BASKETBALL SMALL-SIDED GAMES: EFFECTS OF VARYING FORMATS AND USING SUCCESSIVE BOUTS

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Abstract:

This study compared athletes' rate of perceived exertion (RPE) and the number of their technical-tactical actions in small-sided basketball games (SSG) played within the same relative area with adjusted bout durations in (a) varied game formats; and (b) in two successive bouts of different formats. Ten young female basketball players (14.3±1.3 years) played two bouts of five small-sided game (SSG) formats (1x1, 2x2, 3x3, 4x4, and 5x5). The number of technical-tactical actions per player per minute decreased from the smaller to the larger SSG format, and players' RPE tended to be higher in larger compared to smaller formats. We concluded that the smaller basketball SSG formats increased players' participation. In addition, adjustments of the relative playing area and bout duration seemed to decrease players' effort. The use of two SSG bouts did impact the number of technical-tactical actions and RPE.

Key words: *basketball, drill-based games, conditioned games, performance, notational analysis*

Introduction

Small-sided games (SSG) have been used in team sport training because they combine physical, physiological, and technical-tactical aspects of the actual game (Hoffmann, Reed, Leiting, Chiang, & Stone, 2014). SSG can be arranged to emphasize certain tactical situations (Bredt, et al., 2017; Clemente, Martins, Mendes, & Oliveira, 2016) or improve athletes' physical/physiological capacities (Delextrat, Gruet, & Bieuzen, 2018; Delextrat & Martinez, 2014; Hammami, Gabbett, Slimani, & Bouhlel, 2017). Coaches and physical trainers can easily alter and control SSG characteristics (task constraints) such as the number of players (formats), the court size, and the rules in order to prompt different physiological, physical, technical, or tactical responses from players (Clemente, 2016).

The use of SSG of varied numbers of players per team (e.g., smaller formats) may help training specific technical-tactical skills, because varied formats allow players to perform more technical-tactical actions compared to the actual game (Conte, Favero, Niederhausen, Capranica, & Tessitore, 2015; Klusemann, Pyne, Foster, & Drinkwater, 2012b; Tallir, Philippaerts, Valcke, Musch, & Lenoir, 2012). Indeed, for basketball SSG, Conte et al. (2015) and Klusemann et al. (2012) found that the 2x2 format increased frequency of dribbling, passing, close-range shots, mid-range jump shots, 3-point shots, rebounds, and ball screens in individual players in comparison to the 4x4 format. However, studies that have investigated different numbers of players per team within the same playing area have suggested that smaller formats usually increase players' heart rate (HR) (Castagna, Impellizzeri, Chaouachi, Ben Abdelkrim, & Manzi, 2011; Delextrat & Kraiem, 2013; Klusemann, et al., 2012), frequencies of sprints, high-intensity shuffling movements and jumps (Klusemann, et al., 2012), and the perceived rate of exertion (RPE) (Castagna, et al., 2011; Conte, et al., 2015; Klusemann, et al., 2012). Most of these studies have associated these increased physical and physiological demands within smaller formats with

a larger relative area (i.e., area per player) players must cover and a higher running velocity players reach in SSG. Thus, research using similar relative areas with varied SSG formats might better control the playing area variable to evaluate the technical-tactical demands of varied formats while maintaining similar effort. The only two studies that decreased the playing area for smaller SSG formats (i.e., studies that kept the relative playing area similar) did not find HR or RPE differences between the smaller and larger SSG formats (McCormick, et al., 2012; Sampaio, Abrantes, & Leite, 2009). However, these few studies investigated only a few SSG formats (3x3 and 5x5 or 3x3 and 4x4) and did not investigate the players' technical-tactical actions (Sampaio, et al., 2009), or used young national players (McCormick, et al., 2012).

Another variable of interest and of uncertain effect on SSG training, especially in basketball, is whether training bouts are singular or sequenced back-to-back in quick succession. Soccer studies suggest that HR, blood lactate concentration, and RPE may increase with successive SSG bouts (Dellal, Lago-Penas, Wong, & Chamari, 2011; Kelly & Drust, 2009; Köklü, Asçi, Koçak, Alemdaroglu, & Dündar, 2011). The number of technical-tactical actions played may decrease from the first to the last SSG bout (Dellal, et al., 2011; Fanchini, et al., 2011; Kelly & Drust, 2009). These results may be related to the influence of over-the-bouts accumulated fatigue. However, some studies adjusted the duration of the SSG bouts to the number of players per team, increasing bout duration for larger formats (i.e., adjusted bout duration) (Dellal, Chamari, Payet, Djaoui, & Wong, 2016; Köklü, et al., 2011; Owen, et al., 2016; Rebelo, Silva, Rago, Barreira, & Krustrup, 2016). Although these studies did not justify the increase in bout duration for the larger formats, we suppose that this choice assumes that larger formats are more complex and might need a longer duration to create a favorable scoring situation. Also, the decrease in SSG bout duration in smaller formats may decrease players' effort. Therefore, it is important to verify the effect of successive SSGs on the number of technical-tactical actions per player and players' effort in different basketball SSG with adjusted bout durations.

