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ORIGINAL RESEARCH

Effects of different small-sided games on psychological responses and technical activities in young female basketball players

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Abstract

Background: Although small-sided games (SSG) have been a popular method recently, the number of studies on female athletes is limited. **Objective:** This study investigated the effects of basketball-specific 2vs2, 3vs3 and 4vs4 SSG on psychological and technical responses. **Methods:** Eighteen young female basketball players with an age of 15.6 ± 0.7 years, a height of 175.0 ± 4.9 cm, a basketball experience of 5.6 ± 0.7 years, and a body mass index of 20.8 ± 1.1 kg/m^2 participated in the study. Anthropometric measurements and Yo-Yo Intermittent Recovery Test 1 were conducted. Rating of perceived exertion (RPE), enjoyment of physical activity (PACES-S), mental fatigue and emotion responses of the players were assessed after each bout in basketball-specific 2vs2, 3vs3 and 4vs4 SSG. **Results:** Significant differences in RPE, PACES-S and emotional responses were found for 2vs2, 3vs3 and 4vs4 games ($p < .05$). In addition to these results, 2vs2 and 3vs3 formats revealed significant differences in rebounding, successful shots, unsuccessful shots and successful passes in the technical responses ($p < .05$). **Conclusions:** The findings show that changing game forms can improve player experiences and encourage higher levels of physical activity, enjoyment, emotional responses, and technical ability. Further research could explore additional variables, such as tactical decision-making, cognitive load, and long-term effects of using different game forms.

Keywords: team sports, basketball, basketball specific-games, psychological responses, woman

Introduction

Basketball is a team sport with an intermittent game nature that involves high-intensity neuromuscular activities, change of direction activities and complex technical-tactical scenarios (Sampaio et al., 2014; Torres-Ronda et al., 2016). However, frequent repetition of high-intensity activities such as jumping, acceleration, deceleration, change of direction and sprinting (Marcelino et al., 2016) is important for success (Torres-Ronda et al., 2016). Different game formats affect internal and external loads in players and are one of the most common training methods used (Stojanović et al., 2021). Basketball coaches also often use various on-court training strategies to encourage players' specific physical and skill adaptations (Delextrat & Martinez, 2014). Therefore, sports scientists and coaches have recently been using small-sided games (SSG) to improve players' aerobic conditioning in combination with technical and tactical stimuli (Arslan et al., 2020; Soylu et al., 2022).

SSG are enjoyable, practical, time-efficient, and a training method that improves technical-tactical and physical fitness compared to traditional aerobic training methods (Arslan et al., 2020). In addition, SSG have simulated the game profiles and demands of training similar to the competition goal (Bredt et al., 2018; Davids et al., 2013). During games, the variation of psychophysiological and technical-tactical responses is usually influenced by the number of players (formats), field size and game rules (Clemente et al., 2021). Therefore, training stimuli similar to the competitive environment while simulating football-specific movements also provide decision-making, problem-solving skills, and positive psychological responses (Conte et al., 2015).

In team sports, players' responses to training should be monitored to ensure that the players' performances are psychologically and physiologically optimal with good training planning (Coutts & Reaburn, 2008). While physical and technical capacity can be improved through regular training, psychological fitness is also an important determinant of performance in basketball (Zhou, 2022). Understanding the impacts on player performance under pressure during basketball games requires psychological analysis of basketball players (Sighinolfi, 2020). Although SSG provide similar physical adaptations with different training methods of similar intensity and are more effective for young basketball players' psychological and technical skills (Arslan et al., 2022). Researchers (Conte et al., 2015; Klusemann et al., 2012) reported that 2vs2 games in basketball increase the frequency of various technical actions such as dribbling,

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passing, different types of shots and rebounding compared to 4vs4 games. Basketball coaches should use full-court games such as 2vs2 and 3vs3 to increase physiological reactions' intensity in training and improve technical skills (Köklü et al., 2017). According to these results, it can be stated that games played with fewer players increase participation in the game, thus increasing the acute physiological reactions and physical demands of the players (Clemente et al., 2020).

SSG improve physical, physiological and technical responses while also improving enjoyment, commitment and level of play (Clemente et al., 2014). However, although there are many studies examining the physical effects of SSG on basketball players (Arslan et al., 2020; Clemente et al., 2020; Köklü et al., 2017), there are very few studies on the cognitive and psychological effects (Brini et al., 2021; Sansone et al., 2020). To the best of our knowledge, no study examined the effects of SSG on enjoyment, mental fatigue and emotion, especially in young female basketball players. This study aims to examine effects of SSG on psychological and technical responses in young female basketball players.

