

Acute effects of bout duration in small-sided games on physiological and kinematic responses

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Abstract

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This study was conducted to investigate the responses of 4 × 6 minute (min) matches to 6 × 4 min small sided games (SSG) on heart rate (HR), perceived exertion rates (RPE), enjoyment, total distance covered and technical abilities in young soccer players. The SSG took place separately with a 4v4 format on a 25 × 32-sized field, 4 × 6 min bouts, and 6 × 4 min bouts. Twenty-four amateur soccer players (age = 16.83 ± 0.381 years; height= 175.83 ± 6.75; weight: 66.21 ± 7.19; body mass index; 21.36 ± 1.36) participated in the study voluntarily. Based on the study results, 6 × 4 min SSG was higher than 4 × 6 min SSG of the RPE response and successfully passed the technical ability results (p<0.05). There was no significant difference in HR, enjoyment, total distance covered, and unsuccessful passes (p>0.05). The findings of this study emphasize that a 6 × 4 min SSG is more effective than a 4 × 6 min SSG in RPE and successfully passes the technical abilities of soccer players. Therefore, coaches may prefer short bout matches in SSGs to significantly increase the training load and successfully pass technical performance.

Introduction

The game of soccer demands many physiological, biomechanical, technical, tactical, and psychological elements to be considered in match play and training schedules (Aguir et al., 2012; Diaz-Ochoa et al., 2023). Small-sided games (SSG) are used in training programs because they repeat these requirements at the same level as in a soccer match (Gabbett et al., 2009; Hill-Haas et al., 2011; Katis & Kellis, 2009). SSG training is a multifunctional method used by coaches, especially in team sports, to simultaneously improve athletes' technical, tactical, physical, and psychological skills while exposing them to a competitive environment (Farhani et al., 2022; Gonçalves et al., 2016; Moran et al. 2019; Arslan et al., 2021; Soyulu et al., 2022).

Different field sizes, numbers of players, duration bouts, formats, and rules are used in SSG (Halouani et al., 2014; Köklü et al., 2011; Köklü et al., 2015; Arguz et al., 2023; Aktas et al., 2014). Different SSG formats and task manipulations given to players can allow players to reach the desired effort level in their technical, tactical, physiological, and cognitive development (Junior et al., 2023; Hammami et al., 2018). Therefore, coaches must know how and when to appropriately structure SSG training to achieve the stated practice goal (Mallo &

Navarro, 2008). The duration of bouts in SSG is crucial in constructing a training program as it influences the allocation and intensity of the drills employed (Fanchini et al., 2011). Previous studies have indicated that running distance, heart rate (HR), enjoyment, rating of perceived exertion (RPE), and technical characteristics are influenced by differences in SSG bouts (Alcantara et al., 2021; Farhani et al., 2022; Köklü et al., 2017; Esqueda et al., 2021; Fanchini et al., 2011; Casamichana et al., 2013).

Alcantara et al. (2021) found in their study of a SSG game played for different bouts of time that 4 × 5 minutes (min) were higher than 2 × 10 and 1 × 20 min in total distance covered, 1 × 20 min were higher than 4 × 5 and 2 × 10 min in RPE, 4 × 5 min higher than 1 × 20 min in ball involvement. There were no significant differences in the technical parameters of this study: successful passes, unsuccessful passes, contact with the ball, goals scored, shots on target, and unsuccessful shots (Alcantara et al., 2021). In another study, 1 × 12 min SSG enjoyment, successful passes, and %HRpeak results were higher than 2 × 6 min, and 3 × 4 min in 4v4 and 3v3 SSGs, and 3x4-min RPE responses were higher than 1 × 12 and 2 × 6 min in 4v4 SSG (Farhani et al., 2022). Köklü et al. (2017) stated that 6 × 2 min

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%HRmax responses were lower than 2 × 6 min, 6 × 2 min total distance covered result higher than 2 × 6 min and 6 × 2 min RPE responses were higher than 2 × 6 min bouts duration in 2v3, 3v3, 4v4 SSG.