Finally, to the best of our knowledge, only a few studies have investigated the effects of different SSG formats on female athletes' responses (Atli, Koklu, Alemdaroglu, & Koçar, 2013; Klusemann, et al., 2012, 2012a; Sanchez-Sanchez, et al., 2018); only two included technical-tactical variables (Klusemann, et al., 2012; Sanchez-Sanchez, et al., 2018). In addition, women's and men's basketball present different physical demands (Matthew & Delextrat, 2009; Portes, Jiménez, Navarro, Scanlan, & Gómez, 2020), suggesting differences in the way the game is played between sexes. These data support the need for further investigation about female basketball players, which will be addressed in this study.

Based on prior research, we hypothesized that (a) smaller SSG formats would be associated with a higher frequency of technical-tactical actions per player per minute and a lower RPE, and that, in successive bouts, (b) there would be a reduced number of technical-tactical actions per player and an increased player RPE from the first to the second bout. In order to test these hypotheses we compared ten female athletes' RPE and the number of their technical-tactical actions in varied SSG formats (1x1, 2x2, 3x3, 4x4, and 5x5) played within the same relative playing area; we also adjusted bout durations and again compared the participants' RPE and number of technical-tactical actions in two successive SSG bouts of different SSG formats played within the same playing area with adjusted bout durations.

Method

Participants

Participants in this study were 10 young women basketball players on the same team who were engaged in national competition (M age =14.3, SD = 1.3 years; M experience = 4.6, SD = 2.1 years; M body height = 162.4, SD = 4.6 cm; M body weight: = 53.2, SD = 2.7 kg). Participants competed in under-16 teams, which had three training sessions (~120 min each session) a week and one official match at the weekend. Participant inclusion criteria were: (a) female basketball players, each with more than three years competitive game experience; (b) no recent (last six months) injuries or illness; and (c) participation in all experimental sessions. The participants and their parents were informed about the study protocol and its implications, risks, and benefits. All players signed a child assent form, and all parents and caretakers gave written informed consent for players' participation in the study. The study followed the ethical standards of the Declaration of Helsinki for studies with humans.

Experimental approach

This cross-sectional study aimed to compare the number of technical actions per player per minute and the players' rate of perceived exertion (RPE) in different SSG formats and between successive SSG bouts. The study was conducted after 15 weeks of play, after the beginning of the season (midseason). We used five SSG formats (1x1, 2x2, 3x3, 4x4, and 5x5) at an indoor facility on a regular basketball court during a 3-week period. Each SSG format was played as two successive bouts with 2-minute rest intervals in-between. Players were familiarized with all SSG formats before the start of data collection. During week one, we implemented the 1x1 and 3x3 SSG formats on different days, interspersed by

48 hours. During week two, we implemented the 5x5 and 2x2 formats in two sessions interspersed by 48 hours. During week three, we implemented the 4x4 format 48 hours after the weekend match. We replicated the 3x3 and 4x4 formats to allow all players to experience these formats, and in these cases, we recorded only the first participation for players who repeated the formats. In each session only one SSG format was implemented.

All SSG sessions occurred at 7 p.m. at an average temperature of 17ºC on an indoor court. The SSG sessions started with a standard warm-up protocol consisting of five minutes of jogging, five minutes of dynamic stretching and mobility, five minutes of sprints, accelerations, and decelerations, and five minutes of a ball possession game. We recorded the SSGs with digital cameras, and collected individual RPE data immediately after each SSG bout.

Small-sided games

The head coach formed the SSG teams, aiming to balance the opponent teams in their technical/tactical skill levels and playing positions (e.g., 1 guard + 1 center against 1 guard + 1 center). There were no specific tactical instructions for players before or during the SSGs. We adopted all International Basketball Federation (FIBA) rules except time-outs and free throws. Any personal foul led to the loss of ball possession by the team that committed the foul, and the team that suffered the foul regained ball possession by throwing the ball in from the side line. Team coaches provided verbal encouragement to athletes to maintain high exertion. Table 1 presents the court dimensions and exercise regimen (i.e., bout and rest durations) used in each SSG format.

Rate of perceived exertion (RPE)

As noted, players rated their perceived exertion immediately after each SSG bout, using a 10-point scale in which "1" means very light activity and "10" means maximal exertion (CR-10 Borg scale; Borg, 1998). RPE is a valid and consistent method to estimate effort during exercise (Scherr, et al., 2013). All players were previously familiarized with this scale to ensure reliability of data. The absolute RPE was considered as outcome per game, thus no standardization per minute was made.

