. *7v7+3: seven against seven plus three Jks. Duration: 05:18±00:40 min. Dimensions: 29 x 36 m, surface area per player: 61.4 m^2; one of the Jks (always a MF) is located inside and the other two Jks (always a CD and FW) on the sides of the playing area, which creates an overload of 10 vs. 7 in the possession phase.*
4. *8v8+3: it is eight against eight plus three Jks. Duration: 05:23±00:37 min. Dimensions: 40 x 35 m, surface area per player: 73.7 m^2; one of the Jks is located inside and the other two Jks on the sides of the playing area, which creates an overload of 11 vs. 8 in the possession phase.*

Variables and MDP of the games

The variables recorded were relativized to metres per minute ($m \cdot min^{-1}$): the distance covered (TD), distance covered at high speed running (HSR: >19.8 $km \cdot h^{-1}$, $m \cdot min^{-1}$), distance covered in sprinting (SPR: >25.2 $km \cdot h^{-1}$, $m \cdot min^{-1}$), the number of high intensity accelerations and decelerations (ACC/DEC: >3 $m \cdot s^{-2}$, $n \cdot min^{-1}$), the high metabolic load distance (HMLD; >25.5 $W \cdot kg^{-1}$, $m \cdot min^{-1}$), and the average metabolic power (AMP: $W \cdot kg^{-1}$). The intensity thresholds used were the same as those employed in previous studies (Osgnach et al., 2010; Owen et al., 2017; Stevens et al., 2017; Tierney et al., 2016). ACC/DEC in the STATSports software was calculated from the differentiated GPS Doppler speed; for an ACC/DEC to register it had to have a minimum duration of 0.5 seconds and a minimum magnitude of 0.5 $m \cdot s^{-2}$ (Varley et al., 2017).

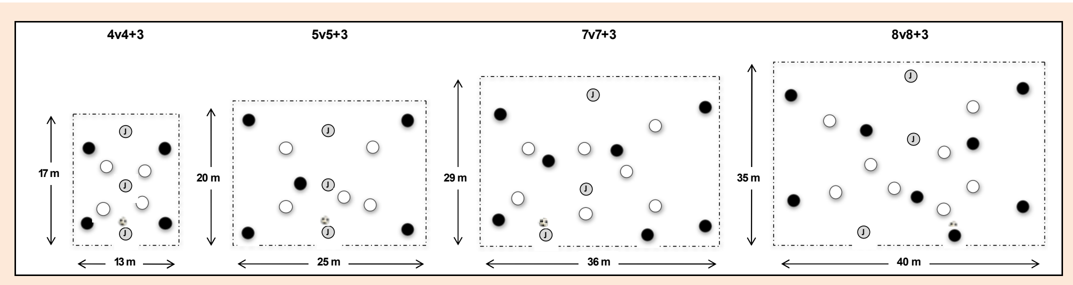

Figure 1. Dimensions and format of each the small-sided ball possession games analyzed. 4v4+3 is four against four players plus three jokers; 5v5+3 is five against five players plus three jokers; 7v7+3 is seven against seven players plus three jokers; 8v8+3 is eight against eight players plus three jokers.

The AMP variable was used as a variable criterion to estimate the MDP of the four training game formats and competitive matches. AMP is calculated from an estimation of the energy expenditure by players associated with constant and intermittent activity (di Pampero et al., 2005; Osgnach et al., 2010). Although there are some deficiencies when there is no activity after a player's effort, the inclusion of both dimensions, velocities and ACC/DEC, is considered a valid reference to estimate the load for a player over a given period.

The moving average duration method was used for the AMP variable using two different durations, 3 and 5 min., only in competitive matches. As a result, for each individual match the period with the highest AMP values was selected and analyzed together with the rest of the variables. After that, the intensity of the SSBPGs was expressed both in absolute values ($m \cdot min^{-1}$ for example) and in relative values (%) according to the MDP of the competitive football matches. The 4v4+3 and 5v5+3 were relativized to the values obtained in the MDP of the competitive matches with the 3-min. time window, while the 7v7+3 and 8v8+3 were relativized through comparison with the 5-min. time window.

Procedure

The activity profile of players was monitored during each training game format and competitive match using 10 Hz GPS units (Viper Pod, 50 g, 88 x 33 mm, STATSports Viper, Northern Ireland) that have been employed in previous studies (Bowen et al. 2017; Fox et al., 2017). The accuracy of these devices has been investigated, with a 2.53 ± 6.03% estimation error in distance covered and accuracy (%) improving as the distance covered increases and the speed of movement decreases (Beato et al., 2016). The GPS model used in this study was worn in a vest designed for this purpose inside a mini pocket positioned in the centre of the upper back, just above the shoulder blades, thus not affecting the mobility of the upper limbs and torso. Upon completion of each training session and competitive match, the GPS data were extracted using the appropriate proprietary software (Viper, STATSports, Northern Ireland). This type of system has previously been shown to provide valid and reliable estimates of instantaneous and constant velocity movements during linear, multidirectional and football-specific activities (Anderson et al., 2016).

