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Acute Effects of the Number of Players and Scoring Method on Physiological, Physical, and Technical Performance in Small-sided Soccer Games

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This study aims to examine the effect of differences in the number of players and scoring method on heart rate responses, time–motion characteristics, and technical/tactical performance during small-sided soccer games. Ten male amateur soccer players (26.4 ± 5.3 years old, 8.4 ± 3.2 years of practice, 179.3 ± 5.2 cm body height, 71.2 ± 7.1 kg body weight, 45.8 ± 2.6 ml.kg^{-1}min^{-1}VO$_2$max) from the Portuguese regional league played nine different small-sided games (i.e., 3 formats × 3 scoring methods). The study used two-way

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MANOVA, two-away ANOVA, and one-way ANOVA, depending on the specific procedure for the analysis. Compared with other formats, 2v2 induced significantly greater values of technical/tactical indexes ($p = 0.001$), 3v3 induced significantly higher %HRreserve values ($p = 0.001$), and 4v4 led to significantly greater distance coverage and speed ($p = 0.001$). The study provided evidence for coaches to set different small-sided game conditions depending on the training purpose in terms of physiological, physical, and technical performance.

KEYWORDS task constraints, performance analysis, match analysis, team sports assessment procedure

INTRODUCTION

Small-sided games (SSGs) have been used in the last decade to improve the ecology of training sessions on game performance of team sports (Hill-Haas, Dawson, Impellizzeri, & Coutts, 2011). The potential of such modality for sports training has interested many coaches because it simultaneously develops players' physical, technical, and tactical performance (Owen, Wong, McKenna, & Dellal, 2011). Subsequently, sports scientists are becoming more interested in understanding different variables in SSGs (Aguiar, Botelho, Lago, Maças, & Sampaio, 2012).

Coaches can use many variables to organize SSGs (Davids, Araújo, Correia, & Vilar, 2013). An SSG does not only simulate formal competitions in a smaller scale but can also take on the characteristics of specific games to promote specific team tactics (e.g., penetration principle, attacking coverage, and unity) (Clemente, Couceiro, Martins, & Mendes, 2012). Therefore, the variables used by the coach (designated by task constraints) are important and may induce different players' responses (Newell, 1986). From the coaching point of view, task constraints, such as game format, field dimension, scoring method, specific rules or targets, or tactical missions, can differentiate the drills and provide targeted training (Davids, Araújo, Correia, & Vilar, 2013).

Previous studies on soccer SSGs mainly focus on the effects of field dimensions and formats on physiological responses (Dellal, Lago-Penas, Wong, & Chamari, 2011; Frencken, Lemmink, Delleman, & Visscher, 2011; Hill-Haas, Dawson, Coutts, & Rowsell, 2009; Owen, Twist, & Ford, 2004). Smaller formats have been found to increase heart rate responses, blood lactate concentration, and perceived exertion (Hill-Haas et al., 2011) as well as the frequency of ball contacts per player (Owen et al., 2004). As far as field dimension is concerned, the literature suggests that larger field dimensions increase the physiological responses and distance covered by players (Aguiar et al., 2012). The effects of these task constraints have already been heavily studied (Dellal et al., 2011; Hill-Haas et al., 2011). However, investigations on the effects of specific rules and

scoring methods are lacking (Aroso, Rebelo, & Gomes-Pereira, 2004). The use of specific task conditions is crucial to promoting different technical and tactical behaviors in the field (Davids, Araújo, Correia, & Vilar, 2013).

Research has shown that that SSG simultaneously develops players' physical, technical, and tactical performance (Owen et al., 2011). The technical aspects of SSGs have been widely studied (Owen et al., 2004, 2011). Most researchers have used the notational analysis to inspect some indicators, such as passing, receiving, turning, dribbling, intercepting, and shooting (Owen et al. 2004). Nevertheless, notational analysis cannot explain the players' tactical actions during matches. Recently, spatio-temporal metrics have been used to measure the interrelationships between players during SSGs (Clemente, Couceiro, Martins, Mendes, & Figueiredo, 2013; Frencken et al., 2011). Another alternative is the technical/tactical indices of performance (Gréhaigne, Godbout, & Bouthier, 1997). Despite their usefulness, few studies of small-sided games have used technical/tactical indices to understand the technical/tactical success of players during games (Gréhaigne, Richard, & Griffin, 2005). Scientific knowledge about technical and tactical responses can provide a holistic understanding of the SSG training modality and the learning process of players during the games.

This study aims to investigate regular game formats with different task conditions to understand how different conditions can influence physiological, physical, and technical/tactical responses. Until now, most studies have focused on regular SSGs without using other task conditions that improve the players' perception of specific tactical behavior (Hill-Haas et al., 2011). Technical/tactical indices are used to understand tactical behavior in pedagogical issues, aiming not only to conduct a technical analysis but also to observe changes in tactical skills during matches, which has not been studied previously (Owen et al., 2004).

