Influence of Game Format and Number of Players on Heart Rate Responses and Physical Demands in Small-Sided Soccer Games

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Abstract

Castellano, J, Casamichana, D, and Dellal, A. Influence of game format and number of players on heart rate responses and physical demands in small-sided soccer games. *J Strength Cond Res* 27(5): 1295–1303, 2013–The aim of the study was to examine the extent to which changing the game format (possession play vs. regulation goals and goalkeepers vs. small goals only) and the number of players (3 vs. 3, 5 vs. 5 and 7 vs. 7) influenced the physiological and physical demands of small-sided games (SSGs) in soccer in semiprofessional players. Fourteen semiprofessional male soccer players were monitored with global positioning system and heart rate devices. Heart rate, player load, distance covered, running speed, and the number of accelerations were recorded for 9 different SSGs. The results show that changes both in game format and the number of players affect the players' physiological and physical demands. Possession play places greater physiological and physical demands on players, although reducing the number of players only increases the physiological load. In the 7 vs. 7 games, changing the game format did not alter the heart rate responses. Finally, in the possession play format, changing the number of players did not produce significant differences in heart rate responses, although physical demands did decrease in line with a reduction in the number of players. These results should help coaches to understand how modifying different aspects of SSGs has a differential effect on the players' physiological and physical demands. Moreover, coaches in semiprofessional and amateur teams have now consistent information to design and optimize their training time in mixing the technical, tactical, and physical aspects.

Key Words football, game-based training, time motion, GPS device, physiological responses

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Introduction

For some years now, small-sided games (SSGs) have provided an alternative to traditional training drills without a ball (11,19,21,42). In the design at SSG training, it is common to modify the pitch area, the number of players, and the rules of the game to achieve certain technical, tactical, and physical objectives (5,10,12,13), and the method has proved to be as effective as interval training (11,19,26,28,42). Indeed, the advantage of SSGs is that technical, tactical, and physical aspects can all be addressed, thereby making training more specific (41) while still including the ball (12,35), a factor that increases player's motivation (23) and optimizes training time (33).

Although the influence of the number of players involved has been widely investigated (11,13,17,29,30,38,39), very few studies (18–20,22,34,35,45) have isolated this variable while maintaining the relative dimensions of the pitch. Those studies have concluded that the workload increases as the number of players decrease, for the same relative pitch area. However, it should be noted that this effect has only been studied in SSGs involving regulation goals and goalkeepers, there being no research in relation to other training situations as a collective ball conservation.

With regard to game format, the few studies to have considered this variable have reported contradictory results. Using 4 vs. 4 SSG in a 30 × 30-m pitch, Sassi et al. (44) observed a decrease in heart rate (HR) responses when goals and goalkeepers were used, as opposed to possession play only. Mallo and Navarro (36) studied the effects of altering the game format (possession play, possession with support players, and goals and goalkeepers) when using a 3 vs. 3 SSG on a pitch measuring 33 × 20 m. They found that the inclusion of goalkeepers led to a reduction in both physiological load (mean HR and time spent on high-intensity running in relation to maximum HR) and physical load (distance covered, percentage of time spent at high running speeds, and number of high-intensity sprints), suggesting that this was because of the players' attempts to defend their goal. By contrast, other authors (11) have reported that the

Table 1. Protocol followed for the different small-sided games played over a 6-week period and in 9 sessions.*

Week	Session	W	Task 1	R	Task 2	R	Task 3
1	Test				YYIRT1		
2	First	15 min	5 vs. 5–SSG-P	5 min	5 vs. 5–SSG-G	5 min	5 vs. 5–SSG-g
	Second		5 vs. 5–SSG-G		5 vs. 5–SSG-g		5 vs. 5–SSG-P
3	Third		5 vs. 5–SSG-g		5 vs. 5–SSG-P		5 vs. 5–SSG-G
	Fourth		3 vs. 3–SSG-P		3 vs. 3–SSG-G		3 vs. 3–SSG-g
4	Fifth		3 vs. 3–SSG-G		3 vs. 3–SSG-g		3 vs. 3–SSG-P
	Sixth		3 vs. 3–SSG-g		3 vs. 3–SSG-P		3 vs. 3–SSG-G
5	Seventh		7 vs. 7–SSG-P		7 vs. 7–SSG-G		7 vs. 7–SSG-g
	Eighth		7 vs. 7–SSG-G		7 vs. 7–SSG-g		7 vs. 7–SSG-P
6	Ninth		7 vs. 7–SSG-g		7 vs. 7–SSG-P		7 vs. 7–SSG-G

*Note: 3 vs. 3, 5 vs. 5, and 7 vs. 7: number of on-field players of one team (3-5-7) against on-field players of the other team (3-5-7). SSG-G = small-sided game with goalkeepers; SSG-g = small-sided game with small goals; SSG-P = small-sided game involving possession play; W = standard warm-up; R = passive rest period between tasks; YYIRT1 = Yo-Yo Intermittent Recovery test level 1.

presence of goalkeepers led to greater HR responses in the context of 8 vs. 8 SSG (with pitch size of 60 × 45 m). They argued that this was due to the players making greater efforts to score a goal, although it should be noted that the number and duration of bout periods and the recovery duration period between bouts were altered. The number of players per side may be one of the factors accounting for these discrepant findings.