The number of records for each SSBPG and position is shown in Table 1. The SSPBGs were performed on a natural grass surface and the ball was always available by prompt replacement when kicked out with the aim of maximizing effective playing time (Casamichana and Castellano, 2010). The demands of the SSBPGs were studied according to the position of the players during competition. Data from Jk and Gk were not included in the analysis. In the SSBPG analysis, the pauses between repetitions were excluded in order to compare these with the more intense periods of the match (MDP).

STATSports software (version 1.2) was then used for the computation of a moving average over the AMP variable for competitive matches using two different time windows of 3 and 5 min. As a result, for each competitive match maximum values using the AMP variable were calculated for each of the two moving average durations. These two different durations were analyzed because they correspond to the usual duration of the SSBPGs in the team studied. Descriptive statistics and analysis were then calculated based on positions of play. These data were then averaged across all observations per position for between-group analysis.

Statistical analysis

The data are presented as means and standard deviations (mean ± SD). The homogeneity of variances was examined by means of Levene's test. The presence of significant differences was determined by means of a 2-tailed repeated-measures analysis of variance applied to each of the dependent variables in relation to player position (CD, FB, MF, WMF and FW). Whenever a significant difference was found, a post hoc Bonferroni's test was used, whereas a Dunnett's T3 post hoc test was applied when the variances were not homogeneous. All the statistical analysis was performed using SPSS 16.0 (SPSS Inc., Illinois, USA) for Windows, with significance being set at $p<0.05$. Effect sizes (ES) were also calculated to determine meaningful differences with magnitudes classified as (Batterham and Hopkins, 2006): trivial (<0.2), small (>0.2-0.6), moderate (>0.6-1.2), large (>1.2-2.0) and very large (>2.0-4.0).

Results

Figure 2 shows the average (all positions pooled) SSBPG intensity relative values per minute. As the SSBPGs dimensions increased, TD (ES: 0.0–1.6), HMLD (ES: 0.1–1.0) and AMP (ES: 0.1–1.2) increased significantly while ACC (ES: 0.1–1.1) and DEC (ES: 0.1–0.9) were significantly reduced.

Table 1. Number of records for each of the small-sided ball possession games and playing positions.

Player position	4v4+3	5v5+3	7v7+3	8v8+3	Total files
CD	28	22	44	34	128
FB	58	49	50	52	209
MF	21	17	29	20	87
WMF	39	37	37	46	159
FW	49	39	48	36	172
Total files	195	164	208	189	756

CD = central defender; FB = full back; MF = midfielder; WMF = wide midfielder; FW = forward. 4v4+3 is four against four players plus three jokers; 5v5+3 is five against five players plus three jokers; 7v7+3 is seven against seven players plus three jokers; 8v8+3 is eight against eight players plus three jokers.

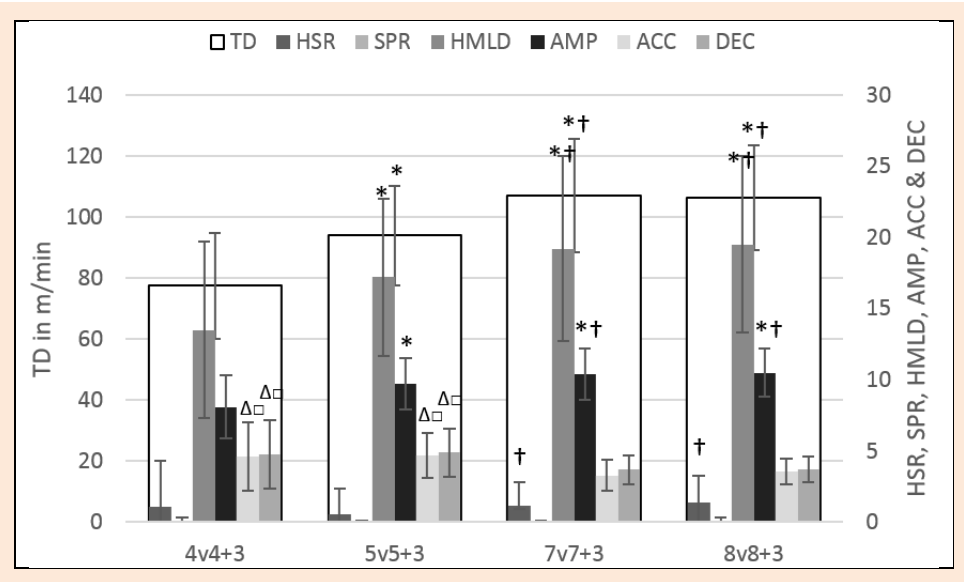

Figure 2. SSBPGs intensity variables in relative values (m/min) according to the MDP. * > 4v4+3; † > 5v5+3; ᐞ > 7v7+3; ▫ > 8v8+3; TD = total distance (m·min^{-1}); HSR = high speed running (m > 19.8 km·h^{-1}, m·min^{-1}); SPR = sprint (m > 25.2 km·h^{-1}, m·min^{-1}); HMLD = high metabolic load distance; AMP = average metabolic power; ACC = accelerations (> 3 m·s^{-2}, n·min^{-1}); DEC = decelerations (< -3 m·s^{-2}, n·min^{-1}); 4v4+3 is four against four players plus three jokers; 5v5+3 is five against five players plus three jokers; 7v7+3 is seven against seven players plus three jokers; 8v8+3 is eight against eight players plus three jokers.

