

Effects of the Sports Level, Format of the Game and Task Condition on Heart Rate Responses, Technical and Tactical Performance of Youth Basketball Players

by

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The aim of this study was to analyze the effect of different small-sided and conditioning games (SSCG) with different tactical contents on heart rate responses, technical performance and collective organization of youth basketball players of different performance levels. Twenty male basketball players from U14 (13.7 ± 0.8 years old; 4.2 ± 1.4 years of practice) and U16 (15.3 ± 1.1 years old; 6.4 ± 2.1 years of practice) participated in this research study. The two-way MANOVA revealed that the sports level ($p = 0.009$; $\eta_p^2 = 0.151$), format ($p = 0.001$; $\eta_p^2 = 0.246$) and task condition ($p = 0.023$; $\eta_p^2 = 0.104$; small effect size) had significant main effects on heart rate responses. It was also found that the format ($p = 0.001$; $\eta_p^2 = 0.182$) had significant main effects on technical performance. A smaller format significantly increased the heart rate, volume of play, efficiency index and collective density during attacking plays. The SSCG with attacking content statistically increased the heart rate, efficiency index and performance score. Therefore, this study revealed that different SSCGs with tactical content influenced the physiological responses of youth players.

Key words: graph theory; adjacency matrices; network analysis; task conditions; performance analysis; match analysis; basketball.

Introduction

Small-sided games (SSGs) are smaller versions of competition (Halouani et al., 2014; Owen et al., 2004). For that reason, SSG are frequently used by coaches in training contexts to simultaneously develop fitness and technical/tactical performance (Clemente et al., 2014; Krstrup et al., 2010; Little, 2009). In order to identify the impact that these games have on players, their effects on acute physiological responses (heart rate, blood lactate concentration or perceived exertion), time-motion profiles (distance covered, speed, accelerations and

decelerations), technical performance and collective behaviour have been researched in the field of sports sciences (Hill-Haas et al., 2009; Köklü et al., 2011; Owen et al., 2014; Randers et al., 2010; Serra-Olivares et al., 2015).

The studies carried out specifically in basketball have found that smaller formats increased the heart rate, cause higher blood lactate concentration and perceived exertion in comparison with larger formats and competitive (five against five) games (Castagna et al., 2011; McCormick et al., 2012; Piñar et al., 2009; Sampaio

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et al., 2009). The majority of studies found that a 2-a-side format statistically increased the heart rate in comparison with a 5-a-side format and it was also more intense than the remaining formats: 3-a-side and 4-a-side (McCormick et al., 2012; Piñar et al., 2009). In some cases of SSGs, it is possible to achieve values above 91% of the maximal heart rate (HRmax), which requires a major role of the anaerobic energy system in the total energy provision (Little, 2009). The size of the court may also induce changes in acute physiological responses. A comparison between the half court and full court in 2 vs. 2 and 4 vs. 4 formats revealed that the full court induced greater heart rate responses and perceived exertion (Kluseman et al., 2012). Similar evidence was found in a 3 vs. 3 format (Atli et al., 2013). A different approach analyzed the effects of SSG on acute physiological responses considering playing positions during 2 vs. 2 and 3 vs. 3 formats (Delextrat and Kraiem, 2013). Results of this study revealed that centres had statistically lower heart rates in the 3 vs. 3 format compared to guards and forwards; nevertheless in the 2 vs. 2 format statistical differences were not found. Moreover, based on the highest heart rate responses during the 2 vs. 2 format, it was suggested that this format may be more adequate for aerobic conditioning in particular for centres than the 3 vs. 3 format (Delextrat and Kraiem, 2013).

The technical analysis carried out in these games suggests that smaller formats significantly increase the amount of passes, dribbles, shots and rebounds (Costa, 2010; Klusemann et al., 2012). Additionally, the official 5-a-side format was found to reduce individual participation of some players due to the fact that other players sometimes monopolize the game (Piñar et al., 2009). Furthermore, smaller formats increase the time dedicated to offensive plays (McCormick et al., 2012). The comparison between half-court and full-court showed that half-court games contained almost 20% more total technical elements and passing than games played on a full-court (Kluseman et al., 2012).