The findings are considered; it becomes clear that limited research has been conducted on different bouts of SSGs. In this context, this study aimed to investigate the effects of 4v4 games played for 4 × 6 SSG and 6 × 4 min SSG on heart rate (HR), ratings of perceived exertion (RPE), enjoyment, and technical ability.

Methods

Participants

Twenty-four amateur soccer players playing as active licensed players in the 2023-2024 season (age = 16.83 ± 0.381 years; height= 175.83 ± 6.75; weight: 66.21 ± 7.19; body mass index; 21.36 ± 1.36) participated in the study. All players were instructed to abstain from physical activity for two days and from eating for at least three hours before the games. The study protocol adhered to the ethical guidelines for human testing articulated in the Declaration of Helsinki with subsequent modifications. The research was conducted following the Declaration of Helsinki, enabling it to be approved by the Research Ethics Committee (2024/21216).

Procedure

This research was conducted during the 2023-2024 soccer pre-season. The SSG took place separately with a 4v4 possession format on a 25 × 32-sized field, 4 × 6 min bouts, and 6 × 4 min bouts. This study examined heart rate (HR), running distance, rating of perceived exertion (RPE), enjoyment and successful and unsuccessful pass outcomes in the game.

Measurements

Heart Rate Monitor and Motion Analysis System

Polar M430 (Polar Electro Oy, FI-90440 Kempele, Finland) was used to ascertain players' heart rates (HR) during the games. This special equipment can record the pulse and also measure the pulse from the wrist. In addition, it can calculate the distance covered during matches.

Rating of Perceived Exertion (RPE)

The players' subjective perception of their effort, known as the Rating of Perceived effort (RPE), was evaluated after each session of the Small-Sided Games (SSGs) using a reliable 20-point scale. This assessment was

conducted to establish the internal training intensity, as described by Foster et al. (2021). Impellizzeri et al. (2004) conducted a study that established the validity and reliability of this scale in order to measure the level of effort that was being exerted. A standardized question ("How was and how did you feel the exercise?") was employed to maintain consistency. To prevent any potential bias, the participants were asked to offer their replies individually and were familiarized with the scale beforehand. This approach increased the dependability of their answers.

Enjoyment Scale

The Exercise Enjoyment scale created by Raedeke (2007) was created from the 8-item short form of the 18-item Physical Activity Enjoyment Scale developed by Kendzierski and DeCarlo (1991). The Turkish version was adapted by Soylu et al. (2023) for young and adult athletes. Participants used a 1–7 Likert measure to rate how much they enjoyed the exercise routine. They did this during intervals between sets and at the end of the session. Players were asked during games, "How do you feel about exercising right now?" Participants were asked to answer this question. The scale was developed to determine how much one enjoys physical activity during and immediately after physical activity.

Technical Analysis

The games were recorded using two high-definition video cameras to analyze the technical actions that occurred during the games. The games were analyzed using a soccer-specific analytic application called e-Analyze Soccer (developed by Espor Digital Ltd. Inc. in Ankara). Successful passes, unsuccessful passes, winning balls, losing balls, successful shots, and unsuccessful shot technical parameters are included in the analysis. A certified match and performance analysis coach with extensive training, experience, and expertise evaluated the technical activities. The analysis was conducted by only one coach.

Data Analyses

Descriptive values are presented as mean ± standard deviation (age = 16.83 ± 0.381 years; height= 175.83 ± 6.75; weight: 66.21 ± 7.19; body mass index; 21.36 ± 1.36). The Kolmogorov-Smirnov test confirmed a normal distribution. An independent-sample t-test was performed to compare physical performance test variables in 4-minute and 6-minute bouts. Effect sizes (Cohen's d) were calculated for each outcome variable using established thresholds: 0.2 = trivial effect, 0.6 = small effect, 1.2 = moderate effect, 2.0 = large effect, and

> 2.0 = very large effects (Hopkins et al., 2009). Data analysis was performed using IBM SPSS Statistics version 26 (IBM Corporation, Armonk, NY, USA).

