 DOI: https://doi.org/10.5114/biolsport.2020.89937

Technical-tactical profile, perceived exertion, mental demands and enjoyment of different tactical tasks and training regimes in basketball small-sided games

AUTHORS: Pierpaolo Sansone[1], Antonio Tessitore[1], Inga Lukonaitiene[2], Henrikas Paulauskas[2], Harald Tschan[3], Daniele Conte[2]

[1] University of Rome 'Foro Italico', Department of Movement, Human and Health Sciences, Rome, Italy
[2] Lithuanian Sports University, Institute of Sport Science and Innovations, Kaunas, Lithuania
[3] University of Vienna, Centre for Sports Science and University Sports, Vienna, Austria

Corresponding author:
Pierpaolo Sansone
University of Rome "Foro Italico"
Stanza 123, Piazza Lauro de Bosis 15, 00135 Rome, Italy
tel: +393803162583
p.sansone@studenti.uniroma4.it;
ppsansone@gmail.com

ABSTRACT: This study aimed to evaluate the technical-tactical, perceptual and mental demands of basketball small-sided games (SSGs). Twelve male semi-professional players participated in four half-court 3vs3 SSGs characterized by different tactical tasks (offensive; defensive) and training regimes (long-intermittent; short-intermittent). The SSGs were video-recorded to perform notational analysis of technical-tactical parameters. Ratings of perceived exertion (RPE, CR-100 scale), mental effort (ME) and e njoyment were collected after completion of each SSG. Before and after the SSGs, players reported their perceived mental fatigue (MF); for this indicator, the difference between post- and pre-SSG values was calculated (ΔMF). Notational analysis evidenced a higher volume of play (ball possessions, ball possessions per minute) [large effect size (ES)], dribbles and shot attempts (moderate ES) in short-intermittent regimes compared to long-intermittent. Two-way (tactical task; training regime) repeated-measures ANOVA showed an interaction effect for RPE (moderate ES). Players reported that playing the offensive task required higher mental effort compared to playing defence (moderate ES), while no differences for mental effort were found between regimes. Enjoyment did not differ between tasks or regimes. No effects were found for ΔMF, while this indicator was significantly correlated with RPE scores ($r= 0.50$, large). This study suggests that, in basketball SSGs, shorter regimes induce higher technical demands, while tactical tasks influence perceived exertion responses and mental effort. Furthermore, perceived exertion appears significantly associated with variations of mental fatigue induced by training drills.

CITATION: Sansone P, Tessitore A, Lukonaitiene I et al. Technical-tactical profile, perceived exertion, mental demands and enjoyment of different tactical tasks and training regimes in basketball small-sided games. Biol Sport. 2020;37(1):15–23.

Received: 2019-05-28; Reviewed: 2019-07-08; Re-submitted: 2019-09-25; Accepted: 2019-10-14; Published: 2019-11-19.

Key words:
Game-based conditioning
RPE
Basketball training
Mental fatigue
Game-related statistics
Notational analysis

INTRODUCTION

Basketball is an intermittent-based team sport characterized by high-intensity neuromuscular actions, frequent changes of activity and complex technical-tactical scenarios [1, 2, 3]. Among the various training methodologies used in basketball, small-sided games (SSGs) are particularly relevant since they can simultaneously develop physical, physiological and technical-tactical aspects required in competition [4, 5, 6].

One of the employed SSGs in basketball training routine is the half-court 3vs3. In this SSG, teams are usually structured to include one player per position (guard; forward; center). The reduced court area per player (35 m^2) of this SSG has been shown to induce more technical actions and collaborations between teammates [4, 7] in youth athletes, compared to full-court 3vs3 and SSGs involving more players, respectively. In fact, thanks to the increased involvement of each player, SSGs with fewer players impose higher technical demands (dribbling, passing, shooting) [4, 6, 8]. Regarding adult players, to our knowledge only one study has evaluated demands in half-court 3vs3 SSGs [3]. Therefore, further information on this SSG is required.

During SSG training, coaches can manipulate tactical tasks by assigning players to the offensive or defensive task to specifically develop the physical and technical-tactical requirements of each game situation. While studies have investigated physical and cardiovascular demands of offensive and defensive basketball drills [9, 10], only one study has evaluated each distinct tactical task (playing exclusively offense or defence) in structured drills [11]. Specifically, this recent investigation revealed higher physical and cardiovascular loads in the offensive task, compared to defensive [11]. However, the perceived exertion responses [12, 13] of offensive and defensive tasks in basketball training are still to be evaluated. This appears to be a significant gap in basketball SSGs literature, since perceived exertion-based monitoring tools are the most utilized in team sports [14] ; furthermore, perception of effort has been proposed as a primary factor limiting physical performance, in both laboratory and team sports settings [15, 16].

As SSG training is implemented since it can integratively stimulate physical, physiological, technical-tactical and cognitive aspects which are specific of competition [4, 8, 11], among the various demands it is important to monitor the tactical ones. However, to our knowledge only few studies have investigated tactical parameters in basketball SSGs [1, 9 , 17]. Collectively, playing area, shot clock duration, defensive strategy and number of players have been found to influence tactical performance [1, 9, 17]. Nevertheless, no study has yet evaluated the effect of training regimes on the SSGs' tactical profile. Training regimes are commonly categorized as continuous (long bouts with no or little rest in between) or intermittent (shorter bouts with more frequent pauses) [4, 18]. In general, continuous regimes are believed to induce higher physiological responses than intermittent ones [4, 18]. However, studies which directly compared different training regimes in basketball SSGs [6, 8, 11] found contrasting results, possibly due to different work:rest ratios and standards of play. Considering the importance of training regimes for physical work and pacing strategies [11, 19] further research is required on this factor.

