

Cytokine responses to small sided games in young soccer players

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Abstract

Background and Study Aim Small-sided games (SSG) are frequently used by coaches due to the effect of soccer players in improving their technical, tactical, and physical characteristics in training. When we try to improve of our players talent, we must know what kind of changes happen in blood samples. For this reason, we aimed to determine of cytokine responses to SSG in young soccer players.

Material and Methods Fourteen active male soccer players (14.5± 0.6 years) in the Under-14 and Under-15 teams voluntarily participated in the study. Soccer players are divided into 2 groups as 3x3 and 4x4 groups. 3x3 group players played 2x6x1 minutes small-sided games in 25x20 m area and 3x6x2 minutes small-sided games in 30x25 m area for 4x4 group players. Blood samples were collected at baseline pre-training and at immediately after the exercise post-training to measure interleukin 6 (IL-6), tumor necrosis factor (Tnf- α), and lactate (La) parameters. And also, heart rate (HR) and rating of perceived exertion (RPE) determined both pre-training and post-training.

Results In the study, post training levels of La, IL-6, Tnf- α , HR, and RPE both in 3x3 group and in 4x4 group were found to be significantly higher than pre-training ($p<0.05$). When the post training parameters of both groups were examined, only the Tnf- α level increased significantly in the 4x4 group ($p<0.05$), while no difference was found in the other parameters ($p>0.05$).

Conclusions Small sided games which are acutely applied in young soccer players, both 3x3 group and 4x4 group is are similar. However, with a more players can increase tnf- α released and this can effect performance as negatively in young soccer players.

Keywords: soccer, cytokine, interleukin, small-sided games

Introduction

Soccer is a sport in which anaerobic movements are practiced on an aerobic basis as a game. It is based on explosive movements such as agility, jumping, and shooting, and while players often change pace during a competition, it covers a distance of approximately 10 km. For this reason, one of the most important parts of training programs should be focused on improving the ability to use muscle strength effectively and continuously [1]. It is known that small-sided games (SSG) are frequently used by coaches due to the effect of soccer players in improving their technical, tactical, and physical characteristics in training [2].

SSG is very popular not only in adult players, but also in young soccer players, and their use begins from an early age. It is stated that it is beneficial to use small-sided games especially in young players and the reason is that it is directly related to the frequency of application of some skills [2]. It is observed that these skills are frequently repeated during small-sided games and also beneficial for the development of endurance [3]. During SSG in young players, training stimuli must be suitable for the characteristics of the individuals and therefore the rules should generally be changed to suit the physical development of young players [4]. Due to

the smaller area and fewer players during the SSG, the number of situations encountered by each player on the ball and based on the game [5], as well as rating of perceived exertion (RPE), heart rate (HR) and blood lactate levels also change with the size of the playing field [6]. IL-6 manifests itself as an inflammatory response, especially following an acute exercise, with skeletal muscle contraction and subsequently IL-6 levels produced by a systemic increase in the concentration of anti-inflammatory cytokines [7]. Tumor necrosis factor-alpha (Tnf- α) and Interleukin (IL)-6 bind firmly and therefore stimulate of TNF- α to IL-6 production [8,9]. The increase in the amount of IL-6 produced by the muscle was found to be related to the duration, intensity, and muscle mass involved in the work done by the body. This increase decreases gradually after exercise [10]

Two hours after 90 minutes of soccer match, IL-6 (125%) and TNF- α (18%) levels significantly increased in children before adolescence [9]. McMurray et al. [11] reported that after 10x2 minutes of high-intensity exercise applied to adolescent children, they increased their anti-inflammatory IL-6 and TNF- α levels by 80%. In response to an acute endurance exercise, some researchers said that there were significant increases in the levels of IL-6 and TNF- α from inflammatory mediators [12], as well as in researchers who said there was

no change [13] or even reduction [14]. As can be seen from the literature, there appears to be a contradiction concerning changes in IL-6 and TNF- α levels after an acute exercise. Also, given the physical development of young soccer players, there is a need for up-to-date information on muscle damage and muscle fatigue during athletes, which are so popular in small-sided games. In this study, it was aimed to determine the effects of 3x3 and 4x4 small-sided games applied to young players on rating of perceived exertion, heart rate, muscle fatigue, and muscle damage of players.