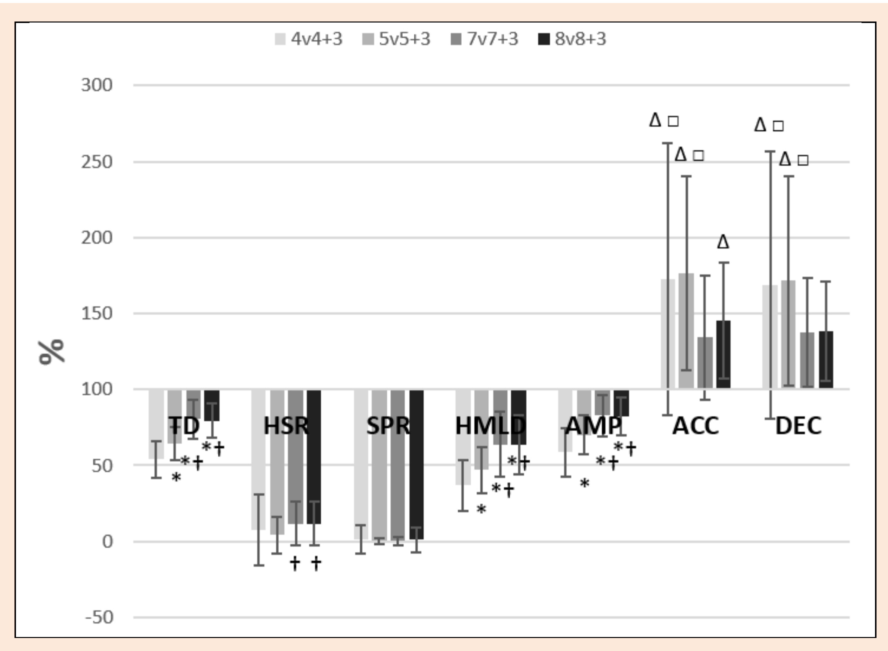

Figure 3. SSBPGs intensity variables (%) according to the MDP. * > 4v4+3; † > 5v5+3; ᐞ > 7v7 + 3; ▫ > 8v8+3; TD = total distance (m·min^{-1}); HSR = high speed running (m > 19.8 km·h^{-1}, m·min^{-1}); SPR = sprint (m > 25.2 km·h^{-1}, m·min^{-1}); HMLD = high metabolic load distance; AMP = average metabolic power; ACC = accelerations (> 3 m·s^{-2}, n·min^{-1}); DEC = decelerations (< -3 m·s^{-2}, n·min^{-1}); 4v4+3 is four against four players plus three jokers; 5v5+3 is five against five players plus three jokers; 7v7+3 is seven against seven players plus three jokers; 8v8+3 is eight against eight players plus three jokers.

Table 2 displays the relative values per minute obtained for the four SSBPGs, differentiating the player positions on the field (CD, FW, MF, WMF, and FW).

Figure 3 shows the average (all positions pooled) SSBPG intensity relative to the MDP of the match-play expressed as a percentage (%).

Table 3 displays the results of the SSBPGs relative to the MDP (expressed as a %) for each player position. The variables ACC and DEC showed significantly greater values (i.e., >100% of MDP) in the SSBPGs format 4v4+3 (AVG: 172/168%) and 8v8+3 (AVG: 145/138%). Among the different playing positions, FBs showed the greatest magnitude of overload according to the MDP in the two smaller SSBPGs formats in the ACC variable during 4v4+3 (201.6 %), 5v5+3 (217.5%) and the DEC variable during 4v4+3 (213.5%) and 5v5+3 (208.2%), while MF presented the lowest overload in the mechanical variables during 4v4+3 (115.2 %), 5v5+3 (138.3%) and the DEC variable during 4v4+3 (105.3%) and 5v5+3 (140.4%). HSR and SPR showed the lowest demand in comparison with the MDP during 5v5+3 (4.1%) and 7v7+3 (11.6%).

Table 2. **Relative values per minute (·min^{-1}) for different variables in SSBPGs according to the players' position.**