Technical-tactical actions

Technical-tactical actions performed by players were recorded using three digital cameras (Go Pro Hero 2, 1280x960, 25 Hz), with two positioned in an open angle and one focusing on the ball-handler. Each of the videos of technical-tactical actions were analyzed by one experienced observer with more than three years of experience in basketball match analysis. We verified the within-observer reliability 20 days after the first analysis. The intraclass correlation coefficient was 0.85 (moderate reliability) based on 10% of the full data.

The observer coded the following technical actions for each player: conquered balls (CB), received balls (RB), lost balls (LB), attacking balls/passes (AB), shots (S), and rebounds (R). The technical actions selected were those from the Performance Assessment in Team Sports instrument (Gréhaigne, Godbout, & Bouthier, 1997). A CB was defined as a player stealing the ball from an opponent. An RB was when a player received the ball from a teammate and did not immediately lose control of it. An LB was when a player lost ball possession to an opponent. An AB was when a player made a pass to a teammate with an attempt to move forward and pressure the other team – passes that did not disturb opponents' defense were not considered (e.g., passes backwards). An S was when a player tried to score by means of a throw, including both successful and unsuccessful throws. An R was when a player gained ball possession after a missed throw attempt. The numbers of actions were made comparable by relating them each to a standardized period of elapsed time (number/minute).

Statistical procedures

Descriptive data regarding variables of interest are presented as either means (M) and standard deviations (SD) or percentage differences. A nonparametric procedure [analysis of variance (ANOVA)-type statistics], as previously suggested (Ghosh, 2003), was used to check the response of the variables during the training protocols for the main effects of protocol and set, as well as the interactions between these factors. Nonparametric inferential procedures were required as the residuals showed significant deviations from the normal distribution ($p<.05$ to all variables). Dunn's *post-hoc* was used to make pairwise comparisons. We employed

Table 1. The description of different SSG formats

	1x1	2x2	3x3	4x4	5x5
Court dimensions*	15x6m	22x8m	24x11m	26x13m	28x15m
Area per player	45m^2	44m^2	44m^2	~42m^2	42m^2
Regimen	2x1'/2' rest	2x2'/2' rest	2x3'/2' rest	2x4'/2' rest	2x5'/2' rest

*The baskets were the length of the court apart in each SSG format.

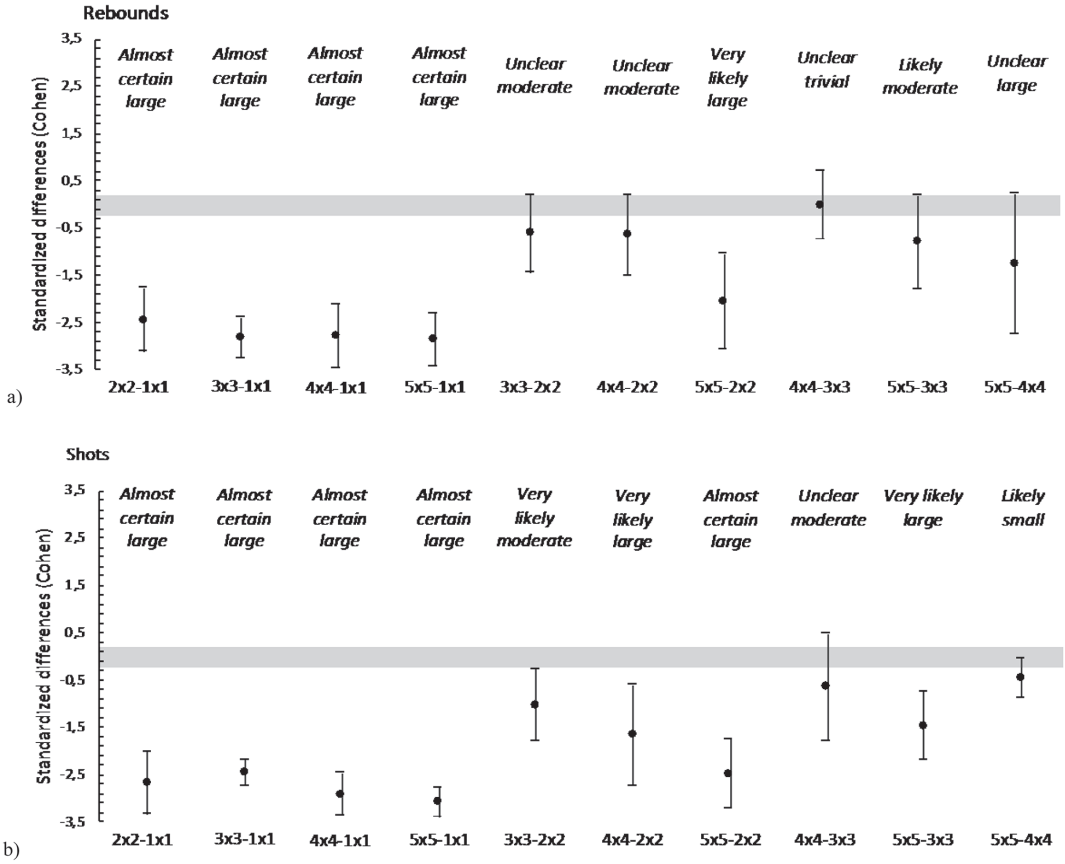
a 90% confidence interval (90% CI). Standardized differences of the effect size (ES), with a 90% CI (Cohen, 1988) were used to analyze the within- and between-format changes. ES was classified as trivial (<0.2), small (0.2-0.6), moderate (0.6-1.2), or large (>1.2) (Batterham & Hopkins, 2006). The percentages and standardized differences were tested in a specifically-designed Excel spreadsheet developed by Hopkins (2018).

