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TECHNOSCIENCE ARTICLE

Acute Effects of 3vs3, 6vs6 and 11vs11 Games on Physical Conditioning and Game Actions of Young Soccer Players

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Key words: Sport technique, Small-sided, Jump Agility

Abstract

Twelve competitive male young soccer players participated in this study. Four different field tests, 30 meters sprint, long passes, agility, horizontal jump were applied to the participants; before, between and after the games for measuring performance. It was observed that heart rate (HR) values were higher at 3x3 small-sided games compared to 6x6 small-sided games and 11Vs11 games. Despite shorter passes, long passes, heading and tackling behaviours on 6x6 and 11Vs11 games exhibited by athletes, during 3x3 games shooting, dribbling and goal numbers were significantly higher. Speed and agility values showed a significant decrease after 3x3 small-sided games. In addition, significant changes were observed on horizontal jump values after 6x6 small-sided games. We found 3x3 small-sided games provided higher stimulus than 6x6 small-sided games in terms of physical condition and technical development of young soccer players.

Introduction:

Soccer is a team sport, which requires highly developed aerobic fitness, and quick recovery among the high intensity runs during the whole game (Bishop & Spencer, 2004). It is determined that elite soccer players cover a total distance of 10-12 km during each match and perform 1200 short distance and powerful activity in every 3 to 5 seconds, including 30-40 tackles and jumps, more than 700 turns and 30 to 40 sprints (Bishop *et al*., 2004; Iaia *et al*., 2009; Mohr *et al*., 2003). Moreover, it is well known that conditioning parameters and the capacity of performing soccer actions decrease as the end of the game approaches. This underlines the importance of fatigue management for entire game performance (Mohr *et al*., 2003; Kelly & Drust, 2008; Katis & Kellis, 2009). In the last two decades, modern coaches have been looking for training alternatives, which may concurrently improve the physical, technical, and tactical capacities of players (Dellal *et al*., 2011) as there is limited time between the games to improve all abilities on time.

Although soccer is played with ten players and one goalkeeper per team in 105m x 68m pitch, training is usually performed with less number of players (with or without a goalkeeper) on reduced pitch areas according to periodization day. These soccer-specific training are known as small-sided games (SSGs), which filled an important place in modern football training to develop athlete's technical, tactical, physical, motor skills and sports-specific physiological capacities simultaneously (Rampinini *et al*., 2007, Aguiar *et al*., 2012, Dellal *et al*., 2011, Akdogan *et al*., 2021). Therefore, it meets the expectation of the coaches to manage the fatigue of the players during the in-season.

The physiological response observed in SSGs changes in terms of playing conditions; which can lead to improvements in both the aerobic and anaerobic physical match performance of players (Helgerud *et al*., 2001; Dellal *et al*., 2012). One of the important determinants of the training load, the heart rate response of adult soccer players may differ depending on the feature of the game (size, number of players etc.) and can reach around 85-95% of maximal HR (HRmax) (Dellal et al., 2008; Impellizzeri et al., 2006). Hill-Haas *et al*. (2009) stated that HR and blood lactate concentration increased significantly in 2vs2 than 4Vs 4 and 6Vs6 when the relative pitch size was the same. In another study, Katis & Kellis (2009) concluded that 3vs3 games required higher stimulus for higher exercise intensity compared to 6Vs6 games for the players. Impellizzeri *et al*. (2006) examined the comparison of the effects of specific (small-sided games) Vs generic (running) aerobic interval training on physical conditioning and game movement actions in soccer. It was reported that there were significant improvements in aerobic

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conditioning and game performance in both experimental groups. This suggests that small-sided games-based training should ensure the activation of muscle groups as they are engaged during the actual matches.