Material and Methods

Participants

Fourteen active male soccer players in the Under-14 and Under-15 teams voluntarily participated in the study. The median age of all players was 14 years old (min: 14 years old, max: 15 years old). There was no significant difference in age between the 3x3 and the 4x4 groups (Table 1). Subjects with any diseases (hypertension, thyroid, diabetes, cardiac, etc.) were not included in this study. We informed family of the participants in detail about the objectives of the study according to the Helsinki Declaration and obtained informed consent. This study was approved by the Ethics Committee of the Selcuk University.

Table 1 shows that descriptive statistics of participants.

Research Design

Soccer players are divided into 2 groups as 3x3 and 4x4 groups. 3x3 group players played 2x6x1 minutes small-sided games in 25x20 m area and 3x6x2 minutes small-sided games in 30x25 m area for 4x4 group players (Table 2).

Measurements

Height of all subjects was measured before the tests with a stadiometer with a sensitivity of 0.01m (m) and an electronic scale (Seca, Germany)

with a bodyweight of a precision of 0.1 kilograms (kg). Heart rate (HR), rating of perceived exertion (RPE) and blood parameters were taken from the soccer players participating in pre-exercise and at immediately after the exercise. IL-6, Tnf- α and La parameters were determined from blood samples.

Heart Rate (HR): The heart rate measurements of the subjects pre-training and post training were measured with a heart rate monitor (Polar Team Pro 2, Polar Electro, Finland), which can measure within 1-second interval.

Rating of Perceived Exertion (RPE): Perceived difficulty levels of the athletes were measured with a 6-20 Borg scale. On the scale, 20 represents the highest value and 6 represents the lowest value.

Collection of Blood Samples: After taking the appropriate amount of blood samples (2.5 ml) from the athletes' cephalic vein, the serum was kept at -80°C until the analysis time after the serum was separated. Lactate (La) levels, which is one of the serum samples obtained from the subjects, was determined via Siemens Advia centaurv, Tnf- α and IL-6 values were studied with the Elisa device using the micro eliza method. Blood collection procedures were performed under the supervision of a physician.

Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics 23 (IBM Corp). Variables were assessed using the visual (histograms, probability plots) and analytical methods (Kolmogorov-Smirnov/Shapiro-Wilk's test) for normal distribution. Descriptive analyses were presented using frequencies, medians, and minimum-maximum values since variables were not normally distributed. In the research, Mann Whitney U Test was used to evaluate the differences between the groups, and The Wilcoxon test was performed to test the significance of pairwise differences using the Bonferroni correction to adjust for multiple comparisons; 5% type-I error level was used to infer statistical significance.

Table 1. Descriptive statistics of the participants

Parameters	N	Mean	Sd
Height (cm)		170	7.8
Weight (kg)	14	68.5	4.2
Years (age)		14.5	0.6

Table 2. Dimension of Small-Sided Games

Parameters	Playing Time(min)	Rest (min)	Play-ground Size (m)	Total Size (m ²)	Per Players (m ²)
3x3 (n=6)	2x6	1	25x20	500	1: 83.33
4x4 (n=8)	3x6	2	30x25	750	1: 93.75

Results

According to Table 3, when the La, IL-6, Tnf- α , HR and RPE levels of the 3x3 and 4x4 groups included in the study were examined, the post training values for both groups were found significantly higher than before the study ($p < 0.05$).

According to the analysis in the present study, when the La, IL-6, Tnf- α , HR and RPE levels of the 3x3 and 4x4 groups in the study were examined, the Tnf- α values at post training were significantly higher than the post training 3x3 group levels ($P < 0.05$). When the La, IL-6, HR and RPE values at post training were analyzed, no significant difference was observed between the data of both groups (Table 4) ($p < 0.05$).