Results

The inferential analysis showed no interaction between SSGs formats and sets (p>.05 to all dependent variables). Results showed no significant differences between the sets for the received balls (H=0.130; p=.718), conquered balls (H=2.481; p=.115), lost balls (H=0.503; p=.478), attacking balls (H=0.001; p=.971), shots (H=0.818; p=.365), rebounds (H=0.434; p=.510), and RPE (H=0.836, p=.360). There was no format effect for the conquered balls (H=8.416; p=.076) and lost balls (H=8.127; p=.087). On the other hand, significant differences were reported for received balls (H=52.795; p<.001; 1x1<all formats), attacking balls (H=39.799; p<.001; 1x1<all formats), shots (H=54.333; p<.001; 1x1>all formats, 2x2 > 4x4 and 5x5), rebounds (H=41.452; p<.001; 1x1>all formats, 2x2 > 5x5), and RPE (H=49.955; p<.001; 1x1 < 4x4 and 5x5, 2x2 < 3x3, 4x4, and 5x5, 3x3 < 5x5, 4x4 < 5x5).

Table 2 presents the ten athletes' RPE and number of each technical-tactical action (performed by each player per minute) in each SSG bout. as well as comparisons between each SSG bout for all the dependent variables. Most differences between SSG bouts for technical actions and RPE were considered small/trivial among varied SSG formats, with the exceptions highlighted in bold font.

The standardized differences between SSG formats for the number of rebounds and shots performed by players per minute are presented in Figure 1. In general, there were large decreases in the number of rebounds from the 1x1 to the larger formats: 2x2 (-60.4%, [-69.3; -49.0]), 3x3 (-63.0%, [-68.2; -57.0]), 4x4 (-65.2%, [-73.1; -55.2]) and 5x5 (-66.2%, [-72.7; -58.1]). The same tendency occurred for the number of shots, with large decreases from the 1x1 format to 2x2 (-42.8%, [-50.2; -34.3]), 3x3 (-44.6%, [-48.1; -40.9]), 4x4 (-50.4%, [-55.5; -44.7]), and 5x5 (-52.4%, [-55.9; -48.6]). Some comparisons between the other formats (2x2 and 3x3, 2x2 and 4x4, 2x2 and 5x5, 3x3 and 4x4, 3x3 and 5x5, and 4x4 and 5x5) also tended to present lower numbers of shots and rebounds as the number of players per team increased (see tendencies in Figure 1).



Note. Grey area represents a trivial magnitude. Standardized value direction depends on the relationship A-B.

Figure 1. Standardized differences (Cohen) between SSG formats for (a) rebounds (n/min) and (b) shots (n/min).