Method

Participants

Eighteen young female basketball players (age 15.6 ± 0.7 years, height 175.0 ± 4.9 cm, weight 63.7 ± 7.0 kg, body mass index 20.8 ± 1.1 kg/m^2, basketball experience 5.6 ± 0.7 years) participated in this study. All players were members of the same youth basketball team competing in a regional league. The athletes regularly participated in at least five training sessions and one weekly competition. Before the study, all young basketball players were given detailed information about the risks and discomforts and their parents signed an informed consent. The study was approved by the local university Ethics Committee (2021/2 E-95860085-050.02.04-15420) and was conducted according to the Declaration of Helsinki.

Instruments

The rating of perceived exertion (RPE) was measured using Borg Scale. It is a subjective method that depends on the feelings of individuals. It is also a frequently used method to determine the intensity of exercise (Borg, 1998). The Borg scale is used as a measurement tool for determining the intensity of training or exercise, is based on psychophysical investigations and evaluates somatosensory sensations and is a tool for psychophysiological assessment (Polito et al., 2017). In this study, the 20-point Borg scale was used. RPE values were asked of the athletes after each set of SSG.

Mental fatigue was measured using a 100 mm Visual Analogue Scale. This scale has two ends fixed from 0 (none) to 100 (maximal) with no descriptors between them. Participants were asked to answer the following question: "How mentally tired do you feel right now?" (Soylu et al., 2021).

The Physical Activity Enjoyment Scale (Kendzierski & DeCarlo, 1991) was used to determine how much one enjoys physical activity during and immediately after physical activity. The original form of the scale has 18 items and is scored on a 7-point scale. Graves et al. (2010) reorganised the short structure of the scale and developed a 5-item Physical Activity Enjoyment Scale-Short Form (PACES-S). The scale is a 7-point Likert-type scale and is bipolar. The highest score that can be obtained from the scale is 35, and the lowest score is 5. The reliability of this revised 5-item scale was tested in 3 different age groups and Cronbach alpha calculated as .739 for youth (11–17 years old), .783 for young adults (21–38 years old) and .840 for middle adults (45–70 years old). Cronbach alpha, internal consistency coefficient, was found to be .742. The Turkish adaptation of the revised scale was conducted by Mirzeoglu and Coknaz (2014).

The emotions experienced by the athletes before, during, and after the SSG were measured using the seven emotion items used by Lane et al. (2016) and Fullerton et al. (2017): "happy", "anxious", "dejected", "energetic", "fatigued", "angry", and "excited" in the form of a 7-point rating. The athletes were asked to rate their current emotional state with a number between *not at all* (1) and *extremely* (7). Since emotions are often assessed during research, it is more appropriate to consciously use a short measure of emotion (Fullerton et al., 2017).

Technical activities

Basketball-specific 2vs2, 3vs3 and 4vs4 SSG were recorded in 1080p quality using a Canon HF R806 video camera (Canon, Tokyo, Japan) for the technical analysis of the players. E-Analyze Digital Basketball Match Analysis Software was used (Version 5.8; Espor Digital, Ankara, Türkiye; Soylu et al., 2022). Technical activities were coded as follows:

- rebounds – winning the ball after a missed shot attempt,
- shots – a player trying to score by throwing the ball into the opponent's basket,
- passes – successful and unsuccessful passes when a player passes the ball to a teammate,
- steals – balls won by a player stealing the ball from an opponent,
- turnovers – a player losing the ball to an opponent or losing the ball by going out of bounds.

The technical activities were assessed by an experienced match and performance analysis coach with more than three years of experience in basketball match analysis.

Design of measurement

Firstly, anthropometric measurements (height, body weight) were conducted. Then, the Yo-Yo Intermittent Recovery Test 1 test was performed. The players were rated according to their aerobic fitness level, from highest to lowest, based on the distance completed in the test to prevent SSG teams with imbalanced aerobic fitness levels. The groups are ranked according to the coach's technical and tactical level differences in knowledge. Game format and the SSG were played according to the team, field size, the number of sets, duration and rest interval determined. The 2vs2, 3vs3 and 4vs4 SSG were all played in four 4-min bouts with 4-min passive rest on the full court (28 × 15 m)

without any special rules, and the observers ensured the continuity of the game at the edges of the field by including the new ball into the game in case the ball went out. During the SSG, the coaches verbally encouraged the players. On the measurement days, SSG were played randomly. During the measurements, the athletes had no training or competition other than the measurements. The warm-up was performed before all measurements except anthropometric measurements. SSG were performed following a 15-min standardized warm-up that included 5 min of low- to moderate-intensity jogging, 5 min of dynamic stretching targeted at the upper and lower limbs, mobility and agility exercises, and 5 min of the ball-possession game.