Furthermore, SSGs are also important as they increase the number of ball contacts and the total distance covered in the case of sprinting, acceleration and deceleration abilities. Therefore, as technical and tactical skills are involved and trained in conditions similar to the actual match, the players could overcome the difficulties, which they face during the real match environment (Dellal *et al*., 2011). For these reasons, the inclusion of small-sided games into soccer training is quite common in soccer clubs at all age levels. In the literature, only Katis & Kellis (2009) analyzed the effects of SSGs (3Vs3, 6Vs6) on physical conditioning and performance in young players (13 years). The effects of 3vs3, 6vs6 and 11vs11 games on physical and technical movement actions have not been studied with young (over U16) players.

Deriving from the information stated above, the aim of this study was to examine the technical movement actions performed during 3Vs3, 6Vs6 and 11vs11 first, and then, to find out their effect on a series of field endurance and technical tests of youth soccer players.

Methodology:

Twelve competitive male soccer players (age 16.5±0.5 years, height 175.16±4.74 cm, body mass 64.25±2.34 kg) from U-17 team of the same professional club, participated voluntarily in this study. Players regularly completed five training sessions a week besides three competitive games. A typical training session includes a general warm-up, small-sided games, the practice of formal game situations and cool down. To be included in this study, athletes had to be actively competing and training soccer for more than five years, without sustaining injuries in the previous 6 months. Along with the club authorization, institutional review board approval for our study was obtained, and all subjects (and their parents or guardians for those under 18 years of age) were carefully informed about the experiment procedures and about the possible risk and benefits associated with participation in the study, and they were all asked to sign the consent form before the tests were performed. The study was approved by the Ethics committee of Anadolu University (42121 protocol number).

This study was started with anthropometric measurements, this was followed by the Yo-Yo intermittent recovery test to identify athletes' maximal heart rates (MHR) and distance covered. In order to quantify HR values obtained in each small-sided game, HRmax values were referred. Therefore, subjects within each team were matched in accordance with their distance measured by Yo-Yo IR 1 test, and the technical/tactical skill level of each player was defined by the coaches of the team.

Two days before the main measurements, the participants were asked to refrain from any vigorous exercise. The protocols were performed during the last month of the competition season in an outdoor field with artificial grass at the same time of the day (total 13 days) in order to avoid circadian effects. The size of the pitch was 40x20m for 3x3, 40x40m for 6x6 and 100x65m for 11x11. Games were played with the goalkeeper in the form of a free game. It was considered that only 6 participants could participate in 3x3 games at once. Therefore, 3x3 games were played as two groups in order to match the total number of players 12. There was trainer encouragement from the sideline during the games (Rampinini et al., 2007). 11vs11 games were played against a team of local best-selected players in the same age group from different teams. Only one player played in the opponent team to gather data. The study was designed regarding duration rules of the Turkish Football Federation U-17 Elit League category (40 x 2 = 80 minutes, 15 minutes half time).

Table 1. Test and interventions protocol for 3vs3, 6vs6 and 11vs11 in Horizontal Jump Agility (HJA); Long Pass 30m sprint (LPS)

TBfI		Set (1-5)	R/R (min)	TBtI		Set (1-5)	R/R (min)	TAI
HJA	3vs3 6vs6	5	4 x 4	HJA	3vs3 6vs6	5	4 x 4	HJA
LPS	11vs11	1	1.half 40 min	LPS	11vs11	1	2.half 40 min	LPS
Total								

TBfI- Test Before Intervention; TBtI- Test Between Intervention; TAI- Test After Intervention; R/R- Repeated/Rest

Horizontal jump, agility, long pass, 30 meters sprint tests were performed in order before, between and after, 3x3 and 6x6 small-sided games. 5 sets of 3x3 and 6x6 small-sided games (totally 40 minutes) were performed twice (4 minutes game, 4 minutes rest), and they were given a 15-minute rest as half time. For 11vs11 games were played in the form of two halves lasted 40 minutes and 15-minute halftime, and the same test protocol was followed. Test between interventions was performed at the beginning of the rest period in the same order (Table-1). All measurements were taken 2 times and the best performances were recorded.