Variable	Position	4v4+3	5v5+3	7v7+3	8v8+3	ES; p:
TD (m·min^{-1})	CD	79.2 ± 17.2	95.7 ± 7.4*	108.6 ± 12.5^{b}*†	104.4 ± 17.8^{b}*	ES: 0.3-2.0; p<0.001
	FB	81.1 ± 16.6^{b}	96.2 ± 11.3*	105.3 ± 13.6^{b}*†	108.7 ± 11.4^{b}*†	ES: 0.3-1.9; p<0.001
	MF	69.3 ± 12.5	89.1 ± 26.4	113.7 ± 17.6^{b}*†	104.2 ± 23.5*	ES: 0.5-2.8; p<0.001
	WMF	84.1 ± 18.9^{c,b}	97.9 ± 17.4^{b}*	119.2 ± 25.5^{b,e}*†	118.2 ± 12.6^{a,b,c,e}*†	ES: 0.1-1.6; p<0.001
	FW	70.8 ± 16.2	88.5 ± 16.6*	93.6 ± 12.9*	90.8 ± 11.8*	ES: 0.2-1.5; p<0.001
	ES; p:	ES: 0.2-1.0; p<0.001	ES: 0.1-0.5; p=0.050	ES: 0.5-1.3; p<0.001	ES: 0.8-2.2; p<0.001	
HSR (m·min^{-1})	CD	0.5 ± 1.9	0.3 ± 0.7	1.7 ± 1.5*†	1.2 ± 1.4	ES: 0.3-1.1; p=0.002
	FB	0.7 ± 2.4	0.9 ± 2.5	1.4 ± 1.8	2.9 ± 2.6^{a,b,c,d}*†§	ES: 0.7-0.9; p<0.001
	MF	2.8 ± 5.3	0.9 ± 2.7	0.8 ± 1.0	0.6 ± 1.0	ES: 0.4-0.6; p=0.068
	WMF	0.4 ± 1.6	0.2 ± 0.5	1.3 ± 1.6†	0.7 ± 0.9†	ES: 0.4-0.8; p=0.003
	FW	1.8 ± 4.2	0.6 ± 1.6	1.1 ± 1.6	0.9 ± 1.2	ES: 0.2-0.4; p=0.208
	ES; p:	ES: 0.2-0.7; p=0.030	ES: 0.0-0.4; p=0.410	ES: 0.2-0.7; p=0.160	ES: 0.7-1.0; p<0.001	
SPR (m·min^{-1})	CD	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	ES: 0.0; p=0.687
	FB	0.0 ± 0.1	0.0 ± 0.1	0.0 ± 0.0	0.1 ± 0.3	ES: 0.4-0.5; p=0.041
	MF	0.0 ± 0.2	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	ES: 0.0; p=0.104
	WMF	0.0 ± 0.2	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	ES: 0.0; p=0.383
	FW	0.1 ± 0.6	0.0 ± 0.2	0.0 ± 0.2	0.1 ± 0.4	ES: 0.0-0.2; p=0.675
	ES; p:	ES: 0.0-0.2; p=0.570	ES: 0.0-0.2; p=0.650	ES: 0.0-0.2; p=0.620	ES: 0.0-0.3; p=0.230	
HMLD (m·min^{-1})	CD	14.0 ± 5.3	16.8 ± 3.4^{c}	20.1 ± 4.7^{c}*	18.4 ± 6.1*	ES: 0.3-1.2; p<0.001
	FB	14.8 ± 6.8^{c}	18.4 ± 6.5^{c}*	18.4 ± 7.6*	22.3 ± 6.3^{b,c}*†§	ES: 0.6-1.4; p<0.001
	MF	9.3 ± 3.8	13.2 ± 3.5	16.6 ± 4.9*	15.9 ± 6.6*	ES: 0.1-1.6; p<0.001
	WMF	15.5 ± 6.0^{c}	17.8 ± 5.2^{c}	24.1 ± 0.5^{a,b,c,e}*,†	21.3 ± 5.5^{b,c}*	ES: 0.7-2.0; p<0.001
	FW	12.0 ± 6.0	17.3 ± 5.7*	17.2 ± 5.4*	16.6 ± 4.2*	ES: 0.0-0.9; p<0.001
	ES; p:	ES: 0.1-1.2; p<0.001	ES: 0.1-0.9; p=0.020	ES: 1.1-2.3; p<0.001	ES: 0.2-1.0; p<0.001	
AMP (W·kg^{-1})	CD	8.4 ± 1.9	9.8 ± 0.9*	10.5 ± 1.2^{b}*	10.1 ± 1.7*	ES: 0.3-1.4; p<0.001
	FB	8.6 ± 2.2^{c,b}	10.2 ± 1.4^{b}*	10.4 ± 1.6*	10.9 ± 1.3^{b}*†	ES: 0.3-1.3; p<0.001
	MF	6.7 ± 1.6	8.8 ± 2.6*	10.7 ± 1.6*†	10.0 ± 2.2*	ES: 0.4-2.5; p<0.001
	WMF	8.9 ± 2.3^{c,b}	10.1 ± 1.9	11.7 ± 2.4^{b}*†	11.5 ± 1.3^{a,b,c}*†	ES: 0.1-1.2; p<0.001
	FW	7.2 ± 2.1	9.1 ± 1.9*	9.3 ± 1.3*	9.1 ± 1.2*	ES: 0.1-1.2; p<0.001
	ES; p:	ES: 0.1-1.1; p<0.001	ES: 0.1-0.8; p=0.010	ES: 0.5-1.3; p<0.001	ES: 0.5-1.9; p<0.001	
ACC (n·min^{-1})	CD	4.8 ± 1.7§¶	4.6 ± 0.8§¶	3.2 ± 0.8	3.1 ± 0.5	ES: 0.1-1.4; p<0.001
	FB	5.2 ± 2.5^{b}§¶	5.6 ± 1.5^{b}§¶	3.3 ± 1.2	3.8 ± 0.9^{a}	ES: 0.2-1.7; p<0.001
	MF	3.6 ± 2.2	4.3 ± 1.9	3.1 ± 0.7	3.7 ± 0.8^{a}§	ES: 0.4-0.9; p=0.089
	WMF	5.4 ± 2.3^{b}§¶	4.5 ± 1.6	4.2 ± 1.1^{a,b,c,e}	4.1 ± 0.9^{a,b}	ES: 0.4-0.8; p<0.001
	FW	3.7 ± 2.4	4.1 ± 1.7§¶	2.8 ± 0.8	3.2 ± 0.9	ES: 0.2-1.0; p=0.002
	ES; p:	ES: 0.1-0.8; p<0.001	ES: 0.8-0.9; p<0.001	ES: 0.8-1.5; p<0.001	ES: 0.3-1.3; p<0.001	
DEC (n·min^{-1})	CD	4.9 ± 2.1§¶	4.9 ± 1.2§¶	3.6 ± 0.8	3.2 ± 0.8	ES: 0.0-1.1; p<0.001
	FB	5.7 ± 2.5^{c,b}§¶	5.6 ± 1.5^{b}§¶	3.9 ± 1.1b	4.1 ± 0.8^{a,b}	ES: 0.1-0.9; p<0.001
	MF	3.5 ± 2.3	4.6 ± 2.0	3.7 ± 0.9	3.7 ± 0.8	ES: 0.5-0.6; p=0.137
	WMF	5.4 ± 2.1^{b}§¶	4.9 ± 1.9	4.2 ± 0.9a,b	4.1 ± 1.1^{a,b}	ES: 0.2-0.8; p<0.001
	FW	3.8 ± 2.3	4.3 ± 1.7§¶	3.1 ± 0.9	3.3 ± 0.8	ES: 0.2-0.9; p=0.006
	ES; p:	ES: 0.1-0.9; p<0.001	ES: 0.4-0.6; p<0.001	ES: 0.3-1.2; p<0.001	ES: 0.0-0.9; p<0.001	