Additionally, HR (1) has been one of the most widely used parameters for monitoring workload, although it has

Table 2. Mean values ± *SD* for mean heart rate relative to the individual maximum (%HRmean) and for maximum heart rate relative to the individual maximum (%HRmax).*

Number of players	Game format			
	SSG-P	SSG-g	SSG-G	Mean
3 vs. 3				
%HRmean	87.9 ± 3.7[a]	83.4 ± 2.9	87.0 ± 2.7[a,d]	86.2 ± 3.7[d]
CV (%)	1.0	0.8	0.7	0.6
%HRmax	94.6 ± 3.0[a]	91.8 ± 2.8	94.8 ± 3.7[a]	93.8 ± 3.4
CV (%)	0.8	0.7	1.0	0.5
5 vs. 5				
%HRmean	86.5 ± 3.0[a,b]	81.6 ± 3.3	82.7 ± 3.7	83.6 ± 3.9
CV (%)	0.7	0.8	1.0	0.6
%HRmax	94.6 ± 4.1[a]	91.5 ± 3.5	92.1 ± 4.0	92.7 ± 4.0
CV (%)	0.9	0.8	0.9	0.5
7 vs. 7				
%HRmean	86.0 ± 4.9	83.2 ± 4.9	84.1 ± 4.5	84.4 ± 4.8
CV (%)	1.1	1.2	1.1	0.7
%HRmax	94.9 ± 5.4	94.7 ± 5.9[c]	93.2 ± 4.4	94.3 ± 5.3
CV (%)	1.1	1.3	0.9	0.6
Mean				
%HRmean	86.7 ± 4.9[a,b]	82.7 ± 3.9	84.4 ± 4.1	84.6 ± 4.3
CV (%)	0.6	0.6	0.6	0.4
%HRmax	94.7 ± 4.4[a]	92.8 ± 4.6	93.2 ± 4.4	93.6 ± 4.4
CV (%)	0.6	0.6	0.6	0.3

*Note: 3 vs. 3, 5 vs. 5, and 7 vs. 7: number of on-field players of one team (3-5-7) against on-field players of the other team (3-5-7); SSG-G = small-sided game with goalkeepers; SSG-g = small-sided game with small goals, and SSG-P = small-sided game involving possession play. Bonferroni post hoc test: [a] is >SSG-g; [b] is >SSG-G; [c] is >3:3; [d] is >5:5; $p < 0.05$ in all cases.

TABLE 3. Mean values 6 SD for total distance covered in meters (m), player load in Arbitary Units (AU), and the work: rest ratio in AU for each of the different SSGs.*

Indicators	Players	Game format			
		SSG-P	SSG-g	SSG-G	Mean
Distance covered (m)	7 vs. 7	559.9 ± 59.7[a,b,d]	499.1 ± 58.7[h,d,g]	462.8 ± 37.9	506.6 ± 65.9[d,g]
	5 vs. 5	535.3 ± 42.1[a,b,f]	492.8 ± 65.8[f]	465.2 ± 46.1[f]	476.8 ± 67.9[f]
	3 vs. 3	435.4 ± 58.6[a]	369.7 ± 68.3	433.1 ± 35.0[c]	413.5 ± 62.3
Player load (AU)	7 vs. 7	71.1 ± 10.1[a,b]	62.8 ± 9.6[d]	57.8 ± 7.7	63.8 ± 10.6
	5 vs. 5	73.4 ± 7.5[a,b]	56.6 ± 9.9	60.9 ± 9.1	63.7 ± 11.4
	3 vs. 3	67.5 ± 10.4[a]	54.9 ± 10.7	62.0 ± 5.7	61.5 ± 10.3
Work:rest ratio (AU)	7 vs. 7	5.8 ± 3.5[a,b,d]	4.0 ± 1.7[d,g]	3.3 ± 1.2[d,g]	4.3 ± 2.5[d,g]
	5 vs. 5	4.9 ± 2.2[a,b,f]	2.5 ± 1.4[f]	3.0 ± 1.0[f]	3.5 ± 1.9[f]
	3 vs. 3	2.3 ± 0.8[a]	1.4 ± 0.6	2.2 ± 0.5[c]	2.0 ± 0.7
Distance covered (m)		519.9 ± 73.0[a,b]	443.5 ± 81.0	456.3 ± 42.0	473.1 ± 74.9
Player load (AU)	Mean	71.0 ± 9.5[a,b]	58.7 ± 10.4	59.9 ± 7.9	63.2 ± 10.8
Work:rest ratio (AU)		4.6 ± 2.9[a,b]	2.9 ± 1.7	2.9 ± 1.1	3.5 ± 2.2