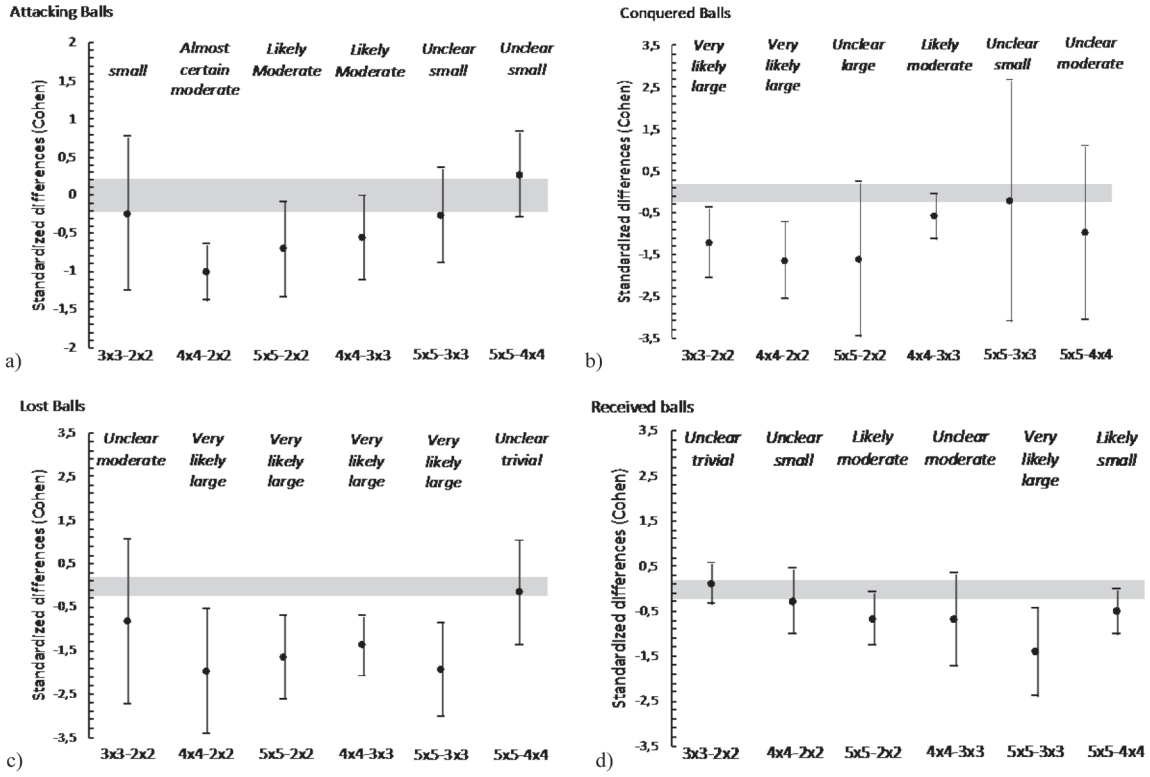
Table 2. RPE and number of technical-tactical actions performed per player per minute in each SSG bout, percentage and standardized differences between SSG bouts for all technical-tactical actions and RPE, and the probabilities of each standardized difference