Most previous studies classically focused on changing the number of players (format) and/or the size of the court. Nevertheless, SSGs provide an excellent opportunity to teach tactics to players, in addition to physical or technical conditioning (Mitchell et al., 2006; Serra-Olivares

et al., 2015). Indeed, coaches can change other variables during SSGs to increase players' awareness of specific tactical principles (Davids et al., 2013). These tactical principles may firstly be developed in the context of smaller versions of the game (Davids et al., 2013). The official format of the game is more complex and not appropriate for young and novice players. Smaller and adjusted versions of the game may be more appropriate to increase individual participation of all players and to learn the basics of tactical behavior, such as driving/passing or space coverage (Serra-Olivares et al., 2015). To achieve this, coaches can change the structure, dynamics and rules of the game, thus turning regular SSGs into small-sided and conditioned games (SSCG) (Davids et al., 2013). Modified games may use floaters instead of targets to enhance players' perception of attacking coverage and to create free spaces for passes. This adjustment modifies the structure of the game only to introduce a specific tactical issue. Despite great opportunities these games provide, there is a lack of research on the effects of the task conditions on players' performance (Clemente et al., 2016). In a recent study (Clemente et al., 2016), three games (scoring by reaching behind the endline, with two targets per endline and with one target per endline) in two formats (3-a-side with floating players and 4-a-side with floater players) were compared. The results revealed that the task condition with two targets showed the highest heart rate responses and the task with the endline had the highest volume of play, attacks with the ball, efficiency index and performance score.

There is a lack of studies related to the physiological, technical and tactical effects of SSCGs especially with regard to youth basketball players. Moreover, no study has simultaneously researched all these aspects (heart rate responses, technical performance, collective organisation and structure) in basketball. Therefore, the aim of this study was to analyze the effects of SSCGs with different tactical contents on heart rate responses, technical performance and collective organisation measured by network analysis in young basketball players. Based on previous findings, we hypothesized that smaller formats would increase the heart rate and enhance technical as well as collective performance. We also hypothesized that the sports level would impact

heart rate responses and technical performance, but with no difference in collective organisation. Finally, we hypothesized that games with attacking tactical content would statistically increase heart rate responses, enhance technical performance and collective organisation.

Methods

Participants

Twenty male basketball players from U14 (13.7 ± 0.8 years; 4.2 ± 1.4 years of practice; national competitive level; 2 centers, 4 guards and 4 forwards) and U16 (15.3 ± 1.1 years; 6.4 ± 2.1 years of practice; national competitive level; 2 centers, 4 guards and 4 forwards) competitive levels participated in this study. Ten players were selected based on the following inclusion criteria: 2 centers, 4 guards and 4 forwards with the greatest average playing time during the season. The players of the squad who did not participate in the study followed a specific training programme with the assistant coach. The head-researcher interviewed each player to explain the experimental protocol and procedures. Moreover, all parents signed an informed consent form in line with the Declaration of Helsinki. Players were asked to maintain normal daily food and water intake during the study period. All players were familiarized with the experimental procedures as well as the requirements of the games and were instructed on how to use the heart rate monitors. They had been previously training for a seven-month period with three basketball-specific training sessions per week, each lasting 70 to 90 min, and one weekly competition.

SSCGs

Players were assigned by their coaches to one of the teams that performed three formats in 3-a-side and 5-a-side games, respectively. An equal distribution of playing positions per team was ensured. All SSCGs lasted 5 min, with 3 min of recovery between games. A rehydration period was provided during recovery as suggested in previous studies (Silva et al., 2014). The size of the court was calculated based on a direct conversion of official measures from the official format of the game in U14 and U16 (5-a-side game in a 28 x 15 m court) for the format of 3-a-side (17 x 9 m). The area per player (area of the court/number of players) was calculated excluding the floater players who only played the task of attacking.

Three task conditions with tactical content (regular SSG, defensive SSCG and attacking SSCG) were designed (Figure 1). For the regular SSG (T1), mini-targets were used and the game was played according to the official rules of basketball (Silva et al., 2014). The defensive SSCG (T2) was designed to develop the tactical content of spatial coverage between teammates and also about how to attack against different numbers of defenders as well. In this SSCG, virtual lines were drawn on the court and the defender or group of defenders were only allowed inside this 'virtual' defensive area.

Finally, the attacking SSCG (T3) was designed to increase players' perception of using the full length and width of the court (Costa et al., 2010). In this game, there were two floater players in the wings who provided a numerical advantage to the team with the ball possession. In order to score, the team had to pass the ball to at least one floater player before attempting a shot.

Procedures

Data collection was carried out during one week in May in the 2014-2015 season. The players of different sports levels participated in SSCGs with two formats and three conditions (3 vs. 3 regular, 5 vs. 5 defensive, 3 vs. 3 attacking, 5 vs. 5 regular, 3 vs. 3 defensive and 5 vs. 5 attacking). These six different SSCGs were played during one session only, but their order was randomised to avoid the effect of fatigue. The heart rate responses were analyzed during recovery periods in order to ensure that it decreased to about 50-60% HR_{max}. The score was kept to encourage competition. Six games were examined in the session. Heart rate responses, technical performance and collective behavior measured by network analysis were collected per SSCG. Players were requested to have a minimum period of 48 h rest without exercising before the day of data collection and no training sessions were scheduled during this period. The session was conducted in steady environmental conditions (indoor), with temperature ranging from 22 to 23°C. Players were allowed to participate in the session only if they presented no signs of injury, illness or severe fatigue. The heart rate response was measured by placing a lightweight and portable heart rate monitor (Polar H7 Bluetooth connected to *PolarTeam App*) on the player's chest at 1 s sampling intervals. Heart rate

data were collected and stored in the *PolarTeam App*. The average HR per SSCG and the time spent in each intensity zone (% of total time in the following HR zones: Z1 – 51-60%; Z2 – 61-70%; Z3 – 71-80%; Z4 – 81-90%; and Z5 – 91-100%) were measured. Technical and tactical performance was assessed using specific protocols (detailed below), and based on video recordings of all the games with three high-definition video-cameras.