CD = central defender; FB = full back; MF = midfielder; WMF = wide midfielder; FW = forward; a > CD; b > FW; c > MF; d > OMF; e > FB; * > 4v4+3; † > 5v5+3; § > 7v7+3; ¶ > 8v8+3; TD = total distance (m·min^{-1}); HSR = high speed running (m > 19.8 km·h^{-1}, m·min^{-1}); SPR = sprint (m > 25.2 km·h^{-1}, m·min^{-1}); HMLD = high metabolic load distance; AMP = average metabolic power; ACC = accelerations (> 3 m·s^{-2}, n·min^{-1}); DEC = decelerations (< -3 m·s^{-2}, n·min^{-1}); 4v4+3 is four against four players plus three jokers; 5v5+3 is five against five players plus three jokers; 7v7+3 is seven against seven players plus three jokers; 8v8+3 is eight against eight players plus three jokers.

Discussion

The aim of this study was to quantify the external training load according to the playing positions of players belonging to an elite soccer team during different SSBPGs. To our knowledge this is the first study to analyze the locomotor (e.g., TD, HSR and SPR) and mechanical (e.g., ACC and DEC) intensity of SSPBGs, considering positional player demands and comparing them in relation to the MDP. The main findings were: 1) irrespective of game format (i.e., size and number of players) and time-window (3 or 5 min.), the density of ACC and DEC variables showed the greatest degree of overload (>100% of the MDP); 2) in contrast, HSR metrics showed the lowest demand (<12% of the MDP), with practically no SPR demand in any SSBPG; 3) despite an overload in the mechanical variables and an underload in the locomotor dimensions in relation to match demands, player position dependent differences were observed; and, 4) all player positions showed intensity and global load metrics (e.g., AMP and HMLD) largely superior to the game demands. In contrast, the MF position showed the least demanding compared to other field positions.

In competition, playing position has been shown to impact the overall physical demands (Di Salvo et al., 2007) and also the MDP in match-play (Delaney et al., 2017).

Table 3. Relative values in % (mean and standard deviation) of different variables according to the position in SSBPGs to MDP.