The study aims to examine the effects of different formats (2v2, 3v3, and 4v4) and scoring methods (cross the endline, two reduced targets, and one central target) on heart rate responses, time-motion profiles, and technical/tactical performance. We hypothesize the following: the heart rate response occurs in small formats and in games with more scoring chances (endline and two goals); greater values of distance coverage and speed can be gained in small formats and in games with two goals; and technical/tactical efficiency is higher in small format games with more scoring chances than in larger format games.

METHODS

Participants

Ten male amateur soccer players (26.4 ± 5.3 years old, 8.4 ± 3.2 years of practice, 179.3 ± 5.2 cm body height, 71.2 ± 7.1 kg body weight, 45.8 ± 2.6 ml. $kg^{-1}min^{-1}$ VO_2max, 66.2 ± 10.2 bpm resting heart rate) from the Portuguese

regional league volunteered for the study. One-by-one interviews were conducted by the main researcher with each player to explain the experimental procedures and to observe if the participants did not have any apparent physical or psychological diseases. Afterwards, all players signed the Free and Clarified Consent Form according to the Helsinki Declaration. The players were asked to maintain normal daily food and water intake during the period of study. All players were familiarized with the experimental procedures and the requirements of the games and were instructed on how to use the heart rate monitors. The players had been previously training for a three-month period with three soccer-specific training sessions per week, each lasting for 70 min to 90 min, and one weekly competition.

Procedures

The study was carried out for three consecutive weeks in November of the 2013–2014 season (i.e. early in-season). All players were tested for one format (either 2v2, or 3v3, or 4v4) during one session, that is performing three SSGs in the same format but with three different scoring methods per session. When needed, more than one situation was developed so that participants would be analyzed in all formats and conditions. During the first week, the players performed 2v2+2 neutral players in three different scoring methods; in the second week, 3v3+2 neutral players in three different scoring methods; and in the third week, 4v4+2 neutral players in three scoring methods. A total of nine games were examined. During each session, the order of the three scoring methods was randomized. Heart rate responses, time-motion profiles, and technical/tactical performance were measured per SSG to compare the three formats and three scoring methods (cross the endline, two reduced goals, and one central goal). Data collection was performed on the same day every week (Thursday) to ensure proximal conditions and to avoid any potential effects of circadian variation on the players. Players were ensured a recovery period of 24 h before the day of data collection so no training sessions were scheduled on Wednesdays. All sessions were conducted in dry conditions, with temperature ranging from 16°C to 19°C. Players were allowed to participate in a session only if they presented no signs of injury, illness, or severe fatigue.

Small-sided Games

All SSGs lasted for 5 min, with 3 min passive recovery between games (Table 1). The area per player was the same (90 m^2) in all SSGs. Each SSG had two neutral players playing in the side line (Figure 1). The field ratio was computed excluding the neutral players. Games with 2v2+2 format were played with field dimensions of 19 m × 19 m, thus resulting in a field ratio per player of approximately 90 m^2. The field dimensions in the two other formats were determined based on the 2v2

TABLE 1 Characteristics of the small-sided games

Format	Task condition	Game duration (min)	Duration of passive recovery between SSG (min)	Field Dimensions (m)	Field Total Area (m^2)	Area per Player (m^2)
2v2+2	T1 T2 T3	3x5 min	3 min	19 × 19 m^2	361 m^2	~90m2
3v3+2	T2 T1 T3	3x5 min	3 min	23 × 23 m^2	529 m^2	~90m2
4v4+2	T3 T2 T1	3x5 min	3 min	27 × 27 m^2	729 m^2	~90m2