Assessment of Technical Performance

Technical performance was measured using the Team Sport Assessment Procedure (TSAP) protocol (Gréhaigne et al., 1997, 2005). It was based on the following indicators (Gréhaigne et al., 2005): (CB) Conquered Ball, when a player intercepts the ball from the opponent; (RB) Received Ball, when a player receives the ball from a teammate; (LB) Lost Ball, when a player loses control of the ball; (NB) Neutral Ball, when a pass was made without penetrating in the opponent's space or without any forward movement; (P) Pass, when the ball is passed into the opponent's defensive space; and (SS) Successful Shot on the Goal, when a basket is scored or when there is a shot that ensures the team keeps possession of the ball. Using these indicators the following indices of technical performance were computed: i) volume of play (**Volume of Play (VP) = CB + RB**); ii) attacks with the ball (**Attacks with ball (AB) = P + SS**); iii) efficiency index (**Efficiency Index (EI) = $\frac{AB}{10+LB}$**); and iv) performance score (**Performance Score (PS) = $\left(\frac{VP}{2}\right) + (EI \times 10)$**).

The observational process was conducted after video collection by the same researcher with experience in game analysis. The reliability was determined by a test-retest protocol using the Cohen's Kappa test (Robinson and O'Donoghue, 2007). After testing 15% of the data, a Kappa value of 0.95 was observed, thus achieving the recommended value for this type of a procedure.

Network Measurements

Our study analysed teammates' interactions during attacking phases based on a Social Network Analysis. This approach has been used in the last few years in order to identify the tendencies of interactions between teammates (Cotta et al., 2013). In our case only attacking interactions represented by passes between teammates were analysed. The protocol of

observation followed previous studies in this field of analysis (Clemente et al., 2015). The following network metrics were computed in the SocNetV (version 1.9.).

Total Arcs

Each element a_{ij} of the adjacency matrix was the number of interactions (passes) from player i to player j and, in terms of the corresponding weighted digraph (sociogram) produced by SocNetV, it was represented by a directed line (arc) between node n_i and node n_j . Passes between each team's players were defined as the link factor. In the corresponding weighted directed graph, this number was the total arcs between all nodes.

Graph Density

In graph theory, the density of a (directed) graph is the proportion of the maximum possible lines (or arcs) that are present between nodes (Clemente et al., 2015).

Clustering Coefficient

The local Clustering Coefficient measures the degree of interconnectivity in the neighborhood of a node. The higher it is, the closer this node and its neighbors are to become a clique (Clemente et al., 2015).

Statistical procedures

The influence of the sports level, format and conditions on %HR_{max}, %Time per HR Zone (% of total time), volume of play, efficiency index, performance score, total arcs, graph density and clustering coefficient were analyzed using two-way MANOVA after validating normality and homogeneity assumptions. The assumption of normality for each univariate dependent variable was examined using Kolmogorov-Smirnov tests ($p > 0.05$). The assumption of the homogeneity of each group's variance/covariance matrix was examined with the Box's M Test. When the MANOVA detected statistically significant differences between the two factors, we proceeded to a two-way ANOVA for each dependent variable, followed by a Tukey's HSD post-hoc test (O'Donoghue, 2012). When the two-way ANOVA showed an interaction between factors, it also generated a new variable that crossed the two factors (e.g., U14*3vs.3*T1; U14*3vs.3*T2) for each dependent variable to identify statistical significance (Clemente et al., 2014). Ultimately, the statistical procedures used were one-way ANOVA and Tukey HSD post-hoc

tests. If no interactions were detected in two-way ANOVA, a one-way ANOVA was used for each independent variable. All statistical analyses were performed using IBM SPSS Statistics (version 23) at a significance level of $p < 0.05$. The following scale was used to classify the effect sizes (ES) of the tests (Lakens, 2013): small, 0.2-0.49; moderate, 0.50-0.79; large, 0.80-1. Partial eta-squared was used for MANOVA, eta-squared for ANOVA and Cohen D to pairwise comparisons.