To the best of our knowledge, only one study has investigated mental demands of basketball training [20]. As the demands of team sports are determined by the interaction between physical, perceptual, mental and technical-tactical aspects [11, 21] this appears to be a relevant gap in basketball research. A recent review on RPE-based monitoring suggested assessing mental demands (e.g. mental fatigue, mental effort) alongside perceived exertion responses [21] as they appear to be linked. In fact, the perception of effort is generated in the sensory areas of the brain based on central (i.e. central command activity) [15] and peripheral (e.g. sensations from muscle, joints, cardiorespiratory) cues [22]. Therefore, by modulating the mental demands of exercise, perceived exertion can be influenced via higher central requirements. In fact, studies have demonstrated how increased mental demands can worsen perceived exertion [16, 23] and, importantly, physical [23, 24] and technical performance [16, 23] of team sport players. Furthermore, the aspect of the central command is particularly relevant for SSGs, since it can significantly influence the pacing strategy [25] adopted by players, which is a crucial aspect in SSG training [11, 19]. Additionally, it might be interesting to evaluate whether different tactical tasks (i.e. offense or defence) induce different mental demands. Thus, it appears relevant to monitor mental demands of SSG training. Two of the main indicators of mental demands are mental fatigue, which refers to a state of lack of energy and tiredness induced by cognitively demanding activities [16, 23], and mental effort, which is the perception of cognitive effort required by a task [16, 23]. In team sports research, a few studies have administered separate scales to monitor perceived physical and mental demands [16, 26, 27] in order to differentially quantify different aspects of training load. However, none of these studies regarded basketball, calling for further research. Another aspect related to perceptual demands and physical performance is enjoyment of exercise. Previous research proposes that enjoyment can be increased, for example by reducing bout duration [28, 29]. Greater enjoyment can allow humans to perform more work, thus leading to higher physiological responses [28, 29]. Regarding sports, studies investigating enjoyment in football training showed that higher enjoyment is associated with positive psychometric responses (i.e. mood balance, motivation) [30, 31] which can increase the players' physical performance and commitment during training [31, 32]. In view of these psychological aspects, and considering how perceived exertion limits human performance during exercise [15, 16], it might be interesting to evaluate whether enjoyment is associated with perceived exertion. However, to the best of the authors' knowledge no study has yet assessed enjoyment responses in basketball training.

Therefore, this study aimed to compare the technical-tactical, perceptual and mental demands, and the enjoyment responses in basketball 3vs3 small-sided games designed with different tactical tasks and training regimes. We hypothesize that: a) the shorter regimes will induce a higher volume of play and technical actions; b) RPE will be greater in the offensive task compared to the defensive task, and longer regimes compared to shorter regimes; c) mental demands will be greater in the offensive task compared to the defensive task; d) enjoyment will be higher in the offensive task compared to the defensive task.

MATERIALS AND METHODS

Participants

Twelve male semi-professional basketball players (age: 21 ± 2 years; stature: 193.9 ± 7.0 cm; body mass: 84.8 ± 6.6 kg; playing experience: 12 ± 3 years) from a team playing in the Lithuanian National League (NKL) (national second-tier championship organized by the Lithuanian Basketball Federation) participated in this study. Players were informed about the study aims and procedures, and provided written informed consent to participate. Ethical approval was received by the local Institutional Review Board (code: BEK-TRS(B)-2018- 30). The weekly schedule of the team featured 5 training sessions (total training time: 10 hours) and one official game. The study was performed immediately after the end of the regular season, when all players were in good fitness conditions.

Experimental design

Five experimental sessions were conducted. In the first one, players familiarized with the monitoring instruments (RPE, visual analogue scales) and SSGs conditions. Afterwards, four experimental sessions took place, each scheduled at 5.00 PM and following at least 48 hours of rest.

The SSG format was 3vs3, played on half-court (14x15 m) (35 m^2 per player). The team's head coach allocated players to four balanced teams which played against the same opponent in all four experimental sessions (Team A vs Team B; Team C vs Team D). Before the SSGs, players underwent an 8-min standardized warm-up characterized by mobility exercises, running, basketball-specific movements and plyometrics.

Two factors were investigated: a) tactical task (offense or defence) and b) training regime (long-intermittent or short-intermittent bouts). Regarding tactical task, one team was playing exclusively the offensive task and the other team was only involved in the defensive task for all the duration of each SSG. The defensive strategy allowed was man-to-man only. Concerning the training regimes, the long-intermittent SSGs consisted of three 4-min bouts interspersed by 2 min of passive recovery, while short-intermittent SSGs consisted of six 2-min bouts interspersed by 1 min of passive recovery. The two regimes were characterized by equal total work time (12 min), and a similar work:rest ratio (long-intermittent: 3:1; short-intermittent: 2.4:1). Therefore, each team played the following four experimental conditions, in a random order: a) offense-long, b) offense-short; c) defence-long; d) defence-short. Table 1 presents the rules of the SSGs.

Technical-tactical demands of SSGs

Notational analysis was performed to assess technical-tactical demands. The SSGs were recorded using a camera (HDR-CX450, Sony, Japan) placed at the right half-court corner and elevated about 3.5 m. Videos were subsequently analysed to evaluate the parameters pre-

TABLE 1. Rules of the SSGs

New ball possession	basket made, foul, rebound (offensive or defensive), steal, turnover, out of bounds
Ball clearance	Yes- pass to assistant (except after offensive rebound)
Shot clock	12 seconds
Free throws	No – 1 point to offensive team
Referees	2
Score	Yes
Encouragement	Yes

TABLE 2. Technical-tactical parameters evaluated

Individual	Team
Dribbles	Ball possessions
Passes: total, correct, wrong, % correct, assists	Ball possessions per min
Shots: total, made, missed, field goal percentage (FG%), effective FG % (eFG%);	Offensive and defensive rating
Recovered balls per ball possession	Recovered balls per ball possession
Mid-range shots: total, %;	Ball reversals
close shots: total, %;	Dribbles in key area
2-point (2pt) FG%;	Post entries
3-point shots: total, 3pt FG%	Hand-offs
Rebounds: offensive, defensive	
Fouls	
Individual points	
Points from fouls on shooting	
Screens: on-ball, off-ball	
Cuts	
Turnovers	
Blocks	
Steals	
Deflections	

sented in Table 2, according to previous research [33, 34]. Points from foul on shooting were gained by offensive players when they were fouled during shooting motion. Deflections were noted when a defensive player deflected the ball but possession remained with the offensive team. Videos were scored by a basketball-experienced researcher two weeks apart; this procedure had a high test-retest reliability [intraclass correlation coefficient (3, k) [35] = 0.91–0.98 (95% confidence interval: 0.72–0.99); coefficient of variation: 1–4%].