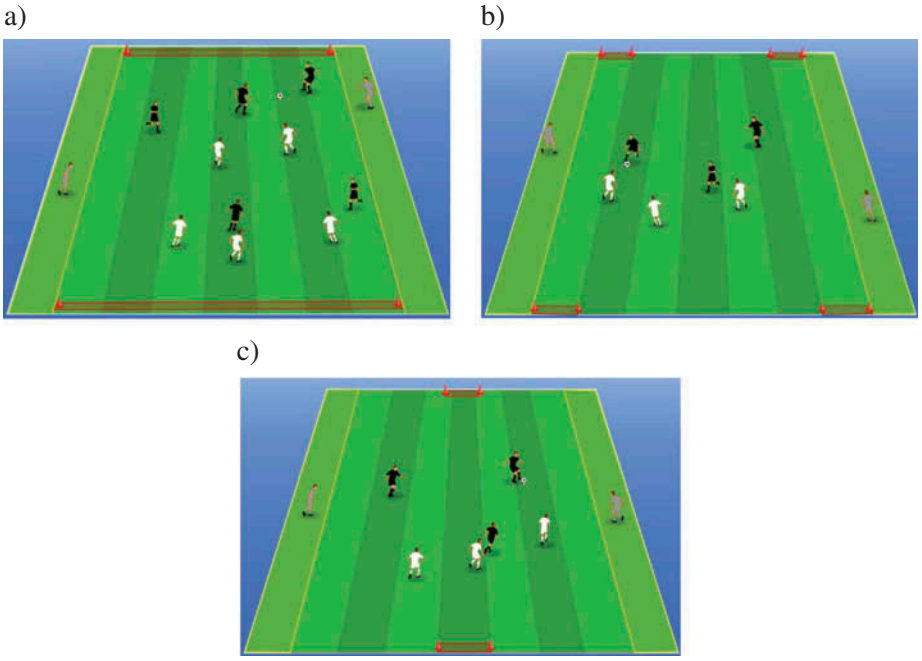

FIGURE 1 Three scoring methods: (a) S1: cross the endline on the opponent's side; (b) S2: cross any of the two goals on each side; and (c) S3: cross the one goal on each side.

+2 format to ensure the same field ratio per player. The neutral players (+2) only provided coverage to the team with ball possession in all SSGs.

The three scoring methods are illustrated in Figure 1. The main goal in the first method (S1, Figure 1(a)) is to cross the opponent's endline of field while receiving the ball with the foot from a teammate. Thus, no goals or targets were used. Two reduced goals of 2 m length were placed near the corners of each side in the second method (S2, Figure 1(b)). One central goal

of 2 m length was placed on each side in the third method (S3, Figure 1(c)). The way to score in all scoring methods is for the player to cross the opponent's endline with possession of the ball.

Assessment of Heart Rate Responses and Time–Motion Profiles

To assess the heart rate at rest, the heart rate monitor was used during a protocol of at least 10 min in a supine position and 7 min in a standing position in a quiet, semi-dark room with a temperature of 18°C to 20°C as adopted by a previous study (Gamelin, Berthoin, & Bosquet, 2006). The three lowest heart rate values were averaged and then used for analysis.

The Yo-Yo intermittent recovery test (level 1) was used to estimate players' VO_2max. The test consists of 20 m runs repeated twice, back and forth between the starting, turning, and finishing lines, and a progressively increasing speed was controlled by audio beeps from a tape recording (Bangsbo, Iaia, & Krustrup, 2008). The heart rate response was measured by placing a lightweight and portable heart rate monitor (Polar RC3 GPS with Heart Rate sensor, Finland) on a player's chest at 1 s sampling intervals. All heart rate data were downloaded to and stored in a computer using dedicated software (Polar WebSync and Polar Pro Trainer 5.0). The maximum heart rate was determined by averaging the three highest values. The maximal aerobic capacity was estimated using the Bangsbo et al. (1991) formula.

During the SSG, the %HRreserve was computed using Karvonen's method (Janssen, 2001). The same heart rate monitor was used to record distance coverage (km) and speed (m/s) at 1 s intervals. The device uses Polar Wind technology at 2.4 GHz transmission. The accuracy of the Polar RC3 GPS measurement is ± 2% for distance and ±0.56 $m.s^{-}$ for speed in moderate and low intensities.

Assessment of Technical/Tactical Performance

The Team Sport Assessment Procedure (TSAP) developed by Gréhaigne et al. (1997) was used to quantify players' overall offensive performance (Gréhaigne et al., 2005). The instrument reflects both technical and tactical aspects of game play by using macro-indicators (Table 2) related to successful game-play (Gréhaigne et al., 1997, 2005). Four indices were used: volume of play, efficiency index, performance score, and attacks with ball (Gréhaigne et al., 1997). Volume of play evaluates general involvement of the play in the game by the sum of received balls and conquered balls (Gréhaigne et al., 2005). The efficiency index depends on the successful passes, shots or finalizations, and balls lost by the player (Gréhaigne et al., 2005).