Variable	Position	4v4+3	5v5+3	7v7+3	8v8+3	ES; p:
TD (%)	CD	57.8 ± 12.5	69.8 ± 5.4^{c}*	85.8 ± 9.9^{b,e}*†	82.5 ± 14.1^{b}*†	ES: 0.3-2.5; p<0.001
TD (%)	FB	56.3 ± 11.5^{c}	66.8 ± 7.8*	79.1 ± 10.3*†	81.7 ± 8.6^{b}*†	ES: 0.3-2.5; p<0.001
TD (%)	MF	45.9 ± 8.3	58.9 ± 17.4	80.7 ± 12.5*†	74.0 ± 16.7*	ES: 0.5-3.2; p<0.001
TD (%)	WMF	54.8 ± 12.3	63.8 ± 11.4*	83.2 ± 17.8*†	82.5 ± 8.8^{b}*†	ES: 0.1-1.9; p<0.001
TD (%)	FW	52.4 ± 12	65.4 ± 12.3*	74.9 ± 10.4*†	72.7 ± 9.5*†	ES: 0.2-2.0; p<0.001
TD (%)	ES; p:	ES: 0.1-1.1; p<0.001	ES: 0.4-0.9; p=0.03	ES: 0.2-1.1; p<0.001	ES: 0.0-0.8; p<0.001	
HSR (%)	CD	4.3 ± 15.9	2.6 ± 6.1	18.5 ± 17.1^{b,e}*†	13.1 ± 15†	ES: 0.3-1.1; p<0.001
HSR (%)	FB	4.0 ± 13.5	5.1 ± 13.7	10.1 ± 12.9	20.5 ± 18.1^{b,c,d}*†§	ES: 0.7-1.0; p<0.001
HSR (%)	MF	25.1 ± 17.4	8.3 ± 24.3	10.0 ± 12.5	8.4 ± 12.4	ES: 0.4-0.5; p=0.145
HSR (%)	WMF	2.9 ± 10.2	1.6 ± 3.1	11.6 ± 14.8*†	6.4 ± 8.9†	ES: 0.4-0.9; p<0.001
HSR (%)	FW	10.4 ± 24.7	3.9 ± 9.3	8.0 ± 11.8	6.7 ± 9.1	ES: 0.1-0.3; p=0.292
HSR (%)	ES; p:	ES: 0.4-0.8; p<0.001	ES: 0.2-0.5; p=0.360	ES: 0.4-0.7; p<0.001	ES: 0.4-1.0; p<0.001	
SPR (%)	CD	0.0 ± 0.0	0.0 ± 0.0	0.1 ± 0.6	0.1 ± 0.9	ES: 0.0-0.1; p=0.687
SPR (%)	FB	0.5 ± 2.7	0.4 ± 1.72	0.1 ± 1.0	2.6 ± 8.6	ES: 0.3-0.4; p=0.024
SPR (%)	MF	3.4 ± 11.2	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	ES: 0.4-0.5; p=0.104
SPR (%)	WMF	0.8 ± 5.4	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	ES: 0.2-0.3; p=0.383
SPR (%)	FW	2.9 ± 16.5	0.6 ± 4.1	0.9 ± 6.2	2.6 ± 15.5	ES: 0.0-0.2; p=0.750
SPR (%)	ES; p:	ES: 0.0-0.5; p=0.480	ES: 0.1-0.2; p=0.650	ES: 0.2-0.3; p=0.600	ES: 0.0-0.4; p=0.340	
HMLD (%)	CD	44.2 ± 16.7^{c}	53.2 ± 10.6^{c}	77.6 ± 18.3^{b,c,e}*†	70.9 ± 23.4^{b,c}*†	ES: 0.3-1.9; p<0.001
HMLD (%)	FB	38.6 ± 17.8^{c}	48.1 ± 17.1*	57.4 ± 23.6*	69.5 ± 19.7^{b}*†§	ES: 0.6-1.6; p<0.001
HMLD (%)	MF	26.7 ± 10.8	38.1 ± 10.1*	56.8 ± 16.7*†	54.6 ± 22.5*†	ES: 0.1-2.1; p<0.001
HMLD (%)	WMF	38.4 ± 14.8^{c}	44.2 ± 12.8	69.6 ± 20.4*†	61.5 ± 15.9*†	ES: 0.4-1.8; p<0.001
HMLD (%)	FW	33.4 ± 16.7	48.1 ± 15.9*	57.8 ± 18.2*†	55.8 ± 14.1*	ES: 0.1-1.4; p<0.001
HMLD (%)	ES; p:	ES: 0.3-1.2; p<0.001	ES: 0.4-1.4; p=0.020	ES: 0.4-1.2; p<0.001	ES: 0.1-0.7; p<0.001	
AMP (%)	CD	63.9 ± 14.7	75.1 ± 7.1^{c}*	87.7 ± 10.2^{b}*†	84.1 ± 14.7*†	ES: 0.3-2.0; p<0.001
AMP (%)	FB	61.6 ± 15.7^{c}	72.7 ± 10.0*	81.1 ± 12.8*†	85.5 ± 10.2^{b}*†	ES: 0.4-1.8; p<0.001
AMP (%)	MF	47.4 ± 11.4	62.4 ± 18.6*	81.8 ± 12.5*†	76.4 ± 17.1*†	ES: 0.4-2.8; p<0.001
AMP (%)	WMF	61.1 ± 15.6^{c}	68.5 ± 12.9	87.0 ± 17.7^{b}*†	85.3 ± 9.6^{b}*†	ES: 0.1-1.6; p<0.001
AMP (%)	FW	55.0 ± 16.0	69.3 ± 14.3*	77.6 ± 11.4*†	76.0 ± 10.5*	ES: 0.1-1.6; p<0.001
AMP (%)	ES; p:	ES: 0.1-1.2; p<0.001	ES: 0.3-0.9; p=0.020	ES: 0.1-0.9; p<0.001	ES: 0.0-0.9; p<0.001	
ACC (%)	CD	173.7 ± 62.7§¶	165.1 ± 29.9§¶	126.7 ± 31.6	124.0 ± 22.2	ES: 0.2-1.1; p<0.001
ACC (%)	FB	201.6 ± 94.8^{c}§¶	217.5 ± 56.5^{b,c,d}§¶	139.7 ± 50.9^{c}	159.3 ± 41.3^{a}	ES: 0.2-1.5; p<0.001
ACC (%)	MF	115.2 ± 70.1	138.3 ± 61.0	112.6 ± 23.9	134.2 ± 27.7§	ES: 0.1-0.9; p=0.197
ACC (%)	WMF	181.4 ± 76.8¶	152.4 ± 53.4	151.5 ± 40.2^{a,c}	144.6 ± 33.8^{a}	ES: 0.4-0.6; p=0.011
ACC (%)	FW	155.9 ± 100.8	171.4 ± 72.2§	135.6 ± 39.8^{c}	151.2 ± 45.4^{a}	ES: 0.2-0.6; p=0.132
ACC (%)	ES; p:	ES: 0.2-1.0; p<0.001	ES: 0.7-1.4; p<0.001	ES: 0.2-1.1; p<0.001	ES: 0.2-1.1; p<0.001	
DEC (%)	CD	159.9 ± 66.4	158.1 ± 39.3¶	142.9 ± 33.9	128.6 ± 31.7	ES: 0.0-0.6; p=0.019
DEC (%)	FB	213.5 ± 95.1^{a,b,c}§¶	208.2 ± 57.6^{b,c,d}§¶	138.9 ± 38.9	144.8 ± 29.1	ES: 0.1-1.0; p<0.001
DEC (%)	MF	105.3 ± 71.6	140.4 ± 61.1	128.1 ± 30.3	126.9 ± 28.1	ES: 0.3-0.5; p=0.172
DEC (%)	WMF	174.6 ± 66.6^{c}¶	160.3 ± 61	146.1 ± 34.2	141.0 ± 36.6	ES: 0.2-0.6; p=0.016
DEC (%)	FW	142.9 ± 86.7	158.2 ± 64.9	130.3 ± 37.1	139.6 ± 33.7	ES: 0.2-0.5; p=0.209
DEC (%)	ES; p:	ES: 0.5-1.2; p<0.001	ES: 0.8-1.2; p<0.001	ES: 0.1-0.6; p= 0.130	ES: 0.1-0.6; p= 0.100	