Statistical analysis

The research analysis used arithmetic mean and standard deviation values for descriptive information. Before the tests, the Shapiro-Wilk test checked normality assumptions, and skewness and kurtosis values were within the acceptable range (–1.5 and +1.5). A one-way analysis of variance was performed for the rating of perceived exertion, enjoyment, mental fatigue, emotion and technical responses. The significance level for pairwise comparisons was calculated using Bonferroni's post-hoc test. Effect sizes were also calculated (η_p^2), and values of .01, .05, and .15 or greater were considered small, medium, and large, respectively (Cohen, 1988). The significance value was set at $p < .05$ in the data analysis. IBM SPSS Statistics (Version 26; IBM, Armonk, NY, USA) was used for all tests.

Results

This part of the study presents the results of young female basketball players' psychological and technical responses to different SSG.

Table 1 shows the comparison of RPE, mental fatigue, and enjoyment responses in different SSG. There was a statistically significant difference in RPE and enjoyment responses between 2vs2, 3vs3, and 4vs4 SSG ($p < .05$). Post-hoc analysis results indicated that the group who played 2vs2 SSG displayed higher RPE than 4vs4 SSG. In addition, enjoyment is higher in the 3vs3 SSG than in 2vs2. There was no significant difference between the SSG in mental fatigue responses.

Table 2 shows the comparison of the technical activities in different SSG. There was a statistically significant difference between 2vs2, 3vs3, and 4vs4 SSG in rebounding, successful shooting, unsuccessful shooting, and successful passing activities ($p < .05$). Post-hoc analysis results indicated that the group who played 2vs2 SSG displayed higher rebounding, and successful and unsuccessful shooting activities were higher than 2vs2 and 3vs3. In addition, the successful passing was higher in the 3vs3 SSG than in 2vs2 and 4vs4. There was no significant difference between the SSG in unsuccessful passes, steals, and turnovers.

Comparison of emotional responses in different SSG is presented in Table 3. There were significant differences in happiness, unhappiness, and fatigue ($p < .05$). The post-hoc results show that players felt happy, most dejected, and fatigued in the 3vs3 SSG. The SSG had no significant difference in anxious, energetic, angry, and excited emotions ($p > .05$).

Table 1 Rate of perceived exertion, mental fatigue and enjoyment responses in different small-sided games

	Mean ± *SD*			Analysis of variance			
Variable	2vs2	3vs3	4vs4	*F*	*p*	η_p^2	Post-hoc
Rate of perceived exertion	14.5 ± 1.1	13.3 ± 1.2	12.5 ± 2.6	7.896	.012	.317	2vs2 vs. 3vs3 ($p = .050$) 2vs2 vs. 4vs4 ($p = .036$)
Mental fatigue	2.8 ± 2.1	2.9 ± 1.7	3.1 ± 1.7	0.137	.716	.008	
Enjoyment responses	22.7 ± 5.5	27.1 ± 1.8	23.8 ± 4.0	14.135	.002	.454	3vs3 vs. 2vs2 ($p = .025$) 3vs3 vs. 4vs4 ($p = .025$)

Table 2 Technical activities in different small-sided games

	Mean ± *SD*			Analysis of variance			
Activity	2vs2	3vs3	4vs4	*F*	*p*	η_p^2	Post-hoc
Rebound	0.9 ± 0.3	0.8 ± 0.4	0.5 ± 0.2	15.286	.001	.433	4vs4 vs. 2vs2 ($p = .003$) 4vs4 vs. 3vs3 ($p = .035$)
Successful shot	1.9 ± 0.1	1.6 ± 0.6	0.9 ± 0.2	20.705	< .001	.549	4vs4 vs. 2vs2 ($p = .001$) 4vs4 vs. 3vs3 ($p = .003$)
Unsuccessful shot	2.1 ± 0.7	1.8 ± 0.6	1.3 ± 0.3	20.937	< .001	.552	4vs4 vs. 2vs2 ($p = .001$) 4vs4 vs. 3vs3 ($p = .008$)
Successful pass	3.7 ± 1.5	4.7 ± 1.2	3.3 ± 0.9	13.491	.002	.442	3vs3 vs. 2vs2 ($p = .040$) 3vs3 vs. 4vs4 ($p = .005$)
Unsuccessful pass	0.3 ± 0.2	0.3 ± 0.2	0.4 ± 0.2	0.996	.332	.055	
Stealing	0.2 ± 0.2	0.5 ± 0.4	0.2 ± 0.1	0.001	.970	.000	
Turnover	0.4 ± 0.3	0.7 ± 0.5	0.5 ± 0.2	1.046	.321	.058	