Results

Heart Rate

The two-way MANOVA revealed that the sports level ($p = 0.009$; $\eta_p^2 = 0.151$; small effect size), format ($p = 0.001$; $\eta_p^2 = 0.246$; small effect size) and task condition ($p = 0.023$; $\eta_p^2 = 0.104$; small effect size) had significant main effects on heart rate responses. There were no significant interactions between sports level x format (Pillai's Trace = 0.092; $F = 1.853$; $p = 0.110$; $\eta_p^2 = 0.092$; small effect size); sports level x task condition (Pillai's Trace = 0.045; $F = 0.424$; $p = 0.934$; $\eta_p^2 = 0.022$; small effect size); and format x task condition (Pillai's Trace = 0.032; $F = 0.301$; $p = 0.980$; $\eta_p^2 = 0.016$; small effect size) on heart rate variables. Finally, there were no interactions between the three factors: sports level x format x task condition (Pillai's Trace = 0.099; $F = 0.972$; $p = 0.469$; $\eta_p^2 = 0.050$; small effect size). As previously indicated in the statistical procedures, in case of no interaction between factors a regular one-way ANOVA was conducted for each variable (O'Donoghue, 2012).

The statistical values resulting from the comparison between formats are presented in Table 1.

A one-way ANOVA was also carried out to compare the values between task conditions for heart rate variables. These results are shown in Table 2.

Technical Performance

The two-way MANOVA revealed that the format ($p = 0.001$; $\eta_p^2 = 0.182$; small effect size) had significant main effects on technical performance. No statistical differences were found in the sports level ($p = 0.149$; $\eta_p^2 = 0.031$; small effect size) and task condition ($p = 0.098$; $\eta_p^2 = 0.032$; small effect size). There were no significant interactions between sports level x format (Pillai's Trace =

0.009; $F = 0.566$; $p = 0.569$; $\eta_p^2 = 0.009$; small effect size); sports level x task condition (Pillai's Trace = 0.019; $F = 0.589$; $p = 0.671$; $\eta_p^2 = 0.010$; small effect size) and format x task condition (Pillai's Trace = 0.011; $F = 0.318$; $p = 0.866$; $\eta_p^2 = 0.005$; small effect size) on technical performance. Finally, there were no interactions between the three factors: sports level x format x task condition (Pillai's Trace = 0.008; $F = 0.250$; $p = 0.910$; $\eta_p^2 = 0.004$; small effect size). As previously indicated in the statistical procedures, in case of no interaction between factors a regular one-way ANOVA was conducted for each variable (O'Donoghue, 2012).

The results from the comparison between formats are presented in Table 3.

The one-way ANOVA was also carried out to compare the values between task conditions for heart rate variables. These values are shown in Table 4.

Network Analysis

The two-way MANOVA revealed that the sports level ($p = 0.002$; $ES = 0.479$; large effect size) and format ($p = 0.001$; $ES = 0.993$; large effect size) had significant main effects on teammates' network. No statistical differences were found in task condition ($p = 0.750$; $ES = 0.069$; small effect size). There were no significant interactions in sports level x format (Pillai's Trace = 0.138; $F = 1.173$; $p = 0.343$; $ES = 0.138$; small effect size), sports level x task conditions (Pillai's Trace = 0.296; $F = 1.333$; $p = 0.262$; $ES = 0.148$; small effect size) and format x task conditions (Pillai's Trace = 0.188; $F = 0.793$; $p = 0.580$; $ES = 0.094$; small effect size) on network variables. Finally, there was a statistically significant interaction between the three factors sports level x format x task condition (Pillai's Trace = 0.544; $F = 2.864$; $p = 0.019$; $ES = 0.272$; small effect size).

An interaction was found between factors for total arcs ($F = 3.541$; $p = 0.045$; $ES = 0.228$; small effect size). No interactions were detected in network density ($F = 1.157$; $p = 0.331$; $ES = 0.088$; small effect size) and a clustering coefficient ($F = 0.386$; $p = 0.684$; $ES = 0.031$; small effect size).

The one-way ANOVA tested crossing between factors. Statistical differences were found between the new variable (crossing between the sports level, format and task condition) and the dependent variable of total arcs ($F = 14.045$; $p =$

0.001; $ES= 0.866$; large effect size). The results are presented in Table 5.

With regard to network density and the clustering coefficient, a one-way ANOVA was performed on each independent variable as no interaction was found between factors. The results

of the comparison between formats are shown in Table 6.

The one-way ANOVA was also performed to compare the values between task conditions for heart rate variables. These values are presented in Table 7.

Table 1
One-way ANOVA values of format in each sports level for %HR_{max} average, Z1, Z2, Z3, Z4 and Z5 variables.