Results

Table 1 shows that RPE and successful passes were significantly higher in 6 × 4-min SSG games than in 4 × 6-min bouts SSG. There were no significant differences in HR, enjoyment, distance covered, or number of unsuccessful passes.

Discussion

The study findings indicate that the 6 × 4 min bouts of SSGs had a more significant impact than the 4 × 6 min bouts of SSG on RPE and successful technical ability. There was no significant difference in HR, enjoyment, total distance covered, or number of unsuccessful passes.

The results of the study show 6 × 4 min bouts RPE result higher than 4 × 6 min bouts RPE in 4v4 SSG. In a similar studies, 6 × 2 min bouts RPE responses higher 2 × 6 min bouts in 2v2, 3v3, 4v4 SSG (Köklü et al., 2017), 3 × 4 min RPE responses higher than 2 × 6 min in 3v3 and 4v4 SSG (Farhani et al., 2022). Köklü et al. (2017) stated that technical activities such as contact with the ball and the number of tackle may occur more in short bout duration than long bout duration, and this may increase RPE values. In our study, successful passing technical skill results in 6 × 4 min bouts were found to be higher than 4 × 6 min bouts results. Therefore, RPE responses can be higher in 6 × 4 min bouts.

Although the HR results of 4 × 6 min bouts of SSG were higher than those of 6 × 4 min bouts of SSGs, the

difference was not statistically significant. In similar studies, no significant difference between 1 × 16 min, 2 × 8 min, and 4 × 4 min bouts in 5v5 SSG (Casamichana et al., 2013) and 3x6-min bouts HRmean and HRpeak responses higher than 6 × 3 min bout in 4v4 SSG (Esqueda et al., 2021) outcomes were observed. Contrary to this findings Köklü et al. (2017) stated 2 × 6 min bouts %HRmax responses higher than 6 × 2 min bouts in 2v2, 3v3 and 4v4 SSG (Köklü et al., 2017), Casamichana et al. (2013) stated that the recovery time between intermittent SSG may reduce the HR values in subsequent intervals. These results show that contrary to our findings, long bout SSG provide a higher HR response than short bouts SSG.

Regarding our study's findings, no significant differences were observed in enjoyment. Few studies have examined how the duration of small-sided games affects enjoyment. A study result shows that 1 × 12 min enjoyment results are higher than 2 × 6 min and 3 × 4 min enjoyment results in 4v4 and 3v3 SSG (Farhani et al., 2022). Long-bout SSG can be more enjoyable because they require more technical demands than short bouts of SSG. Technical movements enable soccer players to demonstrate their abilities and capabilities. Soccer players can have a feeling of mastery by effectively executing technical skills such as passing and dribbling. This may increase the players' enjoyment.

The total distance covered in 4 × 6-min bouts of SSG was higher than 6 × 4-min bouts, but the difference was not statistically significant. In 4 × 6 min SSG, athletes can be more motivated due to shorter rest periods and long bout duration. This may encourage them to cover more distance each set compared to 6 × 4 minutes SSG.

Table 1

HR, RPE, Enjoyment, Distance and Technical results of soccer players to 4x6 minute Bouts SSG and 6x4 minute Bouts SSG conditions.

Variables	4x6 min Bouts SSG	6x4 min Bouts SSG	Mean Difference	%95 CI	<i>p</i>	Cohen <i>d</i>	Descriptor
	Mean ± SD	Mean ± SD					
Distance covered	486.79 ± 5.71	482.35 ± 5.59	4.44	-8.19 – 17.03	0.472	-	-
HR (beat·min ⁻¹)	175.48 ± 2.07	173.98 ± 9.74	1.5	-4.69 – 7.68	0.622	-	-
RPE	13.27 ± 0.31	14.10 ± 0.29 *	-0.83	-1.11 - -0.56	0.000*	-2.77	Very Large
Enjoyment	39.83 ± 1.66	39.78 ± 1.62	0.05	-4.32 – 4.42	0.981	-	-
Successful pass	4.13 ± 0.19	5.17 ± 0.19 *	-1.04	-1.55 - -0.54	0.000*	-5.47	Very Large
Unsuccessful pass	1.92 ± 0.16	2.08 ± 0.21	-0.16	-0.66 – 0.33	0.491	-	-

HR: Heart Rate; RPE: Rating of perceived exertion; SSG: Small Sided Games; Min: Minute.