A set of technical/tactical performance indices was computed according to the second version of TSAP based on the observational variables found in Table 2 (Gréhaigne et al., 2005):

TABLE 2 Observational variables of technical and tactical performance collected by the Team Sport Assessment Procedure

	Observation variables	Operational definition
Gaining possession of the ball	Conquered Ball (CB)	The player intercepted or stole the ball from an opponent or recaptured it after an unsuccessful shot
	Received Balls (RB)	Player received the ball from a teammate and did not immediately lose control of the ball
Disposing of the ball	Lost Ball (LB)	Player lost control of the ball
	Neutral Ball (NB)	It is a routine pass to a teammate that does not put pressure on the opponent's team
	Pass (P)	Pass to a partner that contributes to the displacement of the ball towards the opponent team's defensive region
	Successful Shot on Goal (SS)	It is considered successful when it scores or ensures the possession of the ball

$$Volume\ of\ Play\ (VP) = CB + RB \tag{1}$$

where *CB* represents the balls conquered and *RB* denotes the balls received. The volume of play is the frequency of ball possession during the match. We also computed an index based on attacking performance:

$$Attacks\ with\ ball\ (AB) = P + SS \tag{2}$$

where *P* is the frequency of passes and *SS* is the frequency of successful shots or, in this case, the way to score for each small-sided game. The following index computes the disposing of the ball:

$$Efficiency\ Index\ (EI) = \frac{AB}{10 + LB} \tag{3}$$

where *AB* indicates the attacks with ball and *LB* indicates the balls lost. Using the previous indices, we can compute the performance score index:

$$Performance\ Score\ (PS) = \left(\frac{VP}{2}\right) + (EI \times 10) \tag{4}$$

where *VP* is the volume of play and EI is the efficiency index.

Indices were computed for each game based on the players' performance. Observational analysis was performed after video collection by the same researcher who has more than four years of professional experience in match analysis. Test–retest reliability was analyzed using Cohen's Kappa test, adhering to a 25-day interval for re-analysis to avoid task familiarity issues

(Robinson & O'Donoghue, 2007). A Kappa value of 0.88 was obtained after testing 20% of the full data. The procedure could be repeated with ease.

Statistical Procedures

The influences of Game format and scoring method factors on the % HRreserve, distance coverage, speed, volume of play, efficiency index, performance score, and attacks with ball were analyzed using two-way MANOVA after validating normality and homogeneity assumptions. MANOVA was specifically chosen because it reduces Type I Error Inflation compared with ANOVA (O'Donoghue, 2012, p. 242; Pallant, 2011, p. 283). Moreover, in many cases, MANOVA can detect statistical differences that many one-way ANOVAs cannot (Maroco, 2011, p. 276; Pallant, 2011, p. 283). The assumption of normality for each univariate dependent variable was examined using Kolmogorov-Smirnov tests (p-value < 0.05). The assumption of the homogeneity of each group's variance/covariance matrix was examined with the Box's M Test. No homogeneity was shown. When the MANOVA detected significant statistical differences between the two factors, we proceeded to the two-way ANOVA for each dependent variable, followed by Tukey's HSD post-hoc test (O' Donoghue, 2012, p. 243). When the two-way ANOVA showed an interaction between factors, it also generated a new variable that crossed the two factors (e.g., 2v2*T1; 2v2*T2) for each dependent variable to identify statistical significance (Maroco, 2012). Ultimately, the statistical procedures used were one-way ANOVA and Tukey HSD post-hoc. If no interactions were detected in two-away ANOVA, a one-way ANOVA was used for each independent variable. All statistical analyses were performed using IBM SPSS Statistics (version 21) at a significance level of $p < 0.05$.

The following scale was used to classify the effect size and the power of the test (Hopkins, Hopkins, & Glass, 1996): very small, 0–0.01; small, 0.01–0.09; moderate, 0.09–0.25; large, 0.25–0.49; very large, 0.49–0.81; and nearly perfect, 0.81–1.0.

RESULTS

Heart Rate and Time–Motion Characteristics

The two-way MANOVA revealed that the format ($p = 0.001$; $\eta^2_p = 0.03$; *Power* = 1.00; small effect size) and scoring method ($p = 0.001$; $\eta^2_p = 0.02$; *Power* = 1.00; small effect size) had significant main effects on the heart rate and time-motion characteristics. There was significant interaction (Pillai's Trace = 0.033; $F_{16,61848} = 31.77$; $p = 0.001$; $\eta^2_p = 0.01$; *Power* = 1.00; very small effect size) between format and scoring method on heart rate and time–motion characteristics. As previously indicated in the statistical procedures, a two-

way ANOVA was conducted for each dependent variable after the confirmation of the interaction (O'Donoghue, 2012, p. 243).

Interaction was found between factors for %HRreserve ($F_{4,15462}$ = 49.445; p = 0.001; η_p^2 = 0.013; *Power* = 1.00; small effect size), distance coverage ($F_{4,15462}$ = 23.672; p = 0.001; η_p^2 = 0.006; *Power* = 1.00; very small effect size), and speed ($F_{4,15462}$ = 25.593; p = 0.001; η_p^2 = 0.007; *Power* = 1.00; very small effect size).