Assessment of perceptual demands

Five minutes after completion of the SSGs, players reported their ratings of perceived exertion (RPE) by answering the question "how hard was this SSG?" using the centiMax scale [36]. This scale has been suggested as preferable over the more commonly used CR-10 scale since its wider numerical range (0-100 arbitrary units, AU) can help athletes evaluate more finely their perceived exertion [36, 37]. Players were familiar with the centiMax scale as it was used for monitoring their training sessions during the season.

Before and after [38] the SSGs, players reported their levels of mental fatigue (MF) on separate 100-mm visual-analogue scales (VAS), according to previous suggestions [23, 38, 39]. MF referred to the state of mental fatigue (i.e. feelings of tiredness and lack of energy induced by demanding cognitive activity) at the time of assessment [23, 38, 39]. The difference between post-SSG and pre-SSG values of MF was calculated within each SSG (offense-long: post minus pre; offense-short: post minus pre; defence-long: post minus pre; defence-short: post minus pre) to evaluate any variations of MF induced by experimental conditions, and defined ΔMF. Additionally, following each SSG players reported their mental effort (ME) [23, 38] and enjoyment of the SSG on separate 100-mm VAS. ME referred to the cognitive effort required by each SSG [23, 38]. Enjoyment was intended as the players' perception of enjoyment for each SSG. The three VAS used (MF, ME, enjoyment) reported two verbal anchors: *none at all* at the initial side, and *maximal* at the end one [23, 38]. VAS scores are reported in AU.

Statistical analysis

Normality tests (Shapiro-Wilk) were performed for all variables to check data normality assumptions and then select the appropriate statistical tests (parametric or non-parametric).

Technical-tactical parameters were related to either the offensive or defensive task; therefore, pairwise comparisons (t-test in the case of parametric distribution, Wilcoxon signed-rank test if non-parametric) were performed between the two regimes (long-intermittent; short-intermittent).

RPE, ME and enjoyment were compared via two-way (tactical task; training regime) repeated-measures ANOVA (Bonferroni post-hoc).

Regarding MF, a repeated-measures ANOVA was performed to compare pre-SSG levels between the four experimental days to ensure players entered experimental sessions in similar conditions. Therefore, ΔMF was compared via two-way (tactical task; training regime) repeated-measures ANOVA (Bonferroni post-hoc).

Furthermore, Pearson correlation coefficients were calculated to evaluate relationships between perceived exertion (RPE scores) and: ME; enjoyment; ΔMF.

Data are presented as mean and standard deviation (SD), 95% confidence intervals (CI) of the differences and effect sizes (ESs). ESs of ANOVA analyses were calculated as partial eta squared (η_p^2), and interpreted as: ≤0.039: no effect, 0.04–0.24: minimum, 0.25–0.63: moderate, ≥0.64: strong [40]. For pairwise comparisons, ESs were calculated as Cohen's *d*, and interpreted as: <0.20: trivial, 0.20–0.59: small, 0.6–1.19: moderate, 1.2–1.99: large; ≥2.0: very large [41]. Data of non-parametric analyses are presented as mean, median, p-value and effect size. For non-parametric analyses, ESs were calculated as *r* [42] and interpreted as: 0.1–0.29: small, 0.30–0.49: moderate, and ≥0.50: large. Pearson correlation coefficients were interpreted as: 0.10–0.29: small; 0.30–0.49: moderate; 0.50–0.69: large; 0.70–0.89; very large; 0.90–1: nearly perfect [41].

RESULTS

Table 3 and Table 4 presents the results for technical-tactical parameters. The short-regime SSGs elicited a higher volume of play (more ball possessions) (large ES), dribbles, shot attempts, 3-point attempts, missed shots, points from fouls on shooting and less off-ball screens compared to long-regime SSGs ($p < 0.05$, moderate ES).

Data of RPE, ME and enjoyment are presented in Figure 1. Regarding RPE, no effects were found due to tactical tasks (offense: 85.8 ± 11.1; defence: 79.3 ± 14.4; p= 0.072, 95% CI: -0.7–13.7, η_p^2: 0.27, moderate) or training regimes (long: 80.1 ± 14.7, short: 85.1 ± 11.1; p= 0.102, 95% CI: -11.2–1.2, η_p^2: 0.22, minimum), while there was an interaction effect (tactical task*training regime: p= 0.011, η_p^2: 0.46, moderate) (offense-long: 86.3 ± 9.6; offense-short: 85.4 ± 12.9; defence-long: 73.9 ± 16.6; defence-short: 84.8 ± 9.5). For ME, there was a main effect of tactical tasks (offense: 47.5 ± 21.6; defence: 38.8 ± 17.9; p= 0.042, 95% CI: 0.4–17.1, η_p^2: 0.32, moderate), while no effects of training regimes (long: 45.4 ± 22.9, short: 40.8 ± 17.0; p= 0.317, 95% CI: -5.1–14.3, η_p^2: 0.09, minimum) or interaction (p= 0.897, η_p^2: 0.01, no effect) were found. Enjoyment did not differ between tactical tasks (offense: 70.5 ± 17.9; defence: 58.4 ± 16.0; p= 0.088, 95% CI: -2.1–26.4, η_p^2: 0.24, minimum) or training regimes (long: 64.5 ± 20.5, short: 64.9 ± 15.0; p= 0.978, 95% CI: -9.8–9.5, η_p^2: 0.00, no effect); also, no interaction was found (p= 0.106, η_p^2: 0.22, minimum).