Participants were permitted for liquid intake after the 5th and 10th sets regarding the procedure during 3x3 and 6x6 small-sided games. As for 11x11 games, they were permitted for it at the half times and after the games. Heart rate telemeters (Polar Team System) were attached to the chests of participants to transfer data to monitor during the games. Heart rate values of participants were recorded for 10 sets on 3x3 and 6x6 small-sided games. Since 11x11 games were played for 80 minutes they were divided into 10 and equalized into set numbers. Heart rate values of participants during the 3x3, 6x6 and 11x11 games were examined on 10 sets. After each set, heart rate values were evaluated in themselves individually, and no inter-set evaluation was made.

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During the games, seven different technical action values were studied. These technical actions were; long pass (longer than 10 meters), short pass (shorter than 10 meters), dribbling (at least 2 meters), tackling (tackle the ball from opposition player), heading (positions which ball contact with head), shooting (kicks with the purpose of scoring) and goal (states which ball cross the goal line). Identification of the number of each technical action was made through the camera record system (Sony HDRPJ670B.E35). To determine pass distance, signboards were used while designing the game area. Size measurements were made with a handled meter (First Master Tracker). Cohen Kappa (?) statistics were used for the reliability of technical action data on 3x3, 6x6 and 11x11 games. While 3x3 and 6x6 small-sided games were created with players from the same team, 11x11 games were played against players from Eskisehir U-17 league.

Field tests

Yo-Yo Intermittent Recovery Tests (Yo-Yo IR1) : it was applied on synthetic grass fields. The Yo-Yo IR1 consisted of 2x20-m shuttle runs, which were back and forth between the starting, turning, and finishing lines, and progressively increased speed was controlled by audio bleeps from a tape recorder. Prior to the test, the subjects performed a standardized warm-up, as described by Krustrup *et al.* (2006). The tape (Yo-Yo tests, HO + Strom, Denmark) was calibrated before every trial, and the procedures were identical to those previously described and suggested by Bangsbo *et al.* (2006). The HR data of the players were collected by Polar Team2 (Polar Electro Oy, Finland) transmitters on chest plates that can send data every 5 seconds. The highest HR during the test was recorded as Hrmax.

Horizontal Jump Test: each participant was instructed to perform a maximum horizontal jump. The participant started from a standing position placing both feet just behind the starting line. After several preparatory standing movements, a horizontal jump with freehand contribution was performed. The distance from the starting line to the heel of the rear foot (to the nearest 0.5 cm) was recorded (Katis & Kellis 2009).

Agility Test: smart speed (Fusion Sport) photocell systems were used to record 20 meters of zigzag agility and 30 meters of sprint test. The subjects performed a zigzag agility test 2 times on a synthetic pitch. There was a recovery period of 3 minutes between each trial. The fastest time was recorded as a zigzag agility test score. The zigzag agility tests course consisted of four 5-m sections set out at 100?angles (Köklü *et al.*, 2015).

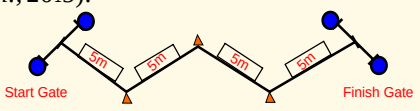
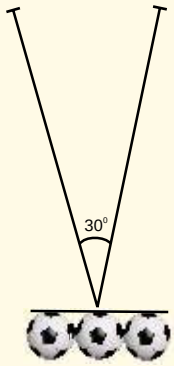


Figure-1: Zigzag agility test.

Long Pass Test (Kick test): the goal was to make a single stroke forward from the determined point within the field. Marking caps were placed at a distance of 5 meters from the starting point of the stroke. The starting point and the point where the ball falls was calculated in meters. Under the outgoing, head height strokes were counted as successful kicks. Each volunteer received 2 measurements and the best grades were recorded.



As shown in Fig.-2, subjects were given two chances to kick the ball as far as possible. The longest distance was recorded, and the angle of the kick was limited to 30 degrees. The subject was given two kicking chances, and the longest kick was recorded (Joo & Seo, 2016).

Figure-2: Kicking skill test was supposed to kick a ball as far as possible with two chances.