Discussion

In this study, during the SSG, 83.3 m² of play area was dropped for each 3x3 group (dividing the field area by the number of players), this ratio was 93.75 m² for the 4x4 group. While the heart rate of the 3x3 group was 180.17 \pm 9,54 beats/min, the heart rate of the 4x4 group, which increased the area per player, was 182.13 \pm 11,46 beats/min. Halouani et al. [2] studied on young footballers, it is important to support our study, by reporting the heart rate of the players as 180 \pm 2.00 beats/min after 4x4 small-sided games. Also, the fact that the heart rate after the small-sided games was significantly higher than the previous heart rate in both groups shows that the small-sided games significantly affect the heart rate. Dellal et al. [15] reported that the number of

heart rate increased significantly after the small-sided games applied to amateur and professional soccer players. In the study carried out, it was seen that the HR of the 3x3 and 4x4 game groups were statistically similar to each other at post training. 4x4 games have been implemented in a larger area with longer playtime compared to 3x3 games, but no significant difference has been found between the two groups in terms of HR. Kelly and Drust's study [16] reported that changes in field size in 4x4 SSG did not cause a change in the study of adult players. Unlike in another study, it has been observed that the field of soccer players decrease as the field size and the number of players increase in English professional soccer players [17]. Although these results show that there is no consensus in the literature, it can be said that the difference is due to the difference in the experimental design with the study groups.

The present study, the significant increase in the post training lactate levels of the 3x3 and 4x4 groups compared pre training shows that both the small sided games performed acutely affect the lactate levels significantly. However, when the lactate values of 3x3 and 4x4 small sided games groups were examined, there was a decrease in the 4x4 game group but it was not found statistically significant. In SSG, it has been reported that the amount of La decreases when the number of players whose field size remains the same [18]. As a matter of fact, in his study where Köklü [19] examined small-sided games, 3 sets of intermittent small-sided games and each playing time was 2 min (15x20 m playground),

Table 3. Comparison of pre training and post training La, IL-6, Tnf- α , HR and RPE levels of the participating groups

Parameters	3x3 (n=6)		4x4 (n=8)	
	Pre training	Post training	Pre training	Post training
Lactate (mmol/L)	2.66 \pm 0.59	6.64 \pm 2.56*	2.35 \pm 0.26	4.96 \pm 2.10*
IL-6 (pg/ml)	18.3 \pm 4.83	29.21 \pm 9.86*	25.13 \pm 12.05	33.53 \pm 26.86*
Tnf- α (pg/ml)	0.75 \pm 0.16	1.23 \pm 0.82*	1.04 \pm 0.11	2.96 \pm 1.15*
HR (beat/min)	135.67 \pm 5.39	180.17 \pm 9.54*	95.13 \pm 15.49	182.13 \pm 11.46*
RPE	6.33 \pm 0.52	12.67 \pm 0.82*	8.63 \pm 1.69	13.63 \pm 2.07*

*: ($p < 0,05$)

Table 4. Comparison of post training La, IL-6, Tnf- α , HR and RPE levels of the participating groups

Parameters	3x3 (n=6)	4x4 (n=8)	Sig.
Lactate(mmol/L)	6.64 \pm 2.56	4.96 \pm 2.10	0.228
IL-6 (pg/ml)	29.21 \pm 9.86	33.53 \pm 26.86	1.000
Tnf- α (pg/ml)	1.23 \pm 0.82	2.96 \pm 1.15*	0.001*
HR (beat/min)	180.17 \pm 9.54	182.13 \pm 11.46	0.755
RPE	12.67 \pm 0.82	13.63 \pm 2.07	0.108

*: ($p < 0,05$)

3 min (18x24 m playground) and 4 min (24x36 m playground). The lactate levels at post training; 7.8 mmol. L-1 for 2x2 small-sided games, 6.8 mmol. L-1 for 3x3 small-sided games and 6.7 mmol. L-1 for 4x4 small-sided games setting it as supports our study. However, contrary to the studies mentioned, there is a study reporting that the lactate values increase in amateur footballers with an increase in the field size in 3x3, 4x4, 5x5, and 6x6 SSG applied as 3 sets [20]. It can be said that these contradictory results seen in the literature may be due to the duration of small-sided games, the duration of rest, and the difference in the groups of players.