Table 3 shows data for MF and ΔMF. One-way repeated-measures ANOVA showed no differences between pre-SSG values of MF (MF: p= 0.269, η_p^2: 0.11, minimum). Two-way analysis for ΔMF showed no single [(tactical task: offense: 15.6 ± 28.9; defence: 5.0 ± 23.3, p= 0.108, η_p^2: 0.22, minimum) (training regime: long: 11.9 ± 32.1, short: 8.7 ± 19.8, p= 0.471, η_p^2: 0.05, minimum)] or interaction effects (p= 0.156, η_p^2: 0.17, minimum).

TABLE 3. Results for technical-tactical parameters of the SSGs

	Parameter	Regime				
		Long	Short	Mean diff. (95% CI)	p	ES (95% CI)
Individual	Dribbles	27.1 ± 8.2	32.5 ± 9.9	-5.4 (-9.4 – -1.4)	**0.013***	**0.86 (moderate)**
	Passes – total	26.2 ± 8.6	25.2 ± 8.5	1.0 (-3.7 – 5.7)	0.651	0.13 (trivial)
	Passes – correct	24.7 ± 8.2	24.0 ± 8.0	0.7 (-4.3 – 5.6)	0.774	0.08 (trivial)
	Passes – assists	3.4 ± 2.6	3.3 ± 1.9	0.1 (-1.1 – 1.5)	0.782	0.08 (trivial)
	Shots – total	19.2 ± 3.6	22.3 ± 4.2	-2.1 (-6.0 – -0.3)	**0.032***	**0.71 (moderate)**
	Shots – made	9.5 ± 4.3	10.1 ± 2.9	-0.6 (-3.1 – 2.0)	0.130	0.14 (trivial)
	Shots- FG%	48.6 ± 15.6	45.6 ± 11.3	3.2 (-6.5 – 12.6)	0.496	0.20 (small)
	Shots – eFG%	53.9 ± 17.7	51.3 ± 13.2	2.6 (-8.7 – 13.9)	0.623	0.15 (trivial)
	Shots – mid range – total	4.5 ± 2.6	3.3 ± 2.6	1.2 (-0.7 – 3.1)	0.202	0.39 (small)
	Shots – close – total	8.7 ± 4.3	10.3 ± 5.2	-1.6 (-3.8 – 0.5)	0.112	0.50 (small)
	Shots – close – %	62.9 ± 19.3	55.2 ± 24.1	7.7 (-13.4 – 28.78)	0.440	0.23 (small)
	Shots – 2pt FG%	54.0 ± 18.1	53.5 ± 16.0	0.5 (-13.7 – 14.8)	0.935	0.02 (trivial)
	Offensive rebounds	2.1 ± 2.2	2.3 ± 2.2	-0.2 (-2.1 – 1.8)	0.854	0.05 (trivial)
	Defensive rebounds	6.3 ± 3.6	7.6 ± 4.1	-1.3 (-3.6 – 1.1)	0.272	0.33 (small)
	Fouls	3.3 ± 1.7	4.7 ± 3.1	-1.4 (-3.2 – 0.5)	0.144	0.46 (small)
	Screens – on-ball	3.6 ± 5.4	3.9 ± 5.1	-0.3 (-2.4 – 1.8)	0.732	0.10 (trivial)
	Cuts	1.8 ± 1.7	2.3 ± 1.9	-0.5 (-1.6 – 0.6)	0.324	0.30 (small)
	Turnovers	2.4 ± 1.5	2.1 ± 1.3	0.3 (-0.5 – 1.2)	0.417	0.24 (small)
	Points from fouls on shooting	1.6 ± 1.0	2.8 ± 2.0	-1.2 (-2.2 – -0.1)	**0.032***	**0.71 (moderate)**
	Individual points	23.0 ± 9.3	25.7 ± 7.6	-2.7 (-8.6 – 3.3)	0.345	0.29 (small)
	Deflections	2.1 ± 2.0	2.5 ± 1.6	-0.4 (-1.3 – 0.5)	0.318	0.30 (small)
Team	Ball possessions	75.0 ± 7.1	87.3 ± 8.8	-12.3 (0.8 – -25.3)	0.058	1.50 (large)
	Ball possessions/min	6.3 ± 0.6	7.3 ± 0.7	-1.0 (0.1 – -2.6)	0.052	1.59 (large)
	Offensive and defensive rating	0.92 ± 0.09	0.88 ± 0.05	0.1 (-0.2 – 0.3)	0.623	0.27 (small)
	Recovered balls/ball possession	0.19 ± 0.03	0.16 ± 0.04	0.1 (0.1– -0.1)	0.291	0.60) (moderate)
	Ball reversals	11.8 ± 5.9	11.8 ± 5.6	0.0 (-6.8 – 6.8)	1.000	0.00 (trivial)
	Dribbles in key area	36.5 ± 8.1	47.3 ± 13.1	-10.8 (-25.1 – -3.6)	0.098	1.20 (moderate)
	Post entries	15.5 ± 9.3	13.8 ± 7.1	1.8 (-13.1 – 9.6)	0.657	0.25 (small)
	Hand-offs	8.8 ± 5.7	13.8 ± 10.4	-5.0 (-17.1 – 7.1)	0.281	0.66 (moderate)

Data presented as mean ± SD and 95% CI of the differences; *= p< 0.05; *p* values and ES of significant differences in bold.