*Note: 3 vs. 3, 5 vs. 5, and 7 vs. 7: number of on-field players of one team (3-5-7) against on-field players of the other team (3-5-7); SSG-G = small-sided game with goalkeepers; SSG-g = small-sided game with small goals, and SSG-P = small-sided game involving possession play. Bonferroni post hoc test: [a] is SSG-P > SSG-g; [b] is SSG-P > SSG-G; [c] is SSG-G > SSG-g; [d] is 7:7 > 3:3; [e] is 3:3 > 5:5; [f] is 5:5 > 3:3; [g] is 7:7>5:5; [h] is SSG-g > SSG-G; $p < 0.05$ in all cases.

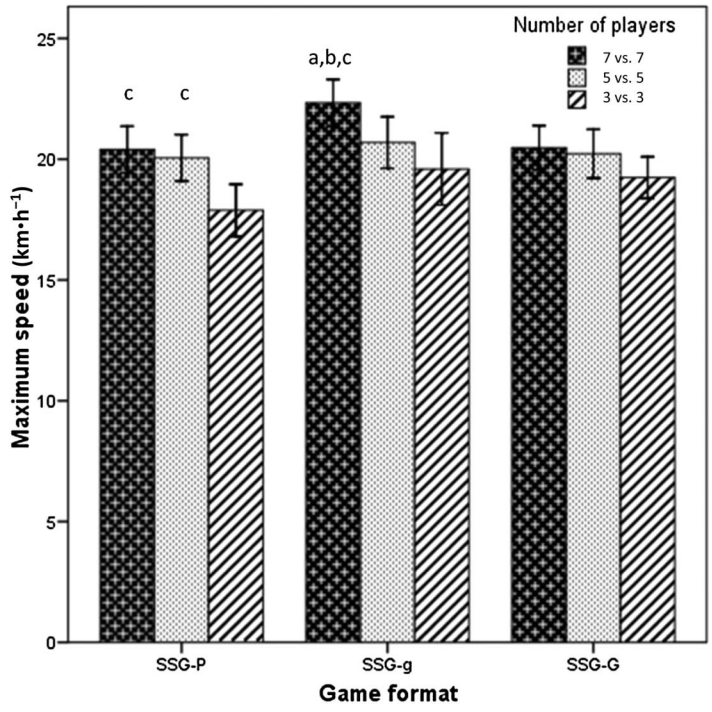

Figure 1. Maximum speed reached ($km \cdot h^{-1}$) in each of the game formats. 3 vs. 3, 5 vs. 5, and 7 vs. 7: number of on-field players of one team (3-5-7) against on-field players of the other team (3-5-7); SSG-G = small-sided game with goalkeepers; SSG-g = small-sided game with small goals; SSG-P = small-sided game involving possession play. Note: a is >SSG-P; b is >SSG-g; c is >3:3.

recently been suggested that measures based solely on this indicator do not adequately reflect potential differences in exercise performed at high speeds (2). With regard to physical demands, several studies (10,12,13,20) have monitored these in the context of training, although the increase of the global positioning system (GPS) technology, which provides a rapid, valid, and reliable measure of physical demands during training (7,8,27), will no doubt lead to a considerable increase in research of this kind. However, all the studies on SSG focussed on youth soccer players or professional players. Small-sided game is a key training method especially in amateur and semiprofessional players because in this playing level, players have shorter training duration per week, and they need to optimize or mix the physical, technical, and tactical component to gain time.