30 m Sprint Test: Smart speed (Fusion Sport) photocell systems were used to record 20 meters zigzag agility and 30 meters sprint test results Short-sprint performance was evaluated over 30-m distances on synthetic fields. Time was recorded using Smart speed (Fusion Sport Pty Queensland, Australia), with photoelectric cells placed at 0.30 m distances. The photocells started capturing measurements just as participants started their run behind the first photocell and did the same at the 30th meter. Then, it sent the data to a computer, and the data were saved as seconds. As Svensson & Drust (2005) suggested, a 30-cm head start was given before the start line. Players were given 3-minute breaks among three sprints. Only the best performance over three trials was considered.

To find out the normality and sphericity of the data, the Shapiro-Wilk test and Mauchly's Sphericity test were applied. One Way ANOVA was used regarding the existence of parametric assumptions; unless the parametric assumptions were met Freidman One Way ANOVA test were used. To determine the significance between parameters, the Bonferroni Post-Hoc test among parametric tests, and the Wilcoxon Two-Sample Test among non-parametric tests was used. As for the reliability of technical action data, Cohen Kappa (?) statistics were used. The significance level was =0.05 in statistical analyses.

Result

The highest HR value emerging on Yo-Yo IR1 test was accepted as the HRmax of the player. Significant differences were recorded on 3vs3 small-sided games' % maximal heart rate values compared to 6vs6 and 11vs11 games ($p<0,05$). No significant difference was observed between games on 1st set. Significant differences were found on 3vs3 games compared to 6vs6 and 11vs11 games on the 2nd set ($p < 0.05$). Significant differences were recorded on 3vs3 games

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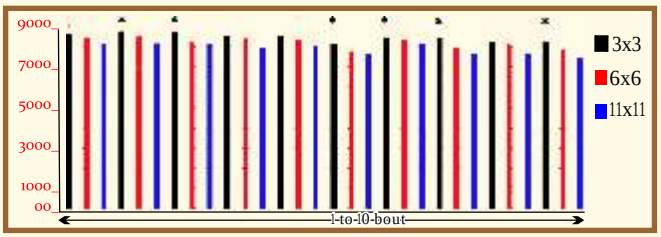
compared to 6vs6 and 11vs11 games on 3rd set ($p < 0,05$). No significant difference was observed between games on the 4th and 5th sets. Significant differences were recorded on 3vs3 games compared to 6vs6 and 11vs11 games on 6th set ($p < 0,05$). Significant differences were found on 3vs3 games compared to 6vs6 and 11vs11 games on 7th set ($p < 0,05$). There was a significant difference among 3vs3, 6vs6 and 11vs11 games in favour of 3vs3 games on the 8th set. No significant difference was recorded between games on the 9th set. But were recorded on 3vs3 games compare to 6vs6 and 11vs11 games on 10th set ($p < 0.05$) (Fig.-3).



*statistically significant in comparison with 6x6 and 11x11 ($p<0.05$)

Figure-3: Mean (±SD) percentage of maximum heart rate (HRmax) during the protocol for 3vs3, 6vs6 and 11vs11 situation.

6vs6 small sided games were showed significantly higher ($p<0,05$) long pass values compered to 3vs3 small sided games and 11vs11 games ($F = 7.342$; $p = 0.005$, $?2 = 0.391$). Higher number of short passes ($p<0,05$) were found in 11vs11 games compared to 6vs6 games ($F = 5.210$; $p = 0.001$, $?2 = 0.238$). Statistically lower number of dribblings were recorded during 11vs11 and 6vs6 games compered to 3vs3 small sided games ($F = 9.679$; $p = 0.016$, $?2 = 0.325$). There was a significant difference on heading numbers among 3vs3, 6vs6 and 11vs11 games ($p<0,05$). Higher number of headings were observed during 11vs11 games and 6vs6 games compered to 3vs3 games ($X2 = 18.667$; $P = 0.001$). No differences were observed in tackling numbers among 3vs3, 6vs6 and 11vs11 games ($X2 = 2.229$; $P = 0.001$). Lower number of shootings ($p<0.05$) were recorded during 11vs11 and 6vs6 games compared to 3vs3 games ($F = 54.089$; $p = 0.001$, $?2 = 0.724$). On 3vs3 games, goal numbers were found significantly higher ($p<0,05$) compared to 6x6 and 11vs11 games ($X2 = 17.684$; $P = 0.001$) (Fig.-4).