TABLE 4. Technical-tactical parameters of the SSGs analysed via non-parametric test

	Regime			
	Long	Short	*p*	ES
Passes – wrong	1.5 ± 1.2; 1.5	1.2 ± 1.3; 1.0	0.292	0.21 (small)
Passes – % correct	94.5 ± 8.2; 94.1	95.9 ± 8.0; 97.0	0.386	0.18 (small)
Shots – missed	9.7 ± 3.0; 9.0	12.3 ± 3.7; 13.0	**0.045***	**0.41 (moderate)**
Shots – mid range – %	28.9 ± 25.7; 31.0	27.4 ± 28.6; 29.2	0.859	0.01 (trivial)
Shots – 3pt – total	6.0 ± 4.1; 5.5	8.7 ± 5.2; 7.0	**0.032***	**0.44 (moderate)**
Shots – 3pt FG%	39.6 ± 29.3; 43.8	27.2 ± 18.1; 25.0	0.213	0.26 (small)
Screens – off-ball	2.3 ± 2.8; 1.0	0.8 ± 1.7; 0.0	**0.048***	**0.41 (moderate)**
Blocks	0.6 ± 0.8; 0.0	1.1 ± 1.2; 1.0	0.196	0.26 (small)
Steals	1.8 ± 1.2; 2.0	1.3 ± 1.0; 1.0	0.132	0.31 (moderate)

Data presented as mean ± SD and median; *= p< 0.05; *p* values and ES of significant differences in bold

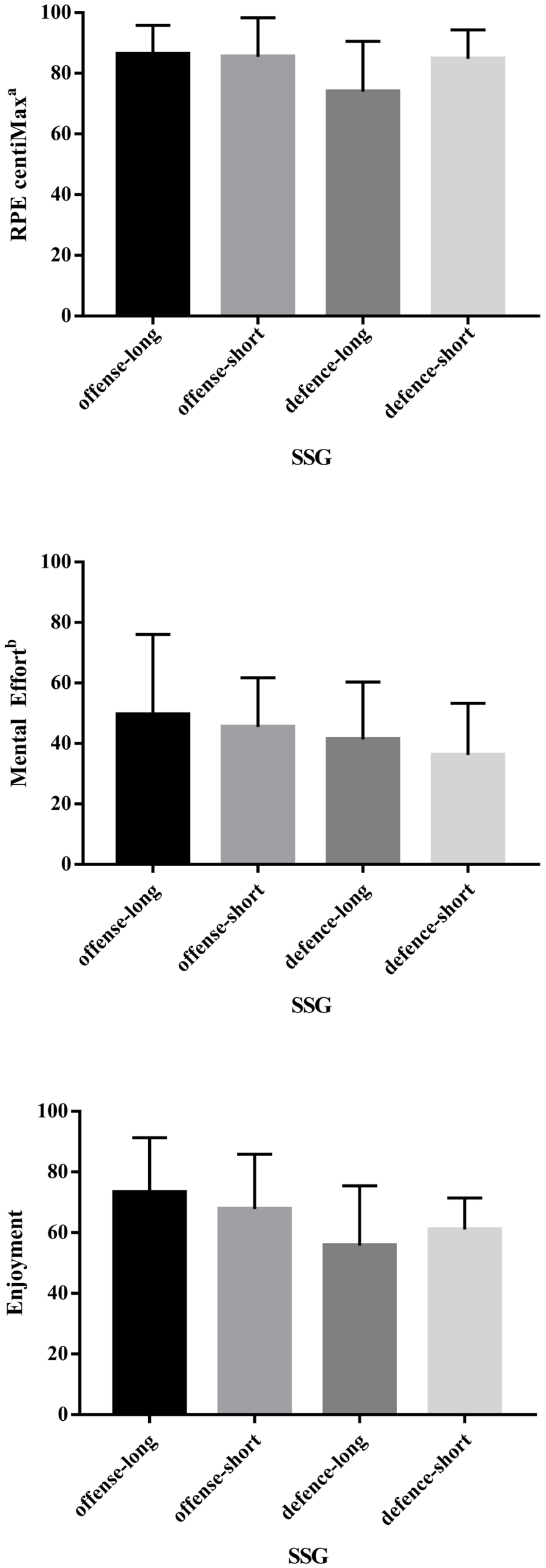

FIG. 1. RPE, mental effort and enjoyment of the SSGs.
Data presented as mean ± SD;
1a- RPE; [a] - interaction effect (tactical task*training regime, ES: moderate);
1b- Mental Effort; [b] - significantly higher in offense (ES: moderate);
1c- Enjoyment.

TABLE 5. Perceived mental fatigue (MF) before and after the SSGs

	MF		
	Pre	**Post**	**ΔMF**
Offense-long	35.2 ± 20.3	58.1 ± 26.9	22.9 ± 31.6
Offense-short	49.2 ± 24.1	57.5 ± 22.5	8.3 ± 25.2
Defence-long	34.8 ± 25.2	35.7 ± 20.8	0.9 ± 29.9
Defence-short	43.7 ± 26.8	52.8 ± 24.5	9.1 ± 13.7

Data presented as mean ± SD

TABLE 6. Correlations between perceived exertion, mental demands and enjoyment

	RPE	
	r	*p*
ME	0.23 (small)	0.117
Enjoyment	0.25 (small)	0.087
ΔMF	**0.50 (large)**	**<0.001**

Significant correlations in bold

Results of correlation analyses are shown in Table 4. Perceived exertion was largely correlated with ΔMF ($p < 0.001$), while it was not associated with ME or enjoyment ($p > 0.05$).

DISCUSSION

This study investigated the technical-tactical, perceptual and mental demands of basketball half-court 3vs3 SSGs characterized by different tactical tasks and training regimes. The number of ball possessions and technical actions were higher in the short-intermittent regimes compared to long-intermittent. Perceived exertion was influenced by the combination of tactical tasks and training regimes, with a tendency for higher RPE scores in the offensive task compared to defensive. Mental effort was higher in the offensive task compared to defensive, while it did not differ between regimes. No effects were found for mental fatigue and enjoyment, but perceived exertion was significantly associated with changes in mental fatigue induced by the SSGs (Table 5).