Many studies show that lactate concentrations and rating of perceived exertion increase with increasing field size [5, 21]. In the study, while RPE values belonging to 3x3 group (1:83.3 m²) were 12.67 ± 0.82 , RPE values belonging to 4x4 group (1:93.75 m²) where the area per player increased, was 13.63 ± 2.07 and there was no statistical difference between the groups. Fanchini et al. [22] applied the duration of the game sets as 2 minutes, 4 minutes and 6 minutes, and the rest time between sets as 4 minutes in their study on 3 to 3 small-sided games. At the post training, there was no significant difference in RPE values between sets. Also, in a study with 14 young soccer players (15.57 ± 0.65 years), stated that RPE values as 10.98 ± 1.43 at the end of the 4-minute game, which was played for 4 minutes, and 4 sets of 47.5x 28.5 m [23]. In the study carried out, 3x3 and 4x4 small-sided games that were acutely applied in different fields and periods did not make a significant difference in terms of RPE values. This result is similar to some of the above-mentioned literature but contradicts others.

Intermittent exercises for young athletes are reported to trigger anti-inflammatory responses to exercise within 24 hours [24]. IL-6 is produced in larger quantities than other cytokines compared to exercise. Northoff and Berg's study [25] were the first to suggest that IL-6 may play a role in the formation of an acute phase response after exercise. In this study, parallel to the first findings in the field, both post-exercise IL-6 values in the 3x3 group were $29,21 \pm 9,86$ U/ L, and post-exercise IL-6 values in the 4x4 group were $33,53 \pm 26,86$ U/ L has increased considerably according to pre-exercise values. Dring et al. [24] found a significant increase in IL-6

levels of participants after a 60-minute basketball training actively applied to 39 participants (20 men, 19 women) between the ages of 11-13. Similarly, Fanchini et al. [21] study on cytokine response after two soccer matches at 72-hour intervals, and a significant increase in IL-6 levels correspond with the findings. In a study stated that played 2 acute small-sided games to 12 young handball players in 5 days and at the end of the study, they found significant increases in IL-6 levels of handball players [26]. Exercise causes a lot of immunological changes, and it has been observed that the working muscles produce and release large amounts of IL-6 into the circulatory system. Besides, TNF- α and IL-6 are tightly bound and are thus known to stimulate of TNF- α to IL-6 production [8, 27]. When the post-exercise values of La, HR, RPE, and IL-6 parameters were compared between the 3x3 and 4x4 groups, no significant difference was observed. Only TNF- α values (2.96 ± 1.15 pg/ml) in the post training 4x4 group showed a significant increase compared to (1.23 ± 0.82 pg/ml) in the post training 3x3 group ($p < 0.05$). This increase suggests that 4x 4 small-sided games causes more bilateral struggles and exercise stress both in terms of playing time and the number of players. Similarly, Dello lacono et al. [26] reported that fatigue and muscle damage may occur as a result of physical contact in team sports that require bilateral struggle. It is also stated that with the increase in exercise severity, activation of the endocrine system and emptying of muscle and liver stores may stimulate cytokine release.

Conclusions

In conclusion, many coaches continue to apply to small-sided games in young soccer player to enhance their performance and this training protocol affects their performance as positive or negative. Fatigue-related conditions and IL-6 released are similar in the 4x4 and 3x3 game form in young soccer players. When coaches apply to SSG with more player it can increase tnf- α released and this can effect performance as negatively in young soccer players. In addition to 3x3 and 4x4 SSG, other SSG protocol with more players should be investigated for future studies. Also, the chronical effects of small-sided games during long period can also be examined.

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