The one-way ANOVA tested the crossing between factors. Statistical differences were found between the new variable (cross between format and task) and the dependent variables of %HRreserve ($F_{8,15462}$ = 49.971; p = 0.001; η_p^2 = 0.025; *Power* = 1.00; small effect size), distance coverage ($F_{8,15462}$ = 48.425; p = 0.001; η_p^2 = 0.024; *Power* = 1.00; small effect size), and speed ($F_{8,15462}$ = 93.813; p = 0.001; η_p^2 = 0.046; *Power* = 1.00; small effect size). The post-hoc results observed are shown in Table 3.

Technical/Tactical Performance

No interaction effects (*Pillai's Trace* = 0.20; $F_{16,252}$ = 0.84; p = 0.638; η_p^2 = 0.05; *Power* = 0.57; very large effect size) were found between the format and scoring method on technical/tactical performance. Therefore, one-way ANOVA was performed on each factor.

In the case of volume of play, a one-way ANOVA was performed on each independent variable because no interaction was found between factors (Table 4). The results for volume of play (Table 4) showed no statistical difference in tasks in the 2v2 (F = 0.394; p = 0.681; η_p^2 = 0.005; *Power* = 0.102; very small effect size), 3v3 (F = 0.084; p = 0.919; η_p^2 = 0.008; *Power* = 0.061; very small effect size), and 4v4 (F = 0.107; p = 0.900; η_p^2 = 0.008; *Power* = 0.065; very small effect size) formats.

One-way ANOVA was used as no interaction between factors was found. The results for efficiency index (Table 5) showed statistical differences between tasks in the 2v2 format (F = 4.23; p = 0.035; η_p^2 = 0.036; *Power* = 0.065; small effect size). No differences were found in the 3v3 (F = 1.04; p = 0.371; η_p^2 = 0.09; *Power* = 0.21; small effect size) and 4v4 (F = 1.17; p = 0.33; η_p^2 = 0.08; *Power* = 0.24; small effect size) formats.

One-way ANOVA was used as no interaction between factors was found. The results for the performance score (Table 6) showed no statistical differences in tasks in the 2v2 (F = 1.70; p = 0.22; η_p^2 = 0.18; *Power* = 0.30; moderate effect size), 3v3 (F = 0.14; p = 0.87; η_p^2 = 0.13; *Power* = 0.07; moderate effect size), and 4v4 (F = 0.34; p = 0.72; η_p^2 = 0.02; *Power* = 0.10; small effect size) formats.

One-way ANOVA was used as no interaction between factors were found. The results for attacks with ball (Table 7) showed statistical differences

TABLE 3 Descriptive table (mean and standard deviation) and statistical comparison between crossing factors

	2v2			3v3			4v4		
	Task 1	Task 2	Task 3	Task 1	Task 2	Task 3	Task 1	Task 2	Task 3
%HRres	74.98 (13.89)[b-i]	81.05 (10.91)[a,c,e,i]	83.38 (12.00)[a,b,g,h]	82.06 (15.26)[a,e,h,i]	84.18 (13.16)[a,b,d,f,g,h]	81.98 (14.08)[a,e,h,i]	81.27 (16.41)[a,c,e,i]	80.32 (14.89)[a,c,d,e,f,i]	83.61 (14.55)[a,b,d,f,g,h]
Distance (km)	0.25 (0.15)[b,d,e,g,h,i]	0.22 (0.14)[a,d,e,g,h,i]	0.24 (0.13)[d,e,g,h,i]	0.29 (0.18)[a,b,c,f]	0.28 (0.16)[a,b,c,f]	0.24 (0.15)[d,e,f,g,h,i]	0.28 (0.17)[a,b,c,f]	0.30 (0.18)[a,b,c,f]	0.29 (0.18)[a,b,c,f]
Speed (m/s)	1.74 (0.61)[b,c,d,e,g,h,i]	1.61 (0.67)[a,d,e,f,g,h,i]	1.60 (0.64)[a,c,d,e,f,g,h,i]	2.10 (0.95)[a,b,c,e,f]	1.97 (0.72)[a,b,c,d,e,h,i]	1.78 (0.64)[b,cd,e,g,h,i]	2.04 (1.08)[a,b,c,f,h]	2.14 (1.04)[a,b,c,e,f,g]	2.10 (1.03)[a,b,c,e,f]

Significantly different compared with 2v2*T1[a]; 2v2*T2[b]; 2v2*T3[c]; 3v3*T1[d*]; 3v3*T2[e]; 3v3*T3[f]; 4v4*T1[g*]; 4v4*T2[h]; 4v4*T3[i] at $p < 0.05$.