Format	Variable	M(SD) Set 1	CV (%)	M(SD) Set 2	CV (%)	% difference (S2-S1)		Standardized difference (S2-S1)	
						Value	[90%CI]	Value (*Magnitude*)	90%CI
	R (n/min)	1.50(0.97)	64.7	1.40(0.70)	50.0	-18.1	[-46.4;25.2]	-0.36 *small*	[-1.14;0.41]
1x1	S (n/min)	2.70(0.95)	35.2	2.50(1.08)	43.2	-10.4	[-42.3;39.1]	-0.24 *small*	[-1.21;0.72]
	RPE (A.U.)	4.30(1.64)	38.1	3.70(1.16)	31.4	-11.3	[-25.2;5.2]	-0.28 *small*	[-0.67;0.12]
	RB (n/min)	1.55(1.01)	65.2	1.60(0.84)	52.5	6.7	[-35.6;76.7]	0.09 *trivial*	[-0.61;0.79]
	CB (n/min)	0.25(0.35)	140.0	0.35(0.53)	151.4	41.4	[84.1;1161.3]	**0.73 *moderate***	[-3.86;5.32]
	LB (n/min)	0.45(0.44)	97.8	0.60(0.46)	76.7	26.0	[-67.3;385.7]	0.51 *small*	[-2.48;3.51]
2x2	AB (n/min)	1.00(0.58)	58.0	0.90(0.57)	63.3	16.4	[-22.8;75.5]	0.25 *small*	[-0.43;0.94]
	R (n/min)	0.60(0.52)	86.7	0.58(0.33)	56.9	-47.9	[-73.4;2.1]	**-1.26 *large***	[-2.57;0.04]
	S (n/min)	1.45(1.01)	69.7	1.15(0.67)	58.3	-18.6	[-51.9;37.5]	-0.29 *small*	[-1.04;0.45]
	RPE (A.U.)	3.40(0.70)	20.6	3.30(0.48)	14.5	-2.2	[-10.5;6.9]	-0.11 *trivial*	[-0.55;0.33]
	RB (n/min)	1.70(0.46)	27.1	1.43(0.63)	44.1	-21.6	[-43.6;9.1]	**-0.80 *moderate***	[-1.88;0.29]
	CB (n/min)	0.20(0.23)	115.0	0.27(0.34)	125.9	44.2	[-50.5;320.2]	**0.95 *moderate***	[-1.81;3.70]
	LB (n/min)	0.20(0.32)	160.0	0.20(0.17)	85.0	-24.0	[-60.2;45.0]	-0.36 *small*	[-1.22;0.49]
3x3	AB (n/min)	0.90(0.92)	102.2	0.60(0.54)	90.0	-38.7	[-73.4;40.9]	**-0.52 *moderate***	[-1.39;0.36]
	R (n/min)	0.57(0.50)	87.7	0.23(0.27)	117.4	-39.6	[-82.3;106.1]	**-0.77 *moderate***	[-2.64;1.10]
	S (n/min)	0.97(0.43)	44.3	0.57(0.35)	61.4	-30.3	[-51.1;-0.8]	**-0.88 *moderate***	[-1.73;-0.02]
	RPE (A.U.)	5.80(1.87)	32.2	4.60(1.43)	31.1	-20.1	[-33.9;-3.6]	**-0.59 *moderate***	[-1.09;-0.10]
	RB (n/min)	1.28(0.67)	52.3	1.35(0.41)	30.4	14.7	[-6.9;41.4]	0.25 *small*	[-0.13;0.62]
	CB (n/min)	0.05(0.08)	160.0	0.13(0.13)	100.0	76.8	[-80.2;1476.7]	**0.81 *moderate***	[-2.31;3.94]
	LB (n/min)	0.12(0.13)	108.3	0.17(0.17)	100.0	26.0	[-41.8;172.8]	**1.85 *large***	[-4.34;8.04]
4x4	AB (n/min)	0.53(0.36)	67.9	0.53(0.38)	71.7	-6.5	[-37.4;39.6]	-0.13 *trivial*	[-0.90;0.64]
	R (n/min)	0.38(0.27)	71.1	0.38(0.29)	76.3	4.2	[-40.6;82.8]	0.08 *trivial*	[-0.98;1.13]
	S (n/min)	0.58(0.54)	93.1	0.73(0.55)	75.3	-16.7	[-49.4;36.9]	-0.26 *small*	[-0.95;0.44]
	RPE (A.U.)	5.50(1.58)	28.7	6.20(1.62)	26.1	14.1	[6.0;22.8]	0.37 *small*	[0.16;0.57]
	RB (n/min)	0.94(0.57)	60.6	1.20(0.38)	31.7	48.5	[-0.7;122.1]	0.50 *small*	[-0.01;1.01]
	CB (n/min)	0.13(0.16)	123.1	0.22(0.22)	100.0	68.7	[2.6;177.3]	**1.02 *moderate***	[0.05;1.99]
	LB (n/min)	0.10(0.14)	140.0	0.20(0.23)	115.0	26.0	[-35.8;147.4]	0.48 *small*	[-0.93;1.90]
5x5	AB (n/min)	0.56(0.44)	78.6	0.66(0.37)	56.1	13.0	[-34.9;96.2]	0.14 *trivial*	[-0.51;0.80]
	R (n/min)	0.24(0.16)	66.7	0.18(0.20)	111.1	-4.7	[-44.5;63.6]	-0.12 *trivial*	[-1.41;1.18]
	S (n/min)	0.40(0.31)	77.5	0.32(0.23)	71.9	27.0	[-18.3;97.5]	0.33 *small*	[-0.28;0.95]
	RPE (A.U.)	7.50(1.35)	18.0	6.90(1.29)	18.7	-7.6	[-16.3;1.9]	-0.32 *small*	[-0.72;0.08]

Note. RB: received balls; CB: conquered balls; LB: lost balls; AB: attacking balls; R: rebounds; S: shots; CV: coefficient of variation; SD: standard deviation; M: mean; S1: set 1; S2: set 2; CI: confidence interval; n/min: number per minute; A.U.: arbitrary units.

Standardized differences between SSG formats for attacking balls, conquered balls, lost balls, and received balls are presented in Figure 2. The number of these technical actions performed per player per minute also decreased with increases in the SSG formats. Regarding the attacking balls there was moderate decrease from 4x4 to 2x2 (-47.2%, [-58.2; -33.4]), moderate decreases from 5x5 to 2x2 (-36.1%, [-56.8; -5.4]), and moderate decreases of 4x4 versus 3x3 (-37.6%, [-60.8; -0.6]). For conquered balls there was a large decrease from 3x3 to 2x2 (-57.0%, [-75.8; -23.8]), a large decrease from 4x4 to 2x2 (-68.1%, [-83.1; -39.5]), and a moderate decrease from 4x4 to 3x3 (-36.9%, [-58.1; -5.2]).