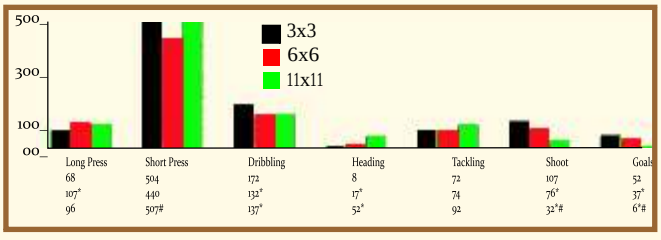


Figure-4: Total number of technical actions and scoring during 3vs3, 6vs6 and 11vs11 games

No differences were observed in horizontal jump values, among 3vs3, 6vs6 and 11vs11 before and after games ($F = 1.242$; $p = 0.308$, $?2 = 0.011$). There was a significant difference between pre-test, intermediate test and post-test results on 6vs6 small sided games ($p<0.05$). Lower values were observed on post-test results compared to pre-test and intermediate test results on 6vs6 small sided games ($F = 8.324$; $p = 0.002$, $?2 = 0.065$). No significant differences observed on 11vs11 horizontal jump values (Table-2).

Lower values were recorded ($p<0.05$) during post- test and intermediate test of agility compared to pre-test on 3vs3 small sided games ($F = 9.336$; $p = 0.001$, $?2 = 0.125$). No significant differences were found during pre-test, intermediate test and post-test of agility on 6vs6 and 11vs11 games ($p>0.05$).

No significant differences was seen on long pass values ($p>0.05$). Significant differences were recorded on 30 meters sprint test pre-test, intermediate test and post-test values on 3vs3 small-sided games ($p<0.05$). Post-test and intermediate test on 30 metres sprint revealed higher values compared to pre-test on 3vs3 small-sided games ($F = 11.778$; $p = 0.001$; $?2 = 0.105$). Pre-test, intermediate test and post-test of a 30-meter sprint on 6vs6 and 11vs11 games did not show any statistical difference compared to each other ($p>0.05$).

Table 2. Examination of field test values on 3vs3. 6vs6 and 11vs11 games through the time (pre. middle. post)

		Hori. Jump (cm)	Agility (sn)	Long Pass (m)	Sprint 30m (sn)
3vs3	Pre	2.3±0.15	5.45±0.15	49.82±8.48	4.25±0.13
	Middle	2.33±0.14	5.53±0.14*	48.86±5.62	4.31±0.12*
	Post	2.33±0.14	5.53±0.16*	47.36±3.57	4.35±0.13*
6vs6	Pre	2.34±0.15**	5.50±0.15	49.08±4.48	4.29±0.15
	Middle	2.34±0.17**	5.51±0.16	47.58±4.94	4.28±0.15
	Post	2.25±0.16	5.49±0.12	51.22±2.62	4.27±0.17
11vs11	Pre	2.37±0.14	5.68±0.22	47.35±3.64	4.40±0.14
	Middle	2.41±0.20	5.64±0.15	46.50±3.55	4.44±0.09
	Post	2.36±0.17	5.54±0.12	46.50±3.98	4.46±0.18

cm: centimeter; sn: second; m: meter; significantlevel : * with pre-test. **: with post test ($p<0.05$)

Discussion:

As it is known, football-specific training models are effective for developing basic motor and technical qualities (Russell *et al.*, 2011). SSGs in football are training models designed with respect to the age and capacities of athletes and develop physical and technical capacity and tactical skills for athletes. Trainers can determine rules, field size, number of players and load volume in a small-sided games training model. It is known that trainers usually prefer to change field size and number of players (Hill-Haas *et al.*, 2011). The purpose of small-sided games is to develop tactical skills besides technical skills; such as pass, dribbling, shooting (Katis & Kellis, 2009).