			M(SD)	F	p	ES
%HR _{max} average	U14	3 vs. 3	90.96 (4.25) ^b	8.870	0.004	0.146
		5 vs. 5	87.00 (5.46) ^a			
	U16	3 vs. 3	87.44 (5.12) ^b	4.943	0.031	0.087
		5 vs. 5	84.33 (5.16) ^a			
Z1	U14	3 vs. 3	0.37 (0.79)	1.597	0.212	0.030
		5 vs. 5	0.15 (0.46)			
	U16	3 vs. 3	0.56 (1.15)	2.253	0.139	0.042
		5 vs. 5	0.19 (0.56)			
Z2	U14	3 vs. 3	1.74 (1.89)	0.047	0.829	0.001
		5 vs. 5	1.89 (3.00)			
	U16	3 vs. 3	3.74 (3.72)	1.203	0.278	0.023
		5 vs. 5	5.19 (5.74)			
Z3	U14	3 vs. 3	5.63 (7.42) ^b	5.011	0.029	0.088
		5 vs. 5	15.67 (22.09) ^a			
	U16	3 vs. 3	9.26 (8.61) ^b	7.729	0.008	0.129
		5 vs. 5	19.67 (17.44) ^a			
Z4	U14	3 vs. 3	31.52 (27.86)	1.331	0.254	0.025
		5 vs. 5	40.04 (26.39)			
	U16	3 vs. 3	46.60 (27.68)	0.804	0.374	0.015
		5 vs. 5	53.11 (25.71)			
Z5	U14	3 vs. 3	60.74 (31.90) ^b	4.233	0.045	0.075
		5 vs. 5	42.26 (34.09) ^a			
	U16	3 vs. 3	39.85 (34.90) ^b	4.218	0.045	0.075
		5 vs. 5	21.85 (29.27) ^a			

Significantly different compared to 3 vs. 3^a; and 5 vs. 5^b at $p < 0.05$

Table 2
*One-way ANOVA values of format in each task condition for %HR_{max} average,
 Z1, Z1, Z2, Z3, Z4 and Z5 variables.*

			M(SD)	F	p	ES
%HR _{max} average	U14	T1 - Regular	89.28 (4.39)	0.073	0.930	0.003
		T2 - Defensive	88.61 (5.80)			
		T3 - Attacking	89.06 (5.69)			
	U16	T1 - Regular	87.11 (5.51)	1.522	0.228	0.056
		T2 - Defensive	86.39 (4.97)			
		T3 - Attacking	84.17 (5.34)			
Z1	U14	T1 - Regular	0.72 (0.96) ^{b,c}	8.956	0.001	0.260
		T2 - Defensive	0.06 (0.24) ^a			
		T3 - Attacking	0.00 (0.00) ^a			
	U16	T1 - Regular	0.72 (1.13)	2.085	0.135	0.076
		T2 - Defensive	0.17 (0.51)			
		T3 - Attacking	0.22 (0.94)			
Z2	U14	T1 - Regular	2.33 (1.41)	0.613	0.546	0.023
		T2 - Defensive	1.44 (2.79)			
		T3 - Attacking	1.67 (3.01)			
	U16	T1 - Regular	3.83 (4.19)	0.410	0.666	0.016
		T2 - Defensive	4.28 (5.45)			
		T3 - Attacking	5.28 (4.98)			
Z3	U14	T1 - Regular	7.94 (8.89)	0.334	0.718	0.013
		T2 - Defensive	12.18 (19.84)			
		T3 - Attacking	11.72 (20.63)			
	U16	T1 - Regular	12.00 (16.55)	2.164	0.125	0.078
		T2 - Defensive	11.22 (7.10)			
		T3 - Attacking	20.17 (16.98)			
Z4	U14	T1 - Regular	35.83 (27.34)	0.258	0.774	0.010
		T2 - Defensive	39.06 (28.04)			
		T3 - Attacking	32.44 (27.43)			
	U16	T1 - Regular	44.67 (29.60)	0.503	0.608	0.019
		T2 - Defensive	52.72 (27.38)			
		T3 - Attacking	52.17 (23.40)			
Z5	U14	T1 - Regular	53.17 (32.30)	0.217	0.806	0.008
		T2 - Defensive	47.17 (34.56)			
		T3 - Attacking	54.17 (36.55)			
	U16	T1 - Regular	38.78 (34.93)	1.142	0.327	0.043
		T2 - Defensive	31.61 (34.01)			
		T3 - Attacking	22.17 (30.09)			

Significantly different compared with T1^a, T2^b, and T3^c at p < 0.05

Table 3
One-way ANOVA values of format in each sports level for the volume of play, efficiency index and performance score variables.

			M(SD)	F	p	ES
Volume of Play	U14	3 vs. 3	9.86 (4.34) ^b	7.474	0.008	0.105
		5 vs. 5	7.07 (3.88) ^a			
	U16	3 vs. 3	11.03 (4.08) ^b	21.262	0.001	0.249
		5 vs. 5	6.77 (3.28) ^a			
Efficiency Index	U14	3 vs. 3	0.43 (0.24) ^b	6.614	0.012	0.094
		5 vs. 5	0.28 (0.26) ^a			
	U16	3 vs. 3	0.54 (0.31) ^b	10.116	0.002	0.136
		5 vs. 5	0.33 (0.23) ^a			
Performance Score	U14	3 vs. 3	9.25 (4.34) ^b	8.010	0.006	0.111
		5 vs. 5	6.26 (4.20) ^a			
	U16	3 vs. 3	10.95 (4.65) ^b	16.772	0.001	0.208
		5 vs. 5	6.64 (3.72) ^a			

Significantly different compared to 3 vs. 3^a; and 5 vs. 5^b at p < 0.05

Table 4
One-way ANOVA values of format in each task condition for the volume of play, efficiency index and performance score variables.