In this context, to the best of our knowledge, no study has

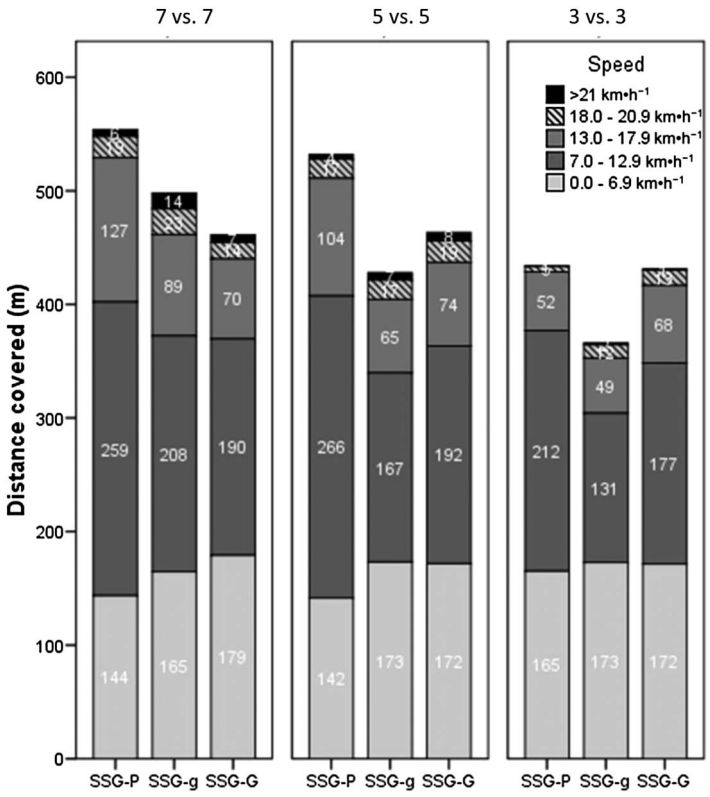

Figure 2. Total distance covered (m) in each speed categories established for each of the game formats. 3 vs. 3, 5 vs. 5, and 7 vs. 7: number of on-field players of one team (3-5-7) against on-field players of the other team (3-5-7); SSG-G = small-sided game with goalkeepers; SSG-g = small-sided game with small goals; SSG-P = small-sided game involving possession play.

Table 4. Significant differences between the total distances covered in each of the speed categories.*

	Speed categories ($km \cdot h^{-1}$)				
SSG	0–6.9	7.0–12.9	13.0–17.9	18.0–20.9	>21
7 vs. 7	G > g = P	P > g = G	P > g = G	g > G	g > P
5 vs. 5	g = G > P	P > G = g	P > g = G		
3 vs. 3		P = G > g	G > P = g	G > P	
SSG-P	3 > 7 = 5	5 = 7 > 3	7 > 5 > 3	7 = 5 > 3	7 > 3
SSG-g		7 > 5 = 3	7 > 5 = 3	7 > 3	7 > 3
SSG-G					5 = 7 > 3

*Note: "3" = 3 vs. 3; "5" = 5 vs. 5; "7" = >7 vs. 7; "G" = SSG-G (the small-sided game with goalkeepers); "g" is SSG-g (the small-sided game with small goals); "P" = SSG-P (the small-sided game involving possession play). Bonferroni post hoc test, with $p < 0.05$ in all cases.

yet examined the physiological and physical demands of semiprofessional players in SSGs in which different game formats are combined with different numbers of players. Thus, the aim of this study was to determine whether changing the game format (possession play [SSG-P] vs. regulation goals and goalkeepers [SSG-G] vs. small goals but no goalkeepers [SSG-g]) and the number of players per side (3 vs. 3, 5 vs. 5, and 7 vs. 7) influences the physical and physiological response of players while maintaining constant all other variables (relative pitch size per player, durations, recovery times, balls placed around the touchline so as to maximize the real playing time, coach encouragement, and the rules used) in semiprofessional players. It is hypothesized that the 3 vs. 3 induce lesser physical demands than the 5 vs. 5 and 7 vs. 7, especially concerning the high-intensity running. Then, a secondary hypothesis was that the 3 vs. 3 SSG could present a greater alteration of the physical demands (i.e., peak speed, number of accelerations, and total distance covered) and HR response when the game format is manipulated.

Methods

Experimental Approach to the Problem

The study was conducted over a 6-week period (February to March) during the 2009–2010 competitive season. The players were familiarized with both the type of SSG and the material to be used during the weeks before the experimentation. During week 1, all players performed the Yo-Yo intermittent recovery test level 1 (YYIRT1) to determine their maximum heart rate (HRmax). The validity and