TABLE 4 One-way ANOVA values in tasks in each format in volume of play

		M(SD)	F	p	η_p^2	Power
2v2	T1	18.33 (2.5)	0.394	0.681	0.005	0.102
	T2	19.83 (3.31)				
	T3	17.50 (6.83)				
3v3	T1	11.88 (3.10)	0.084	0.919	0.008	0.061
	T2	11.50 (4.57)				
	T3	12.25 (3.11)				
4v4	T1	7.70 (3.95)	0.107	0.900	0.008	0.065
	T2	7.00 (3.43)				
	T3	7.30 (2.71)				

TABLE 5 One-way ANOVA values in tasks in each format in efficiency index

		M(SD)	F	p	η_p^2	Power
2v2	T1	0.22 (0.14)[c]	4.23	0.035	0.36	0.65
	T2	0.08 (0.11)				
	T3	0.04 (0.07)[a]				
3v3	T1	0.00 (0.00)	1.04	0.371	0.09	0.21
	T2	0.03 (0.06)				
	T3	0.30 (0.06)				
4v4	T1	0.09 (0.12)	1.17	0.33	0.08	0.24
	T2	0.08 (0.10)				
	T3	0.03 (0.07)				

Significantly different compared with T1[a]; T2[b]; T3[c]; at $p < 0.05$.

TABLE 6 One-way ANOVA values in tasks in each format in performance score

		M(SD)	F	p	η_p^2	Power
2v2	T1	11.34 (0.80)	1.70	0.22	0.18	0.30
	T2	10.72 (1.96)				
	T3	9.18 (2.93)				
3v3	T1	5.94 (1.55)	0.14	0.87	0.13	0.07
	T2	6.04 (2.43)				
	T3	6.42 (1.74)				
4v4	T1	4.76 (3.07)	0.34	0.72	0.02	0.10
	T2	4.3 (1.67)				
	T3	3.93 (1.79)				

Significantly different compared with T1[a]; T2[b]; T3[c]; at $p < 0.05$.

in tasks in the 2v2 ($F = 4.24$; $p = 0.04$; $\eta_p^2 = 0.36$; *Power* = 0.65; large effect size) format. No differences were found in the 3v3 ($F = 1.02$; $p = 0.40$; $\eta_p^2 = 0.09$; *Power* = 0.20; moderate effect size) and 4v4 ($F = 1.25$; $p = 0.30$; $\eta_p^2 = 0.09$; *Power* = 0.25; moderate effect size) formats.

TABLE 7 One-way ANOVA values in tasks in each format in attacks with ball

		M(SD)	F	*p*	η_p^2	Power
2v2	T1	2.50 (1.52)[c]	4.24	0.04	0.36	0.65
	T2	1.00 (1.26)				
	T3	0.50 (0.84)[a]				
3v3	T1	0.00 (0.00)	1.02	0.40	0.09	0.20
	T2	0.38 (0.74)				
	T3	0.38 (0.74)				
4v4	T1	1.00 (1.33)	1.25	0.30	0.09	0.25
	T2	0.90 (1.1)				
	T3	0.30 (0.67)				

Significantly different compared with T1[a]; T2[b]; T3[c]; at $p < 0.05$.

TABLE 8 One-way ANOVA values in formats in each task in volume of play

		M(SD)	F	*p*	η_p^2	Power
Task 1	2v2	18.33 (2.50)[b,c]	12.69	0.001	0.64	1.00
	3v3	11.88 (3.09)[a,c]				
	4v4	7.70 (3.95)[a,b]				
Task 2	2v2	19.83 (3.31)[b,c]	21.15	0.001	0.67	1.00
	3v3	11.50 (4.57)[a]				
	4v4	7.00 (3.43)[a]				
Task 3	2v2	17.50 (6.83)[c]	11.35	0.001	0.52	0.98
	3v3	12.25 (3.11)				
	4v4	7.30 (2.71)[a]				

Significantly different compared with 2v2[a]; 3v3[b]; 4v4[c]; at $p < 0.05$.

One-way ANOVA was used as no interaction between factors was found. The results for volume of play (Table 8) showed statistical differences in the T1 ($F = 12.69$; $p = 0.001$; $\eta_p^2 = 0.64$; *Power* = 1.00; very large effect size), T2 ($F = 21.15$; $p = 0.001$; $\eta_p^2 = 0.67$; *Power* = 1.00; large effect size), and T3 ($F = 11.35$; $p = 0.001$; $\eta_p^2 = 0.52$; *Power* = 0.98; very large small effect size) formats.

One-way ANOVA was used as no interaction between factors was found. The results for efficiency index (Table 9) showed statistical differences in the T1 format ($F = 7.54$; $p = 0.003$; $\eta_p^2 = 0.42$; *Power* = 0.91; large effect size). No differences were found in T2 ($F = 0.86$; $p = 0.437$; $\eta_p^2 = 0.08$; *Power* = 0.18; small effect size) and T3 ($F = 0.12$; $p = 0.887$; $\eta_p^2 = 0.01$; *Power* = 0.07; small effect size).