			M(SD)	F	p	ES
Volume of Play	U14	T1 - Regular	8.82 (4.24)	2.076	0.134	0.062
		T2 - Defensive	7.18 (3.78)			
		T3 - Attacking	9.77 (4.73)			
	U16	T1 - Regular	9.09 (4.12)	0.155	0.857	0.005
		T2 - Defensive	8.73 (3.73)			
		T3 - Attacking	9.45 (5.06)			
Efficiency Index	U14	T1 - Regular	0.32 (0.24)	3.946	0.024	0.111
		T2 - Defensive	0.28 (0.19) ^c			
		T3 - Attacking	0.48 (0.30) ^b			
	U16	T1 - Regular	0.45 (0.34)	0.712	0.495	0.022
		T2 - Defensive	0.39 (0.22)			
		T3 - Attacking	0.50 (0.32)			
Performance Score	U14	T1 - Regular	7.66 (4.37)	3.266	0.045	0.094
		T2 - Defensive	6.34 (3.45) ^c			
		T3 - Attacking	9.68 (5.09) ^b			
	U16	T1 - Regular	9.01 (4.99)	0.494	0.613	0.015
		T2 - Defensive	8.26 (3.78)			
		T3 - Attacking	9.69 (5.43)			

Table 5
 Descriptive data (mean and standard deviation) and statistical comparison between crossing factors.

		Total Arcs	
U14	3 vs. 3	Task 1	5.25 (0.50) ^{d,e,f,j,k,l}
		Task 2	5.50 (1.00) ^{d,e,f,j,k}
		Task 3	5.50 (0.58) ^{d,f,j,k}
	5 vs. 5	Task 1	11.50 (3.54) ^{a,b,c,g,i}
		Task 2	11.00 (2.83) ^a
		Task 3	15.50 (0.71) ^{a,b,c,g,h,i}
U16	3 vs. 3	Task 1	5.50 (1.00) ^{d,f,j,k}
		Task 2	6.00 (0.00) ^{f,j,k}
		Task 3	5.50 (1.00) ^{d,f,j,k}
	5 vs. 5	Task 1	15.00 (1.41) ^{a,b,c,g,h,i}
		Task 2	12.00 (4.24) ^{a,b,c,g,h,i}
		Task 3	11.00 (4.24) ^a

Significantly different compared to U14*3v3*T1^a; U14*3v3*T2^b; U14*3v3*T3^c; U14*5v5*T1^d; U14*5v5*T2^e; U14*5v5*T3^f; U16*3v3*T1^g; U16*3v3*T2^h; U16*3v3*T3ⁱ; U16*5v5*T1^j; U16*5v5*T2^k; U16*5v5*T3^l at $p < 0.05$

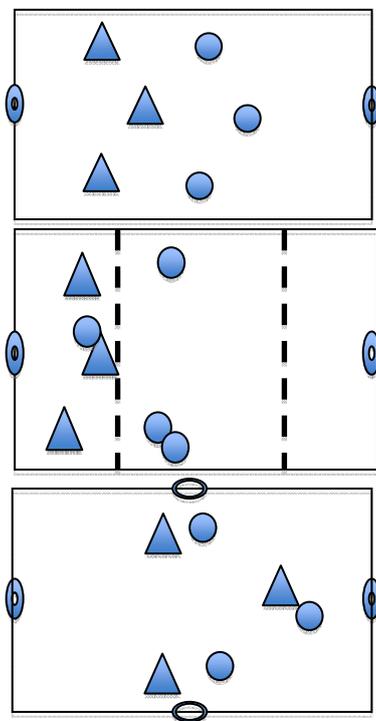
Table 6
 One-way ANOVA values of format in each sports level for network density and clustering coefficient variables.

		M(SD)	F	p	ES	
Network Density	U14	3 vs. 3	0.90 (0.11) ^b	18.381	0.001	0.535
		5 vs. 5	0.63 (0.15) ^a			
	U16	3 vs. 3	0.95 (0.13) ^b	19.437	0.001	0.548
		5 vs. 5	0.63 (0.17) ^a			
Clustering Coefficient	U14	3 vs. 3	0.57 (0.45)	1.220	0.286	0.071
		5 vs. 5	0.35 (0.28)			
	U16	3 vs. 3	0.83 (0.39)	1.420	0.251	0.082
		5 vs. 5	0.62 (0.29)			

Significantly different compared with 3 vs. 3^a; and 5 vs. 5^b at $p < 0.05$

Table 7
One-way ANOVA values of format in each task condition for network density and clustering coefficient variables.