Notational analysis evidenced a greater volume of play (ball possessions, ball possession per minute) in the short-regime SSGs (large ES). Previous literature proposes that, in SSGs, athletes modulate their pace considering bout duration. Specifically, it has been shown that bouts team sport players perform more high-intensity movements [19] and physical work [11] in shorter bouts, possibly due to the lower duration and more frequent pauses available [11, 19]. Therefore, players in this study might have increased their pace under short-intermittent conditions, determining the higher volume of play. Similarly, reducing the shot clock duration has been shown to increase the number of possessions played in basketball SSGs [17], further confirming the importance of temporal characteristics in SSG training.

In fact, the greater ball possessions played is the main determinant of the higher number of technical actions assessed in short regimes. Regarding shots, no reductions were noted for field goal and 3-point percentages despite the higher total and 3-point attempts. Since shorter regimes were characterized by a lower work:rest ratio and more frequent pauses, players might have experienced less fatigue under this condition [11], thereby maintaining their shot efficiency. Short regimes also induced more dribbles in the key area, suggesting that there were more attacks to the basket in the form of penetrations and balls received in the 3-second area. These, in turn, might have determined the higher number of fouls on shooting committed by defensive players in short-regime SSGs. Interestingly, the only actions which had a lower frequency in short regimes were off-ball screens. This tactical play requires the interaction of two players who are not in possession of the ball; therefore, in 3vs3 SSGs this would mean that two thirds of the team have to perform this tactical play, which has been suggested as too complex for this SSG type. [17]. Furthermore, this complexity might have been exacerbated by the lower bout duration of short-regime SSGs. Altogether, our findings suggest that training regimes influence players' technical-tactical performance during basketball SSGs.

Regarding perceived exertion, no differences were found due to either tactical tasks or training regimes, while there was a significant interaction effect (moderate ES) (Table 6). This finding is in line with a previous investigation on basketball SSGs, which highlighted an interaction effect of tasks and regimes on cardiovascular responses [11]. Despite not being significant, our results indicate higher perceived exertion in the offensive task (moderate ES), similarly to a recent study which revealed higher physical and cardiovascular demands in players assigned to the offensive task, compared to defensive during basketball SSGs [11]. Collectively, it can be proposed that the physical, physiological and perceived demands of basketball SSGs are influenced by the tactical task to which players are assigned. In fact, these higher responses reported in the offensive task could be explained by considering that, in this condition, players had to continuously perform efforts (e.g. accelerations, positional efforts to gain an advantageous position) to beat the defence and score. The defensive task, on the other hand, required players to protect the basket, possibly covering less distance by staying within the 3-point line, thus explaining the lower RPE scores observed.

In contrast, RPE responses were not influenced by training regimes. Our findings disagree with two previous studies which found that SSGs with longer regimes determined higher RPE responses [6, 8] than intermittent regimes. Here, the differences between our and previous studies in players' age, competitive level and work:rest ratios implemented [11, 18] might explain the discrepancies in the findings. While no study directly compared responses of players of different age and standards of play in basketball SSGs, it is known that the demands of basketball depend on the playing level [2]. Regarding work:rest ratios, no difference was found in this study, possibly due to the similarity of this indicator between conditions (long-intermittent regime: 3:1 short-intermittent regime: 2.4:1). Differently, in the studies by Conte et al. (continuous: 3:1; intermittent: 1:1) [8] and Klusemann et al. (continuous: 20:1 intermittent: 3.3:1) [6] there were greater differences in the work:rest ratios of the SSGs compared. Nevertheless, as we assessed how shorter regimes induced more technical actions, without consequences for technical efficiency or perceived exertion, we suggest implementing shorter bouts as they provide a training stimulus more similar to competition [6, 11].

To the best of the authors' knowledge, this was the first study measuring perceived mental demands in basketball players. The higher ME and the tendency for higher RPE (moderate ES) observed in the offensive task indicate its higher demands. In fact, playing offense might impose greater cognitive demands due to the need to constantly find solutions to score, whereas the actions of defensive players are, possibly, subordinate to those of the offensive team, and hence require lower mental effort. Similarly, previous studies on offensive and defensive SSGs have shown that possessing the ball induces higher physical [11] and cardiovascular responses [11, 43]. Altogether, it appears that the physical, perceptual and mental demands of basketball training are all influenced by tactical tasks, confirming the importance of monitoring training demands in team sports from multiple perspectives. However, ME was not influenced by training regimes, as found for RPE. In fact, the similar work:rest ratios implemented in the two regimes might have led to these findings. Differently, by using substantially different drill durations (e.g. 2 bouts of 12 min versus 12 bouts of 1 minute) we might have observed significant differences between regimes. Nevertheless, it is not surprising that ME was influenced by tactical task, which confirms our hypothesis on the cognitive demands of different tactical requirements. Future research should evaluate further whether training regimes influence mental demands of basketball SSGs.

Regarding mental fatigue, no differences due to tactical tasks or training regimes were found. It is possible that pre-training levels of MF might have limited our results. Indeed, this study involved semi-professional players, who trained in the afternoon after other daily activities (e.g. working, studying). These activities might have induced some MF, in view of the average MF before the SSGs of 40.7 AU. Similarly, two previous studies involving team sport players [16, 23] reported some levels of MF before experimental procedures (Badin et al. [23]: 33-40 AU; Smith et al. [16]: 22-35 AU). Very interestingly, the experiment by Badin et al. [23] showed significant increases of perceived MF after the SSG in control condition, while MF decreased when players underwent the SSG in mentally fatigued condition [23]. Therefore, it appears that pre-exercise levels of MF can influence its responses in team-sport players. Future studies investigating mental demands of team-sports training should consider pre-exercise levels of MF as well as the daily activities of athletes, as also suggested in a recent review [38]. Nevertheless, our investigation on mental demands might have practical applicability following suggestions [21] on the necessity of considering mental aspects when monitoring training with RPE-based methods. In this line, we found a large correlation between perceived exertion and increases of mental fatigue, similarly to previous studies demonstrating the detrimental effect of MF on physical performance and perception of effort [15, 16, 23]. Differently, perceived exertion was not associated with ME. The absence of correlation between RPE and ME might suggest that semi-professional players are able to differentiate perceived exertion and mental demands in sport. Similarly, previous studies have successfully used differential RPE ratings which asked team sport players to differentiate sensory inputs, including physical and cognitive demands [26, 27].

