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Original Investigation

Effects of Different Endurance Training Models on Players' Fitness Levels during the National Break in the Football Season

Murat Tutar[a,†], Gülbin Rudarlı[b†*], Bülent Kayıtken[c]
[a]Faculty of Sport Sciences, Gedik University, Istanbul, Turkey
[b]Faculty of Sport Sciences, Ege University, Izmir, Turkey
[c]Faculty of Sport and Physical Education, Nisantasi University, Istanbul, Turkey
[†]These authors contributed equally as first author

Purpose: This pilot study aims to determine the effects of different endurance exercises, during the 14-day national break during the football season.
Methods: Four groups were formed randomly from 44 male football players (age 17-19 years old, stature 179.0±6.16 cm, body mass 70.4±5.53 kg, and body fat ratio 10.6±2.18 %) who regularly train and compete in the youth category of a football team: Small-Sided Games (SSG, n=10), Large-Sided Games (LSG, n=18), Running Without the Ball (RWB, n=8), and Control group (CG, n=8). VO2max (30-15 IFT and Bruce Protocol), balance (Y test), 10-20-30 m sprint, and T-test before and after the 14-day national break during the football season were measured. Heart rate and rate of perceived exertion (RPE) followed during the training program.
Results: Significant differences were found in SSG (P= .001) and LSG (P= .005) in 30-15 IFT test (P< .05). In the Y-balance test, a statistically significant difference was found in SSG (P= .001) and LSG (P= .001) only.
Conclusions: As a result, coaches are recommended to apply one of the RWB, SSG, or LSG training in addition to their routine football periods.

Keywords: Agility; balance; oxygen consumption; small-sided game; speed.

Introduction

Football is a popular team sport that requires a high level of tactical, technical, and physical ability to succeed. The games have a 90-minute movement span in which explosive and vigorous activities occur randomly over approximately 10-12 km, with short periods of high-intensity and long periods of low-intensity activities intertwined with combinations of technical and tactical movements.[1] Football involves standing, walking, acceleration, deceleration, jumping, high-speed running, and sprinting.[2,3] Although it varies depending on their position for athletes in the European league, approximately 24% of the total distance during the match is walking, 36% is running, 20% is gliding steps, 11% is sprinting or high-intensity running, and 7% is running backward. Around 2% of the total distance covered may vary according to ball possession.[4] The aerobic energy system is used for 90% of a 90-minute football match. During this time, players move at speeds corresponding to approximately 70% of VO_2max and 80-90% of maximal heart rate (HRmax).[4,5] It has been reported that sprints lasting up to four seconds were performed every 1.5 minutes and high intensity running speeds increased by 37% in a football match. The VO_2max levels of football players vary according to their positions,[6] with wingers and midfielders having the highest values and goalkeepers and defenders having lower values.[7] In addition, there is a significant relationship between the VO_2max levels of the players, their distance covered during a match, and their ranking in the league.[8] Small-sided games are frequently used in training modeling to develop technical capacity, tactical preparations, acceleration/deceleration, and football-specific endurance performance.[9] An increase in the size of the playing field or a decrease in the number of players (exp. 3vs3 12x20m or 15x25m area, 4vs4 16x24m or 20x30m areas). has been reported to change the total distance covered, total high-intensity movements, and total sprint distance.[10] In contrast, when the field size is decreased or the number of players is increased, players possess the ball more but do not have the space for high-speed running. Therefore, the total distance covered is more related to acceleration and deceleration.[10,11] During the national matches break, trainers aim to maintain the conditions of the players by applying a second preparation period periodization for their teams and to ensure that the team performance does not decrease during the rest of the football season. In European leagues, including the Turkish league, at least eight official national matches are played during the season, so the leagues are paused at least four times for various durations. Determining the effects of endurance exercises with or without a ball on conditioning abilities in different football-specific formats and in fields of varying sizes during the national break may enable these practices to be suggested as a training model in football. In light of this information, this pilot study aims to determine the effects of endurance exercises, that will be performed by different numbers of football players

and in different-sized fields, on aerobic and anaerobic capacities, agility, speed, and balance abilities during the 14-day national break in the football season.

Methods

Participants

Forty-four male football players between the ages of 17-19 (Table 1) without any illness or injury who have been regularly training and competing in the youth category of a football team in Izmir for at least five years was enrolled for this study. Inclusion criteria for the study: Regular training (60 min/day, 5 days/week) and competitor for five years or more, Athletes who had not had a sports injury for at least 6 months and who were licensed to play football in elite leagues were included. The exclusion criteria were athletes who could not participate in training and experienced some injury during the study.

Study Design

This is a descriptive cross-sectional study. The training drills were performed in the football facilities where the players trained during the 14-day national break in the football season in March 2022. Before and after this training period, some field and laboratory tests were applied to the players to evaluate their performance. The players were given pre-tests on Tuesday and Thursday of the last match week before the national break. After the 14-day national break, they participated in the post-tests on Tuesday and Thursday. On the first day of the test periods; Y balance and 30-15 IFT endurance test and on the second day, height, body mass, body composition measurements, T-test, Sprint test, and VO_2maxlab tests were performed. After the first tests were completed, four training groups were randomly formed from the participants, and the groups continued their routine football training with the prepared program while performing endurance training.