Owen *et al.*, (2011) compared to large sided games, athletes had higher maximal heart rates on small-sided games, they concluded that athletes reached their maximal heart rate values and maintained it longer on small sided games. The relevant literature that parameters such as the size of the game area, number of players, game durations and rules change the load volume of athletes (Köklü *et al.*, 2017; Sarmento *et al.*, 2018;

Sanchez-Sanchez *et al*., 2018; Arslan *et al*., 2020).

In our study, since 3x3 games were played in narrower areas with fewer players, athletes reached higher number of short passes compared to 6x6 small-sided games. However, the number of short passes showed similarity between 11x11 games and 3x3 small sided games. This result might be caused by the game mentality of trainers on 11x11 games. Colleterally long pass preferences were higher on 6x6 small-sided games compared to 3x3 small-sided games. The number of shoots was much more on 3x3 small-sided games than 6x6 small sided games and 11x11 games. The reason for this might be the small size of the game area providing players more opportunities for goal positions. The findings of present study are similar to those of previous studies. For example, Alcantar et al.2021 stated that, under-14 soccer players had significantly more successful passes, contacts with the ball, ball involvement, goals scored and shots on target during 3v3.

A statistically significant decrease in sprint and agility performances between and after 3x3 small-sided games was evidenced. It may be due to more fatigue created by 3x3 games compared to 6x6 and 11x11 games. GPS revealed there were more acceleration and deceleration moves and direction changes on 3x3 games (Hill-Haas *et al*., 2011) and that caused early fatigue creation via anaerobic load. Maximal heart rate results in this study also support findings of previous studies in terms of 3x3 games' being statistically higher. Reilly & Ball (1984) showed that continued dribbling moves increased perceived level of difficulty and blood lactate levels. The reason was specified as athletes needed more muscle activation during continued dribbling. Somehow our study strengthened the same. 3x3 small-sided games included more dribbling numbers; they increased intensity of training, athletes were exposed to more load and that affected agility and speed negatively. Moreno *et al.* (2020) found a significant difference in 20 m sprint between durations before and after the 4-a-side SSG.

Agility performance changes, depending on muscle strength, speed and balance skills (Cable, 1998). As per Kellis & Katis (2009) decrease in those parameters depends on fatigue level. Therefore, agility skills might be affected negatively after 3x3 small-sided games. In the 6x6 games, there was a decline in the horizontal jump performance, but in the 3x3 and 11x11 games, there was not a change of state. Horizontal jump performance is a product of muscle stretching-shortening mechanisms (Dintiman & Ward, 2003). This mechanism changes depending on sudden acceleration, declaration, vertical jump and sprint numbers. There was not any statistical significance between 3x3 small-sided games and horizontal jump. Gps technology could not be used as a limitation of this study. This state was not described since acceleration and deceleration numbers could not be evaluated.

Results of this study revealed that 3x3 small-sided games provide higher stimulus than 6x6 small-sided games in terms of physical condition and technical development, and it can be advisable for the education of young players. Recently content of football education has undergone serious changes. In the past, the training of the condition was carried out with isolated athletic activities, whereas, today, in the case of tactical periodicity, the technical and tactical training is integrated with the condition which is foreground in a training practice. When these research findings are combined with literature knowledge, 3v3 games can be proposed as anaerobic based studies integrated with technique, while 6x6 games can be used in tactical integrated aerobic-based studies.

`Conclusively, the 3x3 small-sided games provided higher stimulus in terms of physical condition and technical development than 6x6 small field 46 games and can be recommended for the training of young football players. While 6x6 small-sided games and 11x11 games showed similarities in effect to technical actions, heart rate speed and field tests, 3x3 small-sided games were effectuated differences on many parameters for U-17 football players. Therefore, while 3x3 small-sided games are recommended for developing conditional and technical parameters, 6x6 small-sided games can be recommended for developing tactical understanding. There are limited researches on which small-sided games are suitable for improving both conditional and tactical parameters. More work is needed in this regard.

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