Regarding enjoyment of the SSGs, there were no differences due to tactical tasks or training regimes; moreover, no correlation with RPE scores was found, in line with a previous study on football SSGs [44]. As the presence of the ball in SSG training has been associated with positive affective responses [31, 43], we hypothesized that the offensive task would be enjoyed more. Here, the players' competitive level might explain our findings. Specifically, it is possible that, being of a national level, our players participated in the SSGs with a professional approach without being influenced by playing with or without the ball, while youth or amateur players might have participated in the same SSGs with a less professional and more enjoyment-oriented approach. Regarding regimes, as enjoyment has been shown to be higher in shorter bouts of endurance exercise compared to longer [28, 29], it might have been expected that shorter regimes would have led to greater enjoyment; however, this was not the case. While in cyclic exercise more frequent pauses provide a "break" from negative affective responses [28], in team sports, and especially SSGs, the game context is a positive stimulus [44] which counteracts negative perceptions (e.g. fatigue accumulated during longer bouts), possibly explaining our findings.

One limitation of the present study regards the absence of anchoring procedures of the scales used [45]. Further research might consider determining the low and high anchors of perceptual scales for each individual in order for players to quantify more easily their responses to training.

CONCLUSIONS

This study demonstrated that the performance profile of basketball SSGs is influenced by tactical tasks and training regimes. Technical-tactical performance differed between training regimes, with the short-intermittent SSGs inducing a higher volume of offensive play and different tactical behaviours, in terms of number of ball possessions and individual and team-based set actions. The offensive task was more demanding than defensive, in terms of perceived exertion and mental effort. Coaches can use the scales evaluated in this study to gain a more comprehensive perspective on the demands of basketball training.

Ackowledgements

The authors would like to like to thank the players and coaches for their participation.

Conflict of interest declaration

The authors report no conflict of interest for this manuscript.

REFERENCES

1. Sampaio J, Gonçalves B, Rentero L, Abrantes C, Leite N. Exploring how basketball players' tactical performances can be affected by activity workload. Sci Sports. 29(4): e23–e30.
2. Stojanovic E, Stojiljkovic N, Scanlan AT, Dalbo VJ, Berkelmans D, Milanovic Z. The activity demands and physiological responses encountered during basketball match-play: a systematic review. Sports Med. 2018;48(1): 111–135.
3. Torres-Ronda L, Ric A, Llabres-Torres I, de las Heras B, Schelling X. Position-dependent cardiovascular response and time-motion analysis during training drills and friendly matches in elite male basketball players. J Strength Cond Res. 2015;30(1): 60–70.
4. Clemente FM. Small-sided and conditioned games in basketball training: a review. Strength Cond J. 2016;38(3): 49–58.
5. Delextrat A, Martinez A. Small-sided game training improves aerobic capacity and technical skills in basketball players. Int J Sports Med. 2014;35(5): 385–391.
6. Klusemann MJ, Pyne DB, Foster C, Drinkwater EJ. Optimising technical skills and physical loading in small-sided basketball games. J Sport Sci. 2012; 30(14): 1463–1471.
7. Atli H, Koklu Y, Alemdaroglu U, Unver Kocask F. A comparison of heart rate response and frequencies of technical actions between half-court and full-court 3-a-side games in high school female basketball players. J Strength Cond Res. 2013; 27(2): 352–356.
8. Conte D, Favero TG, Niederhausen M, Capranica L, Tessitore A. Effect of different number of players and training regimes on physiological and technical demands of ball-drills in basketball. J Sport Sci. 2016; 34(8): 780–786.
9. Clemente FM, González-Víllora S, Delextrat A, Martins FML, Vicedo JCP. Effects of the sports level, format of the game and task condition on heart rate responses, technical and tactical performance of youth basketball players. J Hum Kinet. 2017; 58(1): 141–155, 2017.
10. Montgomery PG, Pyne DB, Minahan CL. The physical and physiological demands of basketball training and competition. Int J Sports Physiol Perf. 2010;5(1):75–86.
11. Sansone P, Tessitore A, Paulauskas H, Lukonaitiene I, Tschan H, Pliauga V, Conte D. Physical and physiological demands and hormonal responses in basketball small-sided games with different tactical tasks and training regimes. J Sci Med Sports. 2019; 22(5): 602-606.
12. Foster C, Florhaug JA, Franklin J, Gottschall L, Hrovatin LA, Parker S, Doleshal P, Dodge C. A new approach to monitoring exercise training. J Strength Cond Res. 2001; 15(1): 109–115.
13. Sansone P, Tschan H, Foster C, Tessitore A. Monitoring training load and perceived recovery in female basketball: implications for training design. J Strength Cond Res. 2018 [epub ahead of print].