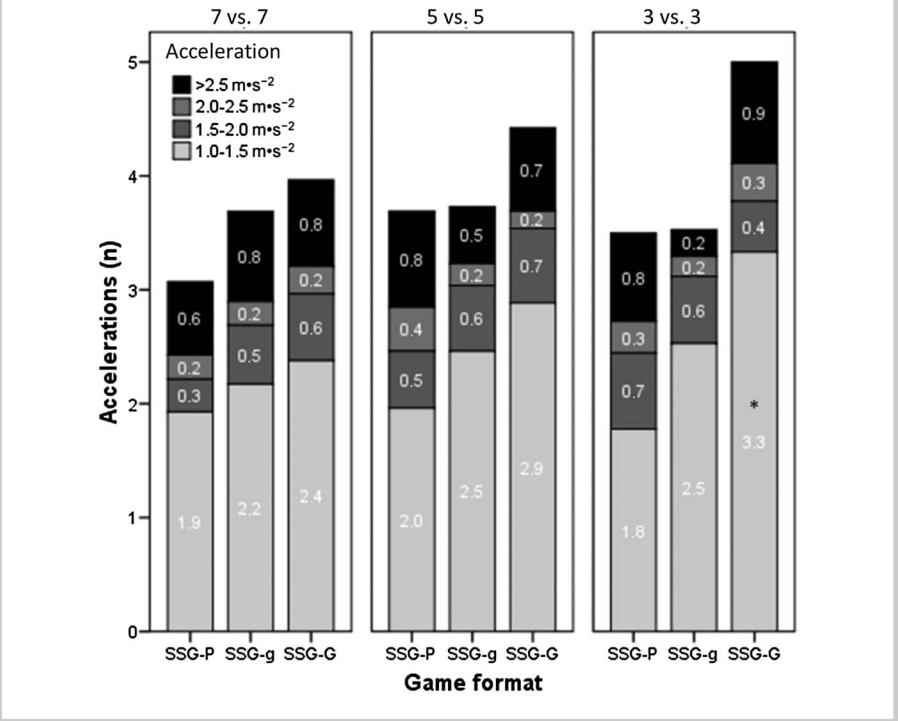

Figure 3. Number of accelerations performed in each of the game formats. 3 vs. 3, 5 vs. 5, and 7 vs. 7: number of on-field players of one team (3-5-7) against on-field players of the other team (3-5-7); SSG-G = small-sided game with goalkeepers; SSG-g = small-sided game with small goals; SSG-P = small-sided game involving possession play. *There are significant differences in the number of accelerations of 1.0–1.5 $m \cdot s^{-2}$ for 3 vs. 3 (SSG-G > SSG-P, $p < 0.05$).

reliability from this test has been done previously (32). This was done on an outdoor artificial pitch with the players wearing football boots.

Then, 9 training sessions were held from weeks 2 to 6 (with an interval of at least 48 hours between them) on an outdoor artificial grass pitch and at similar times of day to avoid any effect of circadian rhythms on the measured variables (14). During the period of this study, no strength training session was performed by the players. Each session began with a 15-minute standard warm-up (running, stretching, and contact with the ball), followed by 3 SSGs involving the same number of players per side (i.e., 3 vs. 3, 5 vs. 5, and 7 vs. 7) but with a different game format (SSG-P, SSG-G, and SSG-g) interspaced by 5-minute passive recovery. During rest periods, players were allowed drink fluids ad libitum. All participants were advised to maintain their normal diet, with special emphasis being placed on a high intake of water and carbohydrates. The order in which the resulting 27 SSGs (3 levels of the variables game format and number of players × 9 sessions) were played and recorded is shown in Table 1. This order of play was established in advance by random selection. To avoid potential imbalances between the 2 teams and to ensure their equivalence, the procedure proposed by Casamichana and Castellano (5) was followed, whereby players are classified according to the following variables: minutes of competitive play, performance on the YYIRT1, playing position, and subjective appraisal of the coach.

During all the SSGs, coaches offered encouragement to the players to ensure a high motivation all along the different sessions (39). In addition, 8 balls were distributed around the edge of the pitch to maximize the effective playing time (5,10,12). All participants were advised to maintain their normal diet, with special emphasis being placed on a high intake of water and carbohydrates.

Subjects

Fourteen semiprofessional male soccer players (age: 21.3 ± 2.3 years; height: 174 ± 4.0 cm; mass: 73.4 ± 5.1 kg; YYIRT1: 2384.6 ± 348.5 m) playing for the same team (senior division) at regional level participated in the study. They had played federation soccer for a mean of 12.5 years before the study. Their standard training involved 3–4 sessions per week (each lasting around 90 minutes), in addition to a competitive match. All the players were notified of the research design and its requirements, as well as the potential benefits and risks, and they each gave their informed consent before the start. The Ethics Committee of the University of the Basque Country also gave its institutional approval of the study.