Table 3 Emotional responses in different small-sided games

	Mean ± *SD*			Analysis of variance			
Response	2vs2	3vs3	4vs4	*F*	*p*	η_p^2	Post-hoc
Happy	3.1 ± 0.9	4.3 ± 0.8	3.2 ± 1.0	20.949	< .001	.552	3vs3 vs. 2vs2 (*p* = .002) 3vs3 vs. 4vs4 (*p* = .008)
Anxious	1.7 ± 0.9	2.1 ± 1.1	1.9 ± 0.9	0.345	.565	.020	
Dejected	2.7 ± 0.8	1.8 ± 0.6	2.0 ± 0.6	4.918	.040	.224	3vs3 vs. 2vs2 (*p* = .011)
Energetic	2.5 ± 0.8	3.9 ± 2.9	3.2 ± 1.4	3.432	.081	.168	
Fatigued	4.2 ± 0.9	3.3 ± 0.8	3.1 ± 0.6	11.845	.003	.411	2vs2 vs. 4vs4 (*p* = .009)
Angry	1.7 ± 0.7	2.1 ± 1.3	1.8 ± 0.8	0.036	.852	.002	
Excited	2.2 ± 1.4	2.8 ± 1.2	2.3 ± 1.0	0.094	.763	.005	

Discussion

SSGs, often called skill-based conditioning games or game-based training, train athletes for various sports, particularly basketball (Arslan et al., 2022). During small-sided games, players are affected by various psychological factors such as enjoyment, mood, motivation, and mental fatigue leading to negative cognitive activity (Arslan et al., 2022; Fortes et al., 2022; Sansone et al., 2020). Also, SSG put players under pressure to work hard and always pay attention and increase physiological demands and cognitive requirements, as well as the amount of weariness players experience in basketball (Klusemann et al., 2012).

Psychological responses

RPE values are highly correlated with heart rate (HR) values. It is an efficient measurement tool providing a more practical and low-cost solution to monitor the internal training load in young players (Scantlebury et al., 2017). In the current study, according to the RPE results of basketball-specific SSG played on the full court, the perceived difficulty in 2vs2 SSG is higher than in other SSG. Factors such as court size and the number of players during the game can manipulate psychophysiological demands such as HR and RPE (Castagna et al., 2011). In the literature, few find RPE load responses of young female basketball players in different SSG. According to the basketball game results played on the same field, the results show that the training intensity increases as the number of players decreases (Castagna et al., 2011). Similarly, Klusemann et al. (2012) reported a higher RPE load in 2vs2 than in 4vs4 SSG in young elite female and male basketball players. Unlike these studies, RPE responses of female basketball players tend to be higher in large game formats compared to small game formats (Clemente et al., 2021). Due to the game structure, SSG put players under pressure, expose them to high-intensity movements, and cause severe physiological stress (Atlı et al., 2013). Results revealed that an SSG, including fewer players playing on the full court, increases training internal load due to both court size and game structure. Coaches can include these game structures in their training plans to meet the physical and physiological needs of the players.

PACES-S responses showed that players enjoyed the 3vs3 game more. Firstly, studies on young female basketball players and half-court SSG revealed no such result. However, Sansone et al. (2020) reported no change in the enjoyment response for male basketball players in 3vs3 half-court SSG played in different tactical and training regimes. On the contrary, Arslan et al. (2022) emphasized that young male basketball players enjoyed SSG training more than HIIT training. In addition, SSG training would have positively affected technical skills and increased commitment. Similarly, studies in football have shown that SSG provide more enjoyment than HIIT training (Los Arcos et al., 2015). Recent studies (Arslan et al., 2020, 2022) have also stated that positive emotions such as enjoyment are associated with games with the ball and training efficiency increases. However, fewer players, such as 2vs2, increased the training load (Conte et al., 2016; Klusemann et al., 2012), and the number of players decreased the average HR responses (Hill-Haas et al., 2009). Different small-sided game formats provide high internal loads with the 2vs2 game and the 4vs4 game with the low game load. Therefore, the 3vs3 game style can be an enjoyable and efficient strategy for young female basketball players during SSG.