			M(SD)	F	p	ES
Volume of Play	U14	T1 - Regular	0.77 (0.18)	0.438	0.653	0.055
		T2 - Defensive	0.80 (0.24)			
		T3 - Attacking	0.87 (0.11)			
	U16	T1 - Regular	0.86 (0.16)			
		T2 - Defensive	0.87 (0.23)			
		T3 - Attacking	0.80 (0.25)			
Performance Score	U14	T1 - Regular	0.35 (0.35)	0.586	0.569	0.072
		T2 - Defensive	0.53 (0.52)			
		T3 - Attacking	0.61 (0.37)			
	U16	T1 - Regular	0.74 (0.40)			
		T2 - Defensive	0.88 (0.19)			
		T3 - Attacking	0.67 (0.48)			



T1 – REGULAR SSG
 Only format and size of the court varies.

T2 – DEFENSIVE CONTENT - CONCENTRATION SSCG
 Defenders can only play inside a “virtual” area (dashed line)

T3 – ATTACKING CONTENT - SPACE SSCG
 During attacking phases, it is required to pass at least once to one of the floater players that provide attacking coverage on the wings to the team with possession of the ball

Figure 1
Graphical representation and description of the three SSCG used in this study.

Discussion

The use of SSCGs in basketball was analyzed in this study. The heart rate, technical performance and collective organisation were tracked during different SSCGs to identify the most adequate SSCG for specific tactical contents. The main results revealed that the smaller format (3-a-side) significantly increased the %HR_{max} and also the time spent in Z3 and Z5 heart rate zones. On the other hand, only one statistical difference was found between task conditions in the Z1. In the technical analysis, the smaller format significantly increased the volume of play, efficiency index and performance score; furthermore, the task condition of attacking also significantly increased the efficiency index and performance score. Finally, in the collective analysis, the smaller format increased the network density and the larger format (5-a-side) significantly increased the total arcs (connections).

With regard to heart rate responses, our study found that in the 3-a-side format, the %HR_{max} for U14 and U16 reached 91% and 87%, respectively. On the other hand, in the 5-a-side format, the values for U14 and U16 were 87% and 84%, respectively. It can be concluded that the 3-a-side format was more intense than the 5-a-side format in both youth sports levels. These results are in line with previous studies in professional and amateur players (McCormick et al., 2012; Piñar et al., 2009; Sampaio et al., 2009). In addition to the average %HR_{max}, the time spent in particular heart rate zones was also analyzed. The 5-a-side format was characterized by significantly more time spent in Z3 (71-80% HR_{max}) and the 3-a-side format showed statistically more time spent in Z5 (91-100% HR_{max}). Previous studies conducted in soccer revealed that values between 90 and 100% (anaerobic metabolism) of HR_{max} during SSGs should be prescribed with an intermittent methodology with duration between 30 seconds and 3 minutes and a work-to-rest ratio of 1:1 and 1:1.5 (Clemente et al., 2014; Little, 2009). Nevertheless, values between 85 and 90% of HR_{max} correspond to a workout focusing on the lactate threshold and in these cases exercise duration between 5 and 30 minutes (intermittently for smaller periods or continuously for longer periods) with a rest period in between from 1 to 3 minutes is recommended (Clemente et al., 2014; Little, 2009).

Based on these recommendations, the 3 vs. 3 format seems to fit better with a workout of the anaerobic type and the 5 vs. 5 format with the lactate threshold workout.

The comparison between different task conditions with tactical contents revealed no significant differences in heart rate variables. Significant differences were found only in Z1 between T1 and the remaining tasks (50-60% HR_{max}). The statistical analysis showed that regular SSGs increased the time spent in this heart rate zone. Nevertheless, in high intensity zones no other differences were found. Such data may suggest that the tactical content did not have a crucial influence on physiological responses. Moreover, our results also suggest that other changes, such as the number of players (format) or the size of the court may be more important variables to determine the physiological load (Clemente et al., 2014).

In the comparison between formats, the 3-a-side had statistically greater values of the volume of play, efficiency index and performance score in U14 and U16 levels. These results are also in line with previous studies that analyzed technical actions in regular SSGs (Klusemann et al., 2012). The small number of players increased individual participation in the game (Clemente et al., 2016); therefore, the significant differences found in this study were supported. In the comparison between task conditions with tactical content, attacking SSCGs presented significantly greater values than defensive and regular SSCGs in the efficiency index and performance score in the U14 competitive level. These results revealed that the tactical content influenced by task conditions may determine specific technical actions occurring during a game and their accuracy. In fact, no differences were found in the volume of play including the volume of passes received. Nevertheless, the specific conditions influenced the efficacy in the actions. The defensive SSCGs were favorable for defenders, while attacking SSCGs were favourable for attackers. The results revealed that the design of SSCGs influenced the efficacy of players in accordance with the tactical goal. Therefore, task conditions represent an important variable for players' technical performance and tactical acquisition (Serra-Olivares et al., 2015).