For lost balls, there was a large decrease from 4x4 to 2x2 (-72.5%, [-89.2; -29.8]), a very large

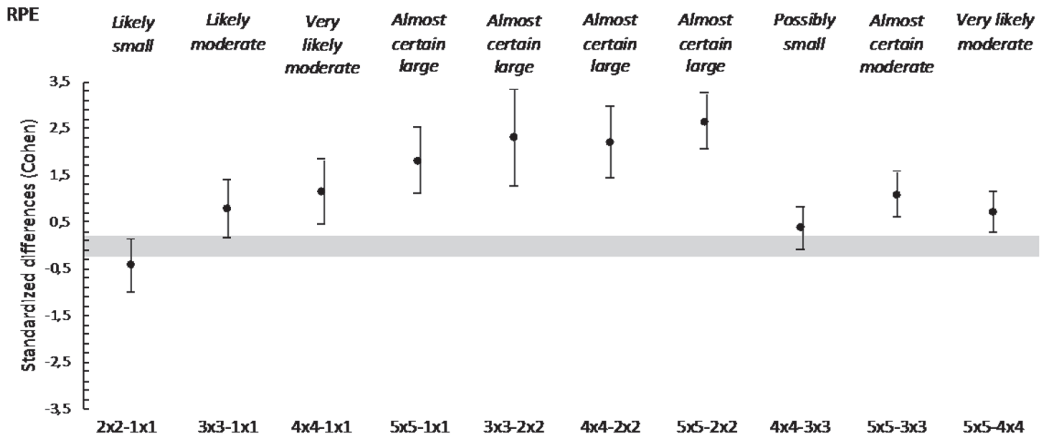


Note. Grey area represents a trivial magnitude. Standardized value direction depends on the relationship A-B.

Figure 2. Standardized differences (Cohen) between SSG formats for (a) attacking balls (n/min), (b) conquered balls (n/min), (c) lost balls (n/min), and (d) received balls (n/min).

decrease from 5x5 to 2x2 (-66.0%, [-81.8; -36.4]), a large decrease from 4x4 to 3x3 (-57.9%, [-72.6; -35.3]), and a large decrease from 5x5 to 3x3 (-70.0%, [-84.6; -41.6]). Finally, for received balls there was a moderate decrease from 5x5 to 2x2 (-30.3%, [-48.7; -5.3]), a large decrease from 5x5 to 3x3 (34.2%, [-50.8; -12.0]), and a small decrease from 5x5 to 4x4 (-19.0%, [-33.9; -0.7]).

Standardized differences for RPE between SSG formats are presented in Figure 3. In general, results indicated higher RPE values in larger formats compared to smaller formats. Large increases were found from 1x1 to 5x5 (85.5%, [45.4;136.7]) and from 2x2 to 5x5 (88.1%, [63.3;116.7]). There was a moderate increase from 3x3 to 5x5 (41.5%, [21.5;64.9]) and a moderate increase from 4x4 to 5x5 (25.7%, [9.7;44.1]). There was a moderate increase from 1x1 to 4x4 (47.6%, [16.9;86.4]), a large increase from 2x2 to 4x4 (57.2%, [34.5;83.6]), and a small increase from 3x3 to 4x4 (12.6%, [-2.4;29.9]). There was a moderate increase from 1x1 to 3x3 (31.1%, [6.5;61.4]) and a large increase from 2x2 to 3x3 (46.9%, [23.6;74.6]). The only exception in the tendency of increase in RPE with increases in the



Note. Grey area represents a trivial magnitude. Standardized value direction depends on the relationship A-B.

Figure 3. Standardized difference (Cohen) between formats in RPE (A.U.) during all small-sided games formats.

formats regards the comparison between 1x1 and 2x2, where a decrease was found from 1x1 to 2x2 (-13.3%, [28.5;5.1]).

Discussion and conclusion

This study aimed to compare the number of different technical-tactical actions and players' RPE in different SSG formats (1x1, 2x2, 3x3, 4x4, and 5x5 – played within the same playing area and in adjusted bout durations) and between two successive SSG bouts played by young female basketball players. Higher numbers of technical-tactical actions per player per minute and lower RPE in the smaller SSG formats were consistent with one of our hypotheses. We also expected a smaller number of technical-tactical actions and a higher RPE in the second, compared to the first, of two successive bouts, but this hypothesis was not confirmed, as indicated by the mostly small effects of successive SSG bouts on these variables.

Differences between SSG formats

The decreases in the number of technical-tactical actions per player per minute in larger SSG formats played within the same relative area are in line with other studies on basketball SSG (Klusemann, et al., 2012; McCormick, et al., 2012; Tallir, et al., 2012). These results may be explained by players' higher involvement with the game within the smaller formats, supporting the use of smaller formats for training individual technical-tactical actions. However, the smallest formats (i.e., 1x1 and 2x2) do not allow the occurrence of some group/collective technical-tactical actions, such as the pass (1x1) and the on ball (1x1) and off ball (1x1 and 2x2) screens, perhaps making the 3x3 format more useful for developing these skills while maintaining high game-intensity in youth athletes. On the other hand, the largest formats (4x4 and 5x5) may require more complex group actions and longer durations for tactical decision-making. Moreover, the larger distance between baskets (i.e., larger absolute area) in the larger formats may have contributed to the decrease in the demand for technical-tactical actions, leading players to spend more time running than performing technical-tactical actions during transition phases (i.e., offense-defense/defense-offense).