Independent Variables: Game Format and Number of Players

The independent variables were the game format and the number of players per side. Each session involved 3 SSGs with a different format: (a) collective possession play only (SSG-P), where the objective was to keep the ball for longer than the opposing team; (b) with goalkeepers and regulation goals (SSG-G); and (c) with a small goal per team (2 m wide × 1.2 m high) but no goalkeepers (SSG-g). The number of players per side had 3 levels: (a) 3 vs. 3 (3 on-field players against 3 on-field players) on a pitch measuring 43 × 30 m; (b) 5 vs. 5 on a 55 × 38 m pitch; and (c) 7 vs. 7 on a pitch measuring 64 × 46 m. The pitch size was varied so as to maintain the relative area per player (≈210 m^2), with a constant length:width ratio. Each SSG lasted for 6 minutes, with a passive recovery period of 5 minutes between the 3 types of SSGs played. By

definition, each side used a goalkeeper in the SSG-G format. Except for the offside rule, the standard rules of 11-a-side soccer were followed.

Heart Rate Responses

The physiological profile was assessed on the basis of HR (15), which was recorded every 5 seconds using a telemetric device (Polar Team Sport System; Polar Electro Oy, Kempele, Finland). The HRmax of each player was determined by means of the YYIRT1 (3,32), and, similarly to previous studies (5,20), this enabled 4 intensity zones to be established: <75% HRmax, 75–84% HRmax, 84–90% HRmax, and >90% HRmax. The variables used were percentage of time spent in each intensity zone during the SSG and the relative values in relation to the mean and maximum HR obtained in the YYIRT1 (%HRmean and %HRmax).

Physical Profile: Distance Covered And Number Of Accelerations Performed

The physical profile was measured using a portable GPS device operating at a sampling frequency of 10 Hz (MinimaxX version 4.0; Catapult Innovations, Melbourne, Australia). After recording, the data were downloaded to a PC and analyzed using the software package Logan Plus version 4.5.1 (Catapult Innovations, 2010). Similarly to previous studies (10,12,13,20,22), 5 speed categories (all in $km \cdot h^{-1}$) were established: 0–6.9, 7.0–12.9, 13.0–17.9, 18.0–20.9, and >21. The total distance covered, the maximum speed reached, the distance covered in each one of the speed categories, number of accelerations, and work: rest ratio, defined as the distance covered by the player at a speed ≥4 or more $km \cdot h^{-1}$ (period of activity or work) divided by the distance covered at a speed less than 3.9 $km \cdot h^{-1}$ (period of recovery or rest). A further indicator used was player load, obtained via accelerometry (4,9,37), combining the accelerations produced in 3 planes of body movement by means of a 100-Hz triaxial accelerometer. Player load is a new indicator that seems to be highly correlated with Edwards and session-RPE methods (6) and has shown high reliability in both inter- and intradevice, suggesting that accelerometers can detect change of differences in physical activity (4,37). It is calculated using the following formula:

$$\text{Player load} = \sqrt{\left(\left((\text{aca}_t = i+1-\text{aca}_t = 1)^2+(\text{act}_t = i+1-\text{act}_t = 1)^2+(\text{acv}_t = i+1-\text{acv}_t = 1)^2\right)/100\right)}$$

where aca is the acceleration in the anteroposterior or horizontal axis, act is the acceleration in the transverse or lateral axis, acv is the acceleration in the vertical axis, i is the current time, and t is time.

This technology has been previously determined as reliable and validated for monitoring the players' high-intensity activities (7) for 30-m runs ($SE = 0.2$ m; coefficient of variation [CV] = 0.7%; bias = 6.5%; and $SEM = 5.1\%$).

Statistical Analyses

The data are presented as mean ± *SD*. The homogeneity of variances was examined by mean values of Levene's test. The presence of significant differences was determined by a 1-tailed repeated-measures analysis of variance, applied to each of the dependent variables. The Bonferroni post hoc test was applied whenever a significant difference was found. The *SE*, expressed as a CV, and the effect size (ES) were also calculated (25). All the statistical analyses were performed using SPSS 16.0 for Windows (SPSS Inc., Chicago, IL, USA), with significance being set at $p < 0.05$.

Results

Physiological Response

Table 2 shows the results obtained for the 9 different SSGs, obtained by combining the 3 levels of the variable "number of players" (3 vs. 3, 5 vs. 5, and 7 vs. 7) with the 3 "game formats" (SSG-P, SSG-G, and SSG-g). When the variable number of players was considered independently of the game format, higher values for %HRmean were only found for 3 vs. 3 respect to 5 vs. 5 ($F_{2,191} = 5.46$; $p = 0.005$; ES = 0.68). Analysis of the variable game format alone revealed significant differences n the %HRmean ($F_{2,191} = 16.45$; $p = 0.01$), the values being higher in SSG-P than in SSG-g (ES = 0.90) and SSG-G (ES = 0.50). For the variable %HRmax, differences were only observed ($F_{2,191} = 3.37$; $p = 0.037$) with respect to SSG-g (SSG-P > SSG-g; ES = 0.42).