CD = central defender; FB = full back; MF = midfielder; WMF = wide midfielder; FW = forward; a > CD; b > FW; c > MF; d > OMF; e > FB; * >4v4+3; † > 5v5+3; § > 7v7+3; ¶ > 8v8+3; TD = total distance (% of the MDP); HSR = high speed running distance (m > 19.8 $km \cdot h^{-1}$, % of the MDP); SPR = sprint distance (m > 25.2 $km \cdot h^{-1}$, % of the MDP); HMLD = high metabolic load distance; % of the MDP; AMP = average metabolic power (% of the MDP); ACC = number of accelerations (> 3 $m \cdot s^{-2}$, % of the MDP); DEC = number of decelerations (< -3 $m \cdot s^{-2}$, % of the MDP); 4v4+3 is four against four players plus three jokers; 5v5+3 is five against five players plus three jokers; 7v7+3 is seven against seven players plus three jokers; 8v8+3 is eight against eight players plus three jokers.

In this study, every game format resulted in marked between-position differences in relative overload in most locomotor performance with the exception of HSR and SPR (see Table 3 and Figure 3). It is worth mentioning that sprint distance in these drills was almost non-existent for all the playing positions and all the formats studied. Similar to previous studies investigating non-position dependent training responses to SSG (Castellano and Casamichana, 2013; Hill-Haas et al., 2009; Lacome et al., 2017), there was an increase in TD and HSR as the size of the playing area of the SSPBGs drills increased in both relative (m^2 per player) and absolute (e.g., pitch dimensions) values, and this impacted HMLD and AMP. In this regard, it seems obvious that players require sufficient pitch dimensions and acceleration time to reach high-speed (>19.8 $km \cdot h^{-1}$) and / or sprint (>25.2 $km \cdot h^{-1}$) speed thresholds (Delaney et al., 2017). In contrast, the number of accelerations and decelerations were greater in the smaller game formats compared with the drills including more players (7v7+3 and 8v8+3).

Regarding the comparison across player positions, significant differences were observed; in particular FW was the position with lowest load in this type of game format in relation to WMF and FB. As the playing space became larger and included more players, these differences increased. Demands were highest in WMF in this type of playing situation overall with respect to CD and FW positions.