One-way ANOVA was used as no interaction between factors was found. The results for performance score (Table 10) showed statistical differences in the T1 ($F = 17.17$; $p = 0.001$; $\eta_p^2 = 0.62$; *Power* = 1.00; very large effect size), T2 ($F = 19.25$; $p = 0.001$; $\eta_p^2 = 0.65$; *Power* = 1.00; very large effect size), and T3 ($F = 11.84$; $p = 0.001$; $\eta_p^2 = 0.53$; *Power* = 0.99; very large small effect size) formats.

TABLE 9 One-way ANOVA values in formats in each task in efficiency index

		M(SD)	F	p	η_p^2	Power
Task 1	2v2	0.22 (0.14)[b]	7.54	0.003	0.42	0.91
	3v3	0.00 (0.00)[a]				
	4v4	0.09 (0.12)				
Task 2	2v2	0.08 (0.11)	0.86	0.437	0.08	0.18
	3v3	0.03 (0.06)				
	4v4	0.08 (0.10)				
Task 3	2v2	0.04 (0.07)	0.12	0.887	0.01	0.07
	3v3	0.03 (0.06)				
	4v4	0.03 (0.07)				

Significantly different compared with 2v2[a]; 3v3[b]; 4v4[c]; at $p < 0.05$.

TABLE 10 One-way ANOVA values in formats in each task in performance score

		M(SD)	F	p	η_p^2	Power
Task 1	2v2	11.34 (0.80)[b,c]	17.17	0.001	0.62	1.00
	3v3	5.94 (1.55)[a]				
	4v4	4.76 (3.07)[a]				
Task 2	2v2	10.72 (1.96)[b,c]	19.25	0.001	0.65	1.00
	3v3	6.04 (2.44)[a]				
	4v4	4.30 (1.67)[a]				
Task 3	2v2	9.18 (2.93)[c]	11.84	0.001	0.53	0.99
	3v3	6.42 (1.74)				
	4v4	3.93 (1.79)[a]				

Significantly different compared with 2v2[a]; 3v3[b]; 4v4[c]; at $p < 0.05$.

TABLE 11 One-way ANOVA values in formats in each task in attacks with ball

		M(SD)	F	p	η_p^2	Power
Task 1	2v2	2.50 (1.52)[b,c]	8.19	0.002	0.44	0.93
	3v3	0.00 (0.00)[a]				
	4v4	1.00 (1.32)[a]				
Task 2	2v2	1.00 (1.26)	0.80	0.465	0.07	0.17
	3v3	0.38 (0.74)				
	4v4	0.90 (1.10)				
Task 3	2v2	0.50 (0.84)	0.14	0.873	0.01	0.07
	3v3	0.38 (0.74)				
	4v4	0.30 (0.67)				

Significantly different compared with 2v2[a]; 3v3[b]; 4v4[c]; at $p < 0.05$.

One-way ANOVA was used as no interaction between factors was found. The results for attacks with ball (Table 11) showed statistical differences in the T1 format ($F = 8.19$; $p = 0.002$; $\eta_p^2 = 0.44$; *Power* = 0.93; large effect size). No differences were found in T2 ($F = 0.80$; $p = 0.465$; $\eta_p^2 = 0.07$; *Power* = 0.17;

small effect size) and T3 ($F = 0.14$; $p = 0.873$; $\eta_p^2 = 0.01$; *Power* = 0.07; small effect size).

DISCUSSION

The study aims to examine the effect of formats and scoring methods on soccer players' heart rate responses, distance coverage, running speed, volume of play, efficiency index, performance score, and attacks with ball during SSG. We found that both format and scoring methods induced different performance responses. Our results showed that the 3v3 format induced higher heart rate responses and the 4v4 format induced greater distance coverage, and speed, compared with all formats. We also found that the use of one central goal increased heart rate responses and that the use of endlines and two goals also increased distance covered, speed, and technical/tactical performance. Generally, small-format SSGs increase physiological responses and technical efficacy, and large-format SSGs develop the endurance system and increase distance coverage, and speed (Owen, Wong, Paul, & Dellal, in press).

Heart Rate Responses and Time–Motion Characteristics

The 3v3+2 format had the highest %HRreserve compared with other formats in the study. The results are in accordance with those of previous studies that 3v3 induces faster heart rate than 2v2 (Aroso et al., 2004; Köklü, 2012; Little & Williams, 2007; Owen et al., 2004). However, some studies have also reported that small SSGs usually increase heart rate responses (Dellal, Hill-Haas, Lago-Penas, & Chamari, 2011; Hill-Haas et al., 2011; Rampinini, Coutts, Castagna, Sassi, & Impellizzeri, 2007; Sampaio et al., 2007). The discrepancy in the findings could be explained by the increasing task complexity in a 3v3 game. More tactical combinations can be performed in 3v3 than that in 2v2 games, giving possibilities for recovery in defensive regions after a great effort. This may increase the active recovery, and thus prepare the players for high intensities and to restarts in the following offensive process. The higher individual participation of every player in defensive and offensive moments in 2v2 format reduces the intensity of both teams, thus lowering general heart rate responses.