The findings of our study showed no significant difference in mental fatigue values. Similarly, it was determined that there was no difference in the mental fatigue effect in 3vs3 SSG with different training regimes and game tasks in basketball (Sansone et al., 2020). Mental fatigue is a psychobiological condition which reduces athletes' performance and causes negative psychophysiological and cognitive responses (Cao et al., 2022; Soylu & Arslan, 2021). A recent study stated that SSG could provide an ecological situation to determine whether mental fatigue occurs (Soylu et al., 2022). Recently, different studies have been conducted on various aspects of basketball performance, such as the effect of mental fatigue on decision-making, visual motor skills (Faro et al., 2022; Fortes et al., 2022), free throw (Filipas et al., 2021), and SSG (Moreira et al., 2018). Mental fatigue modulates the increase in testosterone and alpha-amylase, which may be related to the mistakes made by players during SSG by impairing technique (Moreira et al., 2018). Therefore, in our study, although

different player numbers caused different physical loads, it was observed that decreasing and increasing the number of players did not cause any mental fatigue.

Another important finding of the current study, which is limited in the SSG literature on basketball, is the emotional responses of different SSG. In the 2vs2 game, players felt the feelings of being dejected and fatigued more, and they were happiest in the 3vs3 game. As previously stated, game intensity increases when the number of players decreases, especially in 2vs2 SSG (Castagna et al., 2011; Conte et al., 2016; Klusemann et al., 2012). However, it has been reported that perceived exertion in SSG is significantly related to mental fatigue (Sansone et al., 2020). This result shows that as the internal strain increases with the game's intensity due to the decrease in the number of players, the pleasure taken from the game decreases and fatigue increases. The fact that the game in which the players felt the happiest was 3vs3 also proves our previous enjoyment findings.

Technical responses

The technical results of the study showed that rebounding, successful shooting, and unsuccessful shooting in 2vs2 SSG and successful passing in 3vs3 SSG are significantly different compared to other game formats. No significant difference was found in unsuccessful passes, steals and turnovers. Considering the physical, physiological and cognitive aspects of the game that are specific to competition, it is essential to monitor technical-tactical skills (Conte et al., 2016; Klusemann et al., 2012). In addition, determining the effect of SSG on technical demands will enable coaches to better plan and implement skill-based training programs (Klusemann et al., 2012). The results of a study conducted on young female basketball players in SSG with different numbers of players showed that more successful passes were made in SSG with fewer players (3vs3). However, there was no statistical difference between unsuccessful and successful passes. Also, there were more successful and unsuccessful shots in 2vs2 than in 4vs4 SSG, but there was no statistical difference in the percentage of shots. Therefore, the number of players involved in the game is an important variable that can change the number of passes and shots but not their effectiveness (Conte et al., 2016). A study of young female basketball players found higher values in total successful and unsuccessful passing and ball-catching actions in the SSG played without dribbling compared to the standard game (Conte et al., 2015). Sansone et al. (2020) stated that short-interval games contain more technical actions than long games for male players. In another study, SSG positively affected defense and shooting skills (Delextrat & Martinez, 2014). Similarly, the number of technical actions in games with fewer players increased significantly more than in games with more players (Clemente et al., 2020). It was observed that the increase in the number of players in the full-court and SSG limited the technical activities of the players. It can be stated that this is due to the fast game structure of basketball and the limitation in offence time.

Limitations of the study

Although our study has some limitations, future studies on a larger sample will provide improved results. Also, an objective measure of the internal and external load was not used. HR monitors and blood lactate concentrations help establish associations with physical fitness status. Coaches can design short- and long-term plans for players' developmental stages by expanding scientific understanding in this field. Also, the information regarding the sample size in some studies prevents conclusions from being generalized. As one of the few studies in women's basketball, the trends presented by our study can nevertheless be used as a guide to help coaches create assignments and practice conditions that can improve players' learning.

Conclusions

In conclusion, this study investigated the impact of small-sided games (SSGs) on the technical and psychological responses of players. The findings revealed that varying SSG formats have distinct effects on players' RPE, enjoyment, and technical performance. Participation in 4vs4 SSGs resulted in a lower RPE than in 2vs2 SSGs, and integrating 4vs4 SSGs could effectively manage players' physical intensity during training sessions, promoting a balanced workload and power. Researchers propose that future investigations explore specific emotions during SSGs, such as anxiety, energy, anger, and excitement. A deeper understanding of these emotions may offer valuable insight into the psychological aspects of player engagement. Based on this study, coaches are encouraged to tailor SSGs according to team size and individual preferences and characteristics. This customization optimizes players' RPE, enjoyment, and technical performance, thus contributing to a more effective and personalized training approach.

Conflict of interest

The authors report no conflict of interest.

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