Furthermore, training drills that take into account playing position should, in theory, better mimic individual match demands and therefore result in more specific training stimuli. Comparing training drill demands with the MDP of competitive matches, in addition to average values, can be useful in understanding the magnitude of the overload at the near-maximal intensities a player is subjected to during football-specific training drills. That is, when drill data is expressed as a % of the MDP during the match and values obtained exceed 100%, it means that match demands have been exceeded (overload). This training aspect (i.e., magnitude of the overload) is pivotal to the management of training load since systematic repetition over time could lead to an over- or under-stimulation with implications for performance (Jaspers et al., 2017) and for player health, where both situations might increase the risk of injury (Malone et al., 2017).

In this study, the activity demands expressed as a % of the MDP were position-dependent (see Table 3). When the demands of the different SSPBGs are examined according to the % of the MDP, results indicate that there is an under-solicitation in TD, AMP, HMLD and especially in HSR and SPR. As mentioned above, in this study, the results showed that all the variables approached 100% of the MDP as the SSBPGs increased in size and number of players. Thus, the differences below in TD, HSD and SPR and above in ACC and DEC are lower in the larger formats (7v7+3 and 8v8+3) while the differences increase in the smaller formats (4v4+3 and 5v5+3). Lacome et al. (2017) also reported that as the reduced game format increased, demands were more similar to the MDP demands in the game. Although the ACC and DEC values exceed those obtained in the MDP of the matches, one needs to keep in mind that the criterion variable selected for determining the MDP of the matches was AMP. Therefore, the values obtained for ACC and DEC in the MDP of the matches would be higher if these variables had been used directly as criteria to establish the MDP.

CDs and FBs reported significantly higher values for ACC and FBs also in DEC in small SSPBGs (4v4+3 and 5v5+3) compared to in the other two game formats (7v7+3 and 8v8+3). The MDP for CDs were significantly lower compared to other positions which means that although they did not cover greater distances (in metres), they were subjected to greater loads than other playing positions, such as for example FWs. MFs presented a significantly lower value for HMLD than CDs in all the SSPBGs studied. Furthermore, they reported low values for AMP, especially in the SSPBGs with fewer players. Regarding ACCand DEC it should be noted that full backs reported significantly higher values than MFs and FWs in the small SSPBGs.

As described by Lacome et al. (2017), the results suggested the need to incorporate training drills that replicate and perhaps exceed the demands of the MDP in match-play. Based on the results obtained, the high-speed and sprint displacement actions are the most under stimulated with the studied SSPBGs. Therefore, other drills should be included in training dynamics to stimulate the HSR and SPR of players' actions. Perhaps including some type of work such as HIIT might be useful to exceed the values obtained in the MDP in match-play in variables referring to TD or especially HSR (Lacome et al., 2017), since in our study SSPBGs do not manage to replicate these demands.

Limitations in the present study included the unability to confirm the number of satellites per each data collection which may have led to small errors in the positional data. Furthermore, only physical and external load demands were recorded via GPS. Inclusion of internal load variables (i.e., heart rate-based variables) could give additional information about player responses. In future studies it would be useful to use the same SSPBGs but with larger playing surfaces for the same number of players, enforce game rules that favour or limit the number of contacts with the ball or use a different game space other than a rectangular pitch in order to confirm the results of this report.

Implications for football training

The small SSBPGs, 4v4+3 and 5v5+3, can be used to moderately overload mechanical variables (ACC and DEC), while 7v7+3 and 8v8+3 formats can be used to increase the values in the TD and HMLD variables. In addition, all of the SSBPGs that were designed with relative dimensions per player of less than 75 m^2 failed to stimulate HSR and SPR variables. It is necessary to plan specific intervention strategies (e.g., increase the relative dimensions per player while maintaining a high number of players per team) or complementary exercises to balance the load in relation to the demands of the game.

In the majority of the variables the values relative to minutes of practice showed differences between the positions, increasing when the SSBPGs were larger. However, when values were considered in relative terms to the % of the MDP, these differences decreased, especially in the larger formats.

Analysis acrossplaying positions reported different demands depending on the type of game format. For MFs these types of tasks were less demanding than for the rest of the positions. In addition, in the 4v4+3 and 5v5+3 game formats, FB was the position reporting the highest demands compared to the MDP in the mechanical variables (>200%), while MFs did not exceed 50% in mechanical load compared to its MDP.

Conclusion

This study provides useful information for coaching staff on the impact of SSBPGs on physical load, considering positional differences in relation to the MDP of competitive match play. Based on these results, it may be necessary to include varied training situations to overload the player during the training process. Distance, distance covered at high speed and distance covered when sprinting are the variables that have the lowest MDP percentage while performing the SSBPGs studied. Hence it may be necessary to design other types of tasks where these variables can be stimulated or complemented with other activities where they can be performed.

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Key points

- It is necessary to plan specific intervention strategies (e.g., increase the relative dimensions per player while maintaining a high number of players per team) or use complementary exercises to balance the load in relation to the demands of the game.
- The values relative to minutes of practice showed differences between the positions, increasing when the SSBPGs were larger (7v7+3 and 8v8+3 formats).
- The playing positions reported different demands depending on the type of ball possession game.

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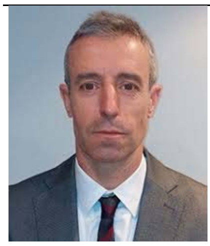

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