*: Significant difference.

In a study similar to our findings, 3×6 min SSG total distance covered was higher than 6×3 min SSG (Esqueda et al., 2021). Another study found no significant differences between 1×24 min and 4×6 min SSG for total distance covered (Hill-Hass et al., 2009). Contrary to these results in other studies, 4×5 min SSG was higher than 2×10 min and 1×20 min SSG (Alcantara et al., 2021), 6×2 min SSG total distance was higher than 2×6 min and 1×12 min SSG (Köklü et al., 2017) in total distance covered. Rest intervals between sets in short bout SSG result in an overall increase in the total duration of rest. This may provide athletes with more recovery opportunities, enabling them to cover more running distances.

Considering technical performance, the 6×4 min SSG was higher than the 4×6 min SSG in a successful pass. No significant differences were observed in the number of unsuccessful passes. Short bout SSG provides athletes with more opportunities for recovery due to more recovery time. Moreover, increased rest periods can reduce athletes' fatigue, allowing them to perform technical skills more precisely. Therefore, it is possible that more passes were successful in 6×4 min SSG. Contrary to our findings, another study showed that in successful pass results, 1×12 min results were higher than 2×6 min and 3×4 min results in the 4v4 SSG (Farhani et al., 2022). Fanchini et al. (2011) stated that there was no significant difference in successful and unsuccessful passes between 3×2 min, 3×4 min, and 3×6 min in 3v3 SSG. The fact that the number of sets remained constant while the bout times increased may have caused inconsistency in terms of SSG design. This might result in a decline in athletes' focus and lead to inconsistent results in passing performance. In another study, no significant difference was seen between 4×5 min, 2×10 min, and 1×20 min SSG (Alcantara et al., 2021). Since players have longer rest intervals in short bout SSG and it may allow players to recover. In this way, technical adaptation can be better and successful technical actions can be realized. Alcantara et al., (2021) stated that as match time increases during SSGs, ball participation per player decreases. Overall, it seems that there are different results in the effect of different bouts SSG on technical performance. Therefore, a general opinion can be provided with new studies.

The results of this study should be evaluated considering some limitations. First, the research participants were young soccer players with amateur experience. Therefore, the results may not apply to people of different ages, skill levels, or competition

types. Second, only the psychological and technical responses of the 4×6 min SSG and 6×4 min SSG 4v4 games were used in the study. The results may not completely reflect the impact of physiological and kinematic factors. Third, only short bout acute responses were evaluated in this study.

Conclusion

In conclusion, 6×4 min bouts RPE and successful pass responses were significantly higher than 4×6 min bouts in 4v4 SSG. There was no significant difference in HR, enjoyment, total distance covered, or unsuccessful passes. Short bout SSG provides athletes with more opportunities for recovery due to more recovery time. Thus, players' technical adaptations can be better and technical activities such as successful passes can be executed with more precision. As level of technical activities increase, the movement activity intensity of the players also increases. This can also increase players' RPE response. It has been observed that 6×4 min bouts increase the number of successful passes and RPE more than 4×6 min bouts. However, although there was no significant difference, 4×6 min bouts distance and HR responses were higher than 6×4 min bouts in 4v4 SSG. According to these results, coaches can use 6×4 min bouts SSG to improve passing success and increase RPE, and 4×6 min bouts SSG to increase distance covered and HR responses while determining the structure of small-field games.

Authors' Contribution

Study Design: OY; Data Collection: OY; Statistical Analysis: OY; Manuscript Preparation: OY; Funds Collection: OY.

Ethical Approval

The study was approved by the Osmaniye Korkut Ata University Ethical Committee (2024-21216) and it was carried out in accordance with the Code of Ethics of the World Medical Association also known as a declaration of Helsinki.

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Conflict of interest

The authors hereby declare that there was no conflict of interest in conducting this research.

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