The final analysis for collective organisation

revealed that the choice of the format influenced teammates' cooperation in attacking plays. The 3-a-side format was characterized by significantly greater values of network density, thus suggesting that in smaller formats the pattern of play was less centered on specific players and more homogenous. Network density is an important indicator of success in the game as observed in previous studies carried out in professional soccer (Clemente et al., 2015; Grund, 2012). On the other hand, the 5-a-side format reduced the capacity to recruit the players and increased the focus on specific players, thus enhancing the heterogeneity in the cooperation profile and network structure (Grund, 2012). Additionally, the 5-a-side format increased the total arcs, thus a greater number of players increased the possibilities of interactions. Nevertheless, the increase in possibilities of interactions also resulted in a decrease in the homogeneity of cooperation. Finally, the task conditions did not influence the collective structure during attacking plays. The small number of players in both games can justify these results. Maybe the tactical principles can influence larger formats in other team sports such as soccer (Clemente et al., 2015). With respect to basketball, a small number of players reduces the possibilities to change the pattern of play based on specific tactical instructions.

Considering the sports level, analysis of variance revealed that U14 players presented significantly greater heart rate responses during SSCGs. They spent significantly more time in Z5 of the heart rate intensity, while U16 players spent more time in Z2 and Z4 of the heart rate intensity. The high intensity of 3 vs. 3 and 5 vs. 5 formats may have influenced the differences between sports levels. Previous studies in youth players revealed that the improvements in repeated sprint ability were associated with greater glycolic capacity and peak lactate reported in older players, achieving a plateau at the age of 16 based on the limit of the percentage of type II fibres (Mendez-Villanueva et al., 2011; Mujika et al., 2009). For that reason, older players may be able to play at higher intensities with a lower physiological load than their younger counterparts. No significant differences were found in technical performance and collective organisation between sports levels. The absence of

difference in collective organisation was expected. The methodology used for network analysis elicited relative values and for that reason, the variation was not strong enough to detect differences. Regarding performance analysis, greater volumes of play in older players would be expected. Nevertheless, our results did not confirm this hypothesis. The tactical behaviour and knowledge may constraint the capacity to be more engaged in the game. Nevertheless, this variable was not studied in our research. Future studies should compare the tactical knowledge and capacities of players to identify if this variable may constrain technical performance during games.

The practical implications of our results are that the 3 vs. 3 format elicited heart rate responses of 87 and 91% of HR_{max} and the 5 vs. 5 format induced heart rate responses between 84 and 87% of HR_{max} , respectively, thus coaches may use intermittent training in both cases. Nevertheless, the 3 vs. 3 format appears to fit better for the development of anaerobic capacity, while the 5 vs. 5 format for the lactate threshold. A smaller task is also recommended to increase individual skills, mainly considering that the volume of play, efficiency and performance will be greater per player. Moreover, using SSCGs with attacking content (example: using multiple targets or floaters) will help increase the volume of attacking skills such as passes, made and received, or shots. This smaller format will also contribute to increasing the collective homogeneity and a more balanced participation of players during the game. A larger format (5 vs. 5) will decrease the individual participation of each player and the heterogeneity of the team. The larger format can be recommended for specific tasks that aim to reproduce an official game.

Despite the evidence found in SSCGs, this study had some limitations. The sample used does not allow for generalization of the findings. Moreover, no time-motion profiles were used to identify the activity profiles of players and spatio-temporal patterns. Future studies should identify how SSCGs influence the spatio-temporal interactions between teammates, mainly identifying the principles of play. Despite these limitations, this study revealed that specific task conditions with tactical content may influence

players' technical performance. Nevertheless, in further studies using observational methods to measure individual tactical behaviour will better determine the tactical influence in collective organisation.

Conclusions

This study revealed that basketball SSCGs with smaller formats significantly increased the %HR_{max} and time spent in high intensity zones. Moreover, smaller SSCGs significantly increased the volume of play, efficiency index, performance score and network density in collective organization. Other analyses of SSCGs with tactical content revealed that attacking conditions

significantly increased the efficacy index and performance score, and defensive conditions had the opposite effects. No results were found in collective organization. Briefly, the 3-a-side format may be used to develop anaerobic capacity using intermittent regimens and the 5-a-side format can be recommended rather for lactate threshold improvement with intermittent or continuous regimens. Task conditions with attacking prevalence are recommended to increase the technical accuracy, while defensive prevalence task conditions should be used to increase accuracy in defensive actions.

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