14. Haddad M, Stylianides G, Djaoui L, Dellal A, Chamari K. Session-RPE method for training load monitoring: validity, ecological usefulness, and influencing factors. Front Neurosci. 2017; 11(612): 1-12.
15. Marcora SM, Staiano W. The limit to exercise tolerance in humans: mind over muscle? Eur J Appl Physiol. 2010; 109(4): 763-770.
16. Smith MR, Coutts AJ, Merlini M, Deprez D, Lenoir M, Marcora SM. Mental fatigue impairs soccer-specific physical and technical performance. Med Sci Sports Exer. 2016; 48(2): 267–276.
17. Bredt SGT, Morales JCP, Andrade AGP, Torres JO, Peixoto GH, Greco PJ, Praca GM, Chagas MH. Space creation dynamics in basketball small-sided games. Percept Mot Skills. 2018; 125(1): 162–176.
18. Hill-Haas SV, Dawson B, Impellizzeri FM, Coutts AJ. Physiology of small-sided games training in football: a systematic review. Sports Med. 2011; 41(3): 199–220.
19. Sampson JA, Fullagar HH, Gabbett T. Knowledge of bout duration influences pacing strategies during small-sided games. J Sport Sci. 2015;33(1): 85-98.
20. Moreira A, Aoki MS, Franchini E, da Silva Machado DG, Paludo AC, Okano AH. Mental fatigue impairs technical performance and alters neuroendocrine and autonomic responses in elite young basketball players. Physiol Behav. 2018; 196: 112–118.
21. Coyne JOC, Haff GG, Coutts AJ, Newton RU, Nimphius S. The current state of subjective training load monitoring: a practical perspective and call to action. Sports Med- Open. 2018; 4(1): 58.
22. Van Cutsem J, Marcora S, De Pauw K, Bailey S, Meeusen R, Roelands B. The effects of mental fatigue on physical performance: a systematic review. Sports Med. 2017;47(8): 1569-1588.
23. Badin OO, Smith MR, Conte D, Coutts AJ. Mental fatigue: impairment of technical performance in small-sided soccer games. Int J Sports Physiol Perf. 2016;11(8): 1100–1105.
24. Coutinho D, Goncalves B, Wong DP, Travassos B, Coutts AJ, Sampaio J. Exploring the effects of mental and muscular fatigue in soccer players' performance. Hum Mov Sci. 2018; 58: 287-296.
25. Waldron M, Highton J. Fatigue and pacing in high-intensity intermittent team sports: an update. Sports Med. 2014; 44: 1645-1658.
26. McLaren S, Smith A, Spears IR, Weston M. A detailed quantification of differential ratings of perceived exertion during team-sport training. J Sci Med Sports. 2017;20(3): 290-295
27. Weston M, Siegler J, Bahnert A, McBrien J, Lovell R. The application of differential ratings of perceived exertion to Australian Football League matches. J Sci Med Sports. 2015; 18(6): 704-708.
28. Crisp, NA, Fourniern, PA, Licari, MK, Braham, R, Guelfi, KJ. Optimising sprint interval exercise to maximise energy expenditure and enjoyment in overweight boys. Appl Physiol Nutr Metabol. 2012;37(6): 1222-1231.
29. Thum JS, Parsons G, Whittle T, Astorino TA. High-intensity interval training elicits higher enjoyment than moderate intensity continuous exercise. PLoS One. 2017;12(1): e0166299.
30. Alvarez MS, Balaguer I, Castillo I, Duda JL. Coach autonomy support and quality of sport engagement in young soccer players. Span J Psychol. 2009; 12(1): 138–148.
31. Selmi O, Haddad M, Majed L, Ben Khalifa W, Hamza M, Chamari K. Soccer training: high-intensity interval training is mood disturbing while small sided games ensure mood balance. J Sports Med Phys Fitness. 2018; 58(7-8): 1163-1170.
32. Garcia-Mas A, Palou P, Gili M, Ponseti X, Borras PA, Vidal J, Cruz J, Torregrosa M, Villamarin F, Sousa C. Commitment, enjoyment and motivation in young soccer competitive players. Span J Psychol. 2010; 13(2): 609–616.
33. Conte D, Tessitore A, Gjullin A, Mackinnon D. Investigating the game-related statistics and tactical profile in NCAA division I men' s basketball games. Biol Sport. 2018;35(2): 137–143.
34. Klusemann, MJ, Pyne, DB, Hopkins, WG, Drinkwater, EJ. Activity profiles and demands of seasonal and tournament basketball competition. Int J Sports Physiol Perf. 2013; 8(6): 623–629.
35. Weir JP. Quantifying test-retest reliability using the intraclass correlation coefficient and the SEM. J Strength Cond Res. 2005;19(1): 231-240.
36. Borg E, Kaijser L. A comparison between three rating scales for perceived exertion and two different work tests. Scan J Med Sci Sports. 2006;16(1): 57–69.
37. Fanchini M, Ferraresi I, Modena R, Schena F, Coutts AJ, Impellizzeri FM. Use of CR100 scale for session-RPE in soccer and interchangeability with CR10. Int J Sport Physiol Perf. 2016; 11(3): 388–392.
38. Smith MR, Thompson C, Marcora SM, Skorski S, Meyer T, Coutts AJ. Mental fatigue and soccer: current knowledge and future directions. Sports Med. 2018;48: 1525-1532.
39. Smith MR, Chai R, Nguyen HT, Marcora SM, Coutts AJ. Comparing the effects of three cognitive tasks on indicators of mental fatigue. J Psychol. 2019 [epub ahead of print].
40. Ferguson, CJ. An effect size primer: a guide for clinicians and researchers. Prof Psychol Res Pr. 2009; 40(5): 532–538.
41. Hopkins WG, Marshall SW, Batterham AM, Hanin J. Progressive statistics for studies in sports medicine and exercise science. Med Sci Sports Exerc. 2009; 41(1): 3–12.
42. Fritz CO, Morris PE, Richler, JJ. Effect size estimates: current use, calculations, and interpretation. J Exp Psychol Gen. 2012; 141(1): 2–18.
43. Abrantes CI, Nunes MI, Macas VM, Leite NM, Sampaio J. Effects of the number of players and game type constraints on heart rate, rating of perceived exertion, and technical actions of small-sided soccer games. J Strength Cond Res. 2012;26(4): 976-981.
44. Selmi O, Goncalves B, Ouergui I, Sampaio J, Bouassida A. Influence of well-being variables and recovery state in physical enjoyment of professional soccer players during small-sided games. Res Sports Med. 2018; 26(2): 199-210.
45. Gearhart RF, Goss FL, Lagally KM, Jakicic JM, Gallagher J, Robertson RJ. Standardized scaling procedures for rating perceived exertion during resistance exercise. J Strength Cond Res. 2001;15(3): 320-325.