When the two variables (number of players and game format) were considered together, the results were as follows: (a) there were no significant differences between the different formats when playing 7 vs. 7 ($F_{2,72} = 2.26$; $p = 0.112$); (b) in the 5 vs. 5 SSG, there were differences between SSG-P ($F_{2,64} = 13.46$; $p = 0.00$) and both SSG-G (ES = 1.13) and SSG-g (ES = 1.55); (c) in the 3 vs. 3 SSG, the results for both SSG-P (ES = 1.35) and SSG-G (ES = 1.28) differed from those of SSG-g ($F_{2,49} = 9.99$; $p = 0.00$); (d) in relation to the number of players, there were differences in the SSG-g ($F_{2,62} = 3.63$; $p = 0.03$), with the %HRmax being higher in the 7 vs. 7 game compared with 3 vs. 3 ($p < 0.05$; ES = 0.63), but there were no differences in the SSG-P; and (e) in SSG-G, the %HRmean was higher when playing 3 vs. 3 compared with 5 vs. 5 ($F_{2,62} = 6.19$; $p = 0.00$; ES = 1.33).

Physical Response

Table 3 shows the values for the load indicators in relation to each of the 9 different SSGs. The maximum speed reached during the 3 game formats was as follows: SSG-P, 19.5 ± 2.5 km·h^{-1}; SSG-g, 21.1 ± 2.8 km·h^{-1}; and SSG-G, 20.1 ± 2.3 km·h^{-1} (Figure 1). The difference between the first 2 values is significant (SSG-g > SSG-P, $p < 0.05$; ES = 0.60). With respect to the number of players per side, the maximum speeds achieved were as follows: 21.1 ± 2.6 km·h^{-1} in 7 vs. 7; 20.3 ± 2.5 km·h^{-1} in 5 vs. 5; and 18.4 ± 2.4 km·h^{-1} in 3 vs. 3. Both the first 2 values are significantly higher than the latter (7 vs. 7 > 3 vs. 3, $p < 0.05$; ES = 1.08; 5 vs. 5 > 3 vs. 3, $p < 0.05$; ES = 0.77). Figure 2 shows the distance covered (m) in each of the speed categories, whereas Table 4 indicates the significant differences obtained for distance covered in relation to speed category. It can be seen that there are significant differences in each of the speed categories. Figure 3 shows the number of accelerations made in relation to each of the acceleration categories. Significant differences ($F_{2,50} = 4.15$; $p = 0.02$) were only found for accelerations of 1.0–1.5 m·s^{-2} in 3 vs. 3 (SSG-G > SSG-P, $p < 0.05$; ES = 0.91).

Discussion

The aim of this study was to determine whether the game format and the number of players involved in SSGs had any effect on HR responses and physical demands, especially on peak speed and number of accelerations. To the best of our knowledge, this is the first study to combine the modification of both these variables, thereby enabling us to examine the extent to which they may influence one another. The results show that HR responses and physical demands are higher in SSG-P than in SSG-G and SSG-g. The exception to this concerns accelerations, as more accelerations of 1.0–1.5 m·s^{-2} were made in SSG-G than in SSG-P. Furthermore, these differences in HR responses were not observed in SSGs involving 7 players per side (7 vs. 7). It seems that the number of players per side is the variable that influences more the energy demands placed on players, and in turn, this variable may be affected by the game format used.

With regard to the game format (Table 2), the present results are similar to those obtained in other studies (36,44), which found that the inclusion of goalkeepers reduced the recorded HR. In a study of 3-a-side SSGs played on a pitch measuring 30 × 33 m, Mallo and Navarro (36) reported intensities of 88% of HRmax, compared with 87% in this study, for games involving goalkeepers (SSG-G), and 91% of HRmax, compared to 88% here, when only possession play was involved (SSG-P). Both these game formats were associated with higher intensities than were found in SSG-g ($p < 0.05$). However, these differences in HR responses according to the game format were no longer observed when there were 7 players per side (7 vs. 7). By contrast, a study by Dellal et al. (11) of games involving 8 players per side (8 vs. 8) still reported greater HR responses when goalkeepers were included.

The 3 indicators of external load that were studied here (total distance covered, player load, and the work:rest ratio) followed the same pattern, their values decreasing when goals/goalkeepers were included (Table 3). This is consistent with the findings of Mayo and Navarro (36), who reported a reduction in total distance covered when goalkeepers were present (638 m in an SSG-G vs. 747 m and 749 m in an SSG-P with and without "floaters"). By contrast, the number of accelerations was higher in games involving goalkeepers/goals (Figure 3).