Regarding players' physical effort, larger (versus smaller) SSG formats led to higher RPE, contradicting other basketball SSG studies (Castagna, et al., 2011; Conte, et al., 2015; Delextrat & Kraiem, 2013; Klusemann, et al., 2012). However, prior studies did not use the same relative sized playing area for different SSG formats and did not adjust for bout duration, perhaps leading to increased physical effort in the smaller SSG formats. On the other hand, we decreased the court size for the smaller formats, possibly reducing the area covered by players during the defense or during transitions and limiting players' maximum velocity reached. This decrease in physical effort is in line with Sampaio et al. (2009) and McCormick et al. (2012) who used more similar relative playing areas for different SSG and did not find significant differences for HR and RPE between formats. In addition, we decreased bout duration for the smaller formats, which probably further decreased physiological stress. Indeed, studies on basketball SSG indicated lower HR and RPE in intermittent SSG regimens (shorter SSG bouts) compared to more continuous ones (longer SSG bouts) (Conte, et al., 2015; Klusemann, et al., 2012). Thus, the effort effect of increasing bout duration and adjusting the relative playing area may have overcome the decreased effort effect of increasing the number of players per team. It is also important to remember that the larger absolute area used in the larger SSG formats may have contributed to the increased effort in these formats, as larger playing areas required players to run larger distances in transition phases.

This study presents data on female (U-16) basketball players during SSG, which has been scarcely investigated. The study by Clemente, Sanches, Moleiro, Gomes, and Lima (2020) conducted a similar experiment with male U-14 and U-16 players, also adjusting bout durations and playing areas according to the SSG format. Their study found similar results with larger formats, in general, presenting a lower number of technical-tactical actions per minute and higher RPE. A visual qualitative comparison between data on each variable suggests that the girls' RPE values were, in general, higher compared to the boys' ones. For the technical-tactical actions, the visual comparisons are harder to make, but some differences may be plausible such as a higher number of received balls in 4x4 and 5x5 and higher number of lost balls in smaller formats such as 2x2 for girls. Quantitative comparisons within the same study may provide insights for coaches in the differences of technical-tactical behavior and perceived effort in different basketball SSG between sexes, broadening the understanding on the differences regarding the training processes of each sex category.

Differences between SSG bouts

In general, there was a small effect of successive SSG bouts on the number of technical-tactical actions per player per minute and RPE. Soccer SSG studies have shown a decrease in the number of some technical-tactical actions and an increase in players' effort after successive SSG bouts (Dellal, et al., 2011; Fanchini, et al., 2011; Kelly & Drust, 2009; Köklü, et al., 2011). These studies explained their results by likely accumulated fatigue over SSG bouts. Although some prior studies found significant differences from the first to subsequent bouts,

for both physical effort (i.e., RPE, HR, and blood lactate concentration) (Fanchini, et al., 2011; Kelly & Drust, 2009; Köklü, et al., 2011) and technical-tactical actions (Kelly & Drust, 2009), others found significant decreases in the number of technical-tactical actions per minute only from the third successive bout (Dellal, et al., 2011; Fanchini, et al., 2011). Therefore, it is possible that fatigue effects require more than two successive bouts. Considering the inherent differences between these two sports (i.e., basketball and soccer), future studies should further address this issue in basketball SSG performed by youth players.

Although our results provide some insights for prescribing basketball SSG, this study employed a small number of participants of one gender, and all were from the same squad. Therefore, our results may have been influenced by these participants' playing style and club training process and by other unknown factors associated with such a restricted participant sample. Finally, we analyzed the effect of only two SSG bouts; further research should be conducted on the effects of a larger number of bouts on the technical-tactical responses. Clearly, future research should utilize a greater number of more diverse participants from different squads and competitive levels to better understand the relationships between variables in the current study (i.e., formats, relative playing area, number of bouts, and bout duration). Additionally, future studies should consider the external load (i.e., velocities, accelerations) and other tactical behaviors.

We can conclude from this research that smaller basketball SSG formats induce higher numbers of technical-tactical actions per player per minute, and adjustments in the relative playing area (i.e., the use of smaller absolute areas for smaller formats) and bout duration (i.e., shorter bouts for smaller formats) may decrease players' effort in basketball SSG, mitigating the effect of a lower number of players per team on physical effort and fatigue. Regarding the effect of successive SSG bouts, only two successive bouts does not seem to impact either the numbers of technical-tactical actions or RPE.

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