A comparison among the three scoring methods in this study found that %HRreserve was the highest in S3 and the lowest in S1. The difference with Casamichana, Castellano Paulis, González-Morán, García-Cueto, & Garcia-López's (2012) results could be because the present study used the central goal. The central goal increased the intensity through the need for variability to circulate the ball, which is necessary to displace the opponents' defenders from the central zone.

Larger distance coverage was observed in the larger format (4v4), consistent with some previous studies that only studied two smaller game (2v2 and 4v4) formats (Hill-Haas et al., 2009). It was found that the 4v4 induced larger distance coverage than the 2v2 (Hill-Haas et al., 2009). Our study findings do not agree with most studies that performed similar analyses (Allen, Butterfly, Welsh, & Wood, 1998; Jones & Drust, 2007; Romero, Paredes, Sancho, & Morencos, 2012) between medium (4v4 and 5v5) and larger formats (7v7, 8v8 and 11v11).

Similarly, distance coverage and speed were also high in the 4v4 format, in accordance with Hill-Haas et al. (2009). The necessarily higher strategic definition may increase the muscular and physiological availability because of the large periods of recovery in-match that enables players to perform higher speed in the areas measured.

The comparison among the three scoring methods showed that a large distance was covered in S1 (opponent's endline). The exploitation of all opponents' endlines to receive the ball from the teammate may have increased players' movements and distance coverage. S1 also induced greater speed, which was perhaps a result of penetration actions that require greater speed to overtake direct opponents. The higher defensive organization in the central zone in S3 (one goal) may have decreased the exploitation of the field, thus reducing the distance coverage and movement speed.

Technical/Tactical Performance

Our study findings are comparable with most technical analyses in soccer SSGs that observed a higher number of individual indicators in smaller formats (Capranica, Tessitore, Guidetti, & Figura, 2001; Katis & Kellis, 2009; Rudolf & Václav, 2009). The highest volume of play in the present study was performed in a smaller format (2v2) and it consistently decreased until the 4v4. The high volume of play suggests higher individual participation in the match because the index considers ball receiving and conquering. The results are further supported by the study of Jones and Drust (2007), which shows that smaller games increase player's individual participation. The finding is useful in coaching and developing the technical skills of novice players because it can promote a higher individual participation and stimulate the technical development.

A higher efficiency index was found in the smaller format (2v2), and it consistently decreased in the larger format (4v4). These results can be explained by the greater number of opponents in larger formats that increase the pressure on the player over ball possession. Moreover, more opponents would have increased the difficulty to explore the field and pass the ball. Performance score was also higher in smaller SSG formats than in larger ones.

Considering the effects of different scoring methods, efficiency index, performance score, and attacks with ball were higher in S1 (opponent's endline). The larger chance to score using the endline may promote the exploitation of attacking players in different zones. This variability of exploitation may decrease the defensive organization and increase the space to ensure the success of passes or balls received. S3 (one goal) may increase the strength of defensive organization in the central area and subsequently reduce opponents' successful passes during attack formations.

Only volume of play was higher in S2 (two goals) than in S1. The use of two targets closer to the corners of the endline and farther from each other may promote defensive clusters closer to each goal and reduce pressing in the middle and central areas. Without pressing, increasing the frequency of balls received and conquered was easy.

This study has some limitations. First, the results cannot be generalized for all soccer training and can only be applied to amateur players in mild temperatures and not to professional players and training in extremely hot or cold conditions. Nonetheless, the study proves that small-sided and conditioned soccer games can change players' performance, even in technical/tactical actions. Future studies can compare the effects of regular small-sided games with those of small-sided and conditioned games, mainly comparing the tactical learning of players and the collective organization of teammates.

PRACTICAL IMPLICATIONS

We observed that smaller formats increased heart rate responses and technical/tactical performance and that large formats increased distance coverage, and speed. Scoring methods also affected these measures: one central goal (S3) increased heart rate responses, and endline scoring (S1) favored attacking players and increased distance coverage, speed, and most technical/tactical performance indices.

The results can be adopted by coaches when developing soccer drills. On one hand, smaller formats (2v2 and 3v3) with one central goal can be used to develop the anaerobic metabolic system and increase technical performance by increasing individual participation. On the other hand, larger formats (4v4) and scoring using the endline (S1) or with two goals (S2) can develop aerobic endurance and increase tactical behavior and strategic definition in the field.

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