With regard to the variable "number of players," the corresponding values of HRmean ranged between 82% for SSG-g with 5 vs. 5 and 88% for SSG-P with 3 vs. 3. These values are slightly lower than those obtained in some studies involving similar SSGs (5,24,31,34,36,39,44), where the HRmean ranged between 86% and 92% of the HRmax, but are similar to the findings of other authors (20,30,40), who reported an HRmean in the range 82–89% of HRmax. Modifying the number of players not only affected the physiological intensity but also altered the patterns of activity, with both the total distance covered and the work:rest ratio decreasing as the number of players was reduced (Table 3). By contrast, the player load did not differ significantly according to the number of players involved.

With respect to the maximum speed achieved, this was lower in SSGs involving fewer players, although this difference was not observed for the SSG-g format. The game format also appears to have an influence, with significant differences being observed only for 7-a-side (7 vs. 7) games (SSG-G > SSG-P = SSG-g). These results are consistent with those reported by Casamichana and Castellano (5), who found that lower maximum speeds were reached when the relative pitch area per player was smaller.

The analysis of distances covered in each of the speed categories showed that in SSG-P, the players covered a greater distance at intermediate speeds (7–12.9 km·h^{-1}, 13.0–17.9 km·h^{-1}, and 18.0–20.9 km·h^{-1}), as compared with the 2 extreme categories (0–6.9 km·h^{-1} and >21 km·h^{-1}). Significant differences were found for the high-intensity speed category (>21 km·h^{-1}) according to the number of players involved for all game formats, with greater distances being covered in this speed category for the 7 vs. 7 game with respect to the 3 vs. 3 one. However, analysis of the relationship between game format and this speed category revealed that differences were only present in the 7 vs. 7 game and between SSG-g and SSG-P (SSG-g > SSG-P). In summary, it can be stated that as the speed category increases, the corresponding distance that players cover also increases significantly in those games involving more players (Table 4).

The use of new GPS devices that incorporate triaxial 100-Hz accelerometers enables the accelerations made by athletes in these kinds of situations to be quantified. Although this is still a new area of research, Gabbett et al.

(16) have reported data regarding the accelerations made by rugby players in SSGs, there being significant differences between the number of accelerations made at low and intermediate intensity. In this study, significant differences were only observed for low-intensity accelerations (1.0–1.5 $m \cdot s^{-2}$), which were more frequent in SSG-G as compared with SSG-P.

The present results also show that in the context of SSG-G, the %HRmean was higher for 3 vs. 3 than 5 vs. 5 games, there being no differences with respect to the 7-a-side (7 vs. 7) game. In the SSG-P, no differences were observed for any of the HR measures, whereas in the SSG-g, there were no significant differences in the %HRmean according to the number of players. In this latter context (SSG-g), Sampaio et al. (43) also found no differences between 2 vs. 2 and 3 vs. 3 games and reported %HRmean values similar to those obtained in this study (81.2 and 79.8%, respectively).

Finally, it seems that an increase in the number of players leads to an absence of significant differences in the HR responses of SSGs of different format. This phenomenon could be because of the fact that individual players are involved in less ball activity when the number of participants is greater (29,30,38). Furthermore, as the SSG-P format does not involve specific playing requirements (zones of attack and/or defense), this situation places similar HR responses on players. Conversely, it may be that when there are fewer players per side, the effect is not observed because those involved are constantly active in direct relation to the ball (29,30,38).

Practical Applications

The main practical applications, for coaches and strength conditioning professionals, to be drawn from this study is that changes both in game format (with goal only possession) and the number of players for team (3, 5, or 7) affect the players' physiological and physical demands differently. Concretely, the results show that firstly, changing the game format affects the intensity of play (the physical demands and HR responses) based solely on possession play being greater than those found in games that include goals/goalkeepers; secondly, changing the number of players also affects the intensity of play: The HR responses of SSG increase as the number of players is reduced, whereas most of the physical indicators increase their value as the number of player increases, especially the peak speed and the number of accelerations; thirdly, in 7-a-side (7 vs. 7) games, the HR responses do not change significantly when the game format is changed. However, most measures of physical demands show higher values when only possession play is used, as opposed to games that include goals/goalkeepers; and, fourthly, in SSG involving possession play only, changing the number of players involved does not produce significant differences in their HR responses, whereas the physical intensity does fall as the number of players decreases.

Despite coaches in semiprofessional and amateur teams know to propose training tasks mixing technical, tactical, and physical aspects, they have now more information that could help them in the design of the SSG training session in competitive period of the season, inducing a better determination of the exercise intensity.

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