Table 1. Descriptive statistics of participants

	CG (n=8)		RWB (n=8)		SSG (n=10)		LSG (n=18)	
	mean±Sd	**min-max**	**mean±Sd**	**min-max**	**mean±Sd**	**min-max**	**mean±Sd**	**min-max**
Age (year)	18.6 ± 0.54	18-19	17.6 ± 0.54	17-18	17.8 ± 0.78	17-19	18.1 ± 0.67	17-19
Height (cm)	179.6 ± 3.43	175-183	178.4 ± 4.56	172-184	176.8 ± 8.49	166-189	180.7 ± 5.76	171-193
Body Mass (kg)	69.5 ± 4.37	62.1-73.6	69.4 ± 4.53	61.5-72.6	69.0 ± 3.38	63.8-73.4	72.3 ± 6.79	54.9-80.7

Note: cm (centimeter), kilogram (kg), control group (CG), running without a ball (RWB), small, sided games (SSG), large sided game (LSG).

Methodology

Familiarization Session

The first session started with the familiarization session to eliminate the learning effect on the test devices. Thus, it is aimed at athletes to get used to the testing devices and protocols.

Height, Body Mass, Body Fat Percentage

The height of the players was measured with an accuracy of .01 mm with a Mesilife (MC-210, Turkey) device. With the subject wearing light indoor clothes and no shoes, body weight (BW) and height (BH) were measured to the nearest .1 kg and .1 cm, respectively, and BMI was calculated with the formula: BMI = BW/BH^2 (kg/m^2). The evaluation of BMI values was based on the criteria given by the World Health Organization. Body composition was assessed with the bioelectrical impedance method using a Tanita TBF-310 Body Composition Analyzer (Tanita Corporation, Tokyo, Japan). This impedance analyzer provides measurements of body fat mass and percent body fat. Since the participants had to be hungry before the measurement, the measurements were performed before breakfast in the morning. Before the measurement, the metal and electronic items on the participants were removed and the measurements were made with bare feet.

Y Balance Test

The "Y Balance Test" was used to measure dynamic postural control. A "Y" shaped figure was drawn on the ground with some floor tape. The tape indicated centimeters and measurements were taken while the players were performing the movements. During the balance test, the participants were asked to keep their hands on the iliac (waist) and heels on the floor and to make a light touch to the farthest point with the fingertip of the reaching foot. They performed the test three times consecutively in each direction with a total of nine times. Normalized reach distance (reach divided by leg length × 100) was applied to the scores (a.u.).[12]

T-test

For the agility and change of direction performances of the players, a track, 10m long and 10m wide, was formed in the shape of a "T".[3] The T-test requires athletes to sprint forward 10 meters, shuffle to the left five meters, shuffle to the right 10 meters, shuffle back to the left five meters, and then run backward to return to the start/finish line. In total, 40 m was covered by each athlete in the shortest time and this time was recorded. Witty Microgate (K_WIT001, Italy) timing system was used for the measurement. The athletes performed the test two times, and the best time was recorded.

10-20-30m Sprint Test

Photocells (Witty Microgate, K_WIT001, Italy) placed at distances of 0, 10, 20, and 30 meters in the test battery automatically took measurements at the start of the test while the athletes ran the 30-meter distance at their fastest.[14] When each athlete arrived at the start point, they exited after hearing the whistle. Participants performed the test twice and their best times were recorded. The reliability of the tests obtained in a previously completed study was expressed as CV = 3.1%, 1.8%, 2.0%.[15]

30-15 Intermittent Fitness Test (30-15 IFT)

The 30-15 IFT consisted of 30-second shuttle runs interspersed with 15-second walking recovery periods. The speed increased by .5 km/h for every 30-second stage. Athletes were required to run back and forth between the two lines set 40m apart. The VO_2max levels of the athletes were automatically calculated in an Excel file with the results of the test protocol developed by Martin Buchheit whose validity and reliability in the assessment of aerobic fitness (VIFT= .91, VO_2max= .94, $P< .05$) was performed by Čović et al. in 2016.[16]

VO_2max Test in The Laboratory (VO_2maxlab)

The aerobic endurance capacity was measured with a Technogym (Jog Forma, Italy) treadmill, and was performed gradually

increasing speed until exhaustion. The treadmill was started at 2.74 km/h and an inclined gradient of 10% in compliance with the Bruce Protocol. The gas analysis mask (V_2 Flowmeter) was properly fitted to the face and VO_2max calculations were automatically obtained from the gas analyzer (Cosmed Fitmate Pro, Italy) based on O_2 consumed and CO_2 produced. The test was completed according to the termination criteria.[17]

Rate of Perceived Exertion

The modified Borg scale was used to measure the rate of perceived exertion (RPE) to determine exercise intensity during endurance training and the VO_2max tests. RPE is associated with peak oxygen uptake (VO_2peak), heart rate reserve, minute ventilation, and blood lactate levels, and it escalates directly with increasing exercise intensity. The study utilised the Borg CR10 scale, a Category-Ratio (CR) scale developed by Borg and pegged to the number 10 representing an extreme intensity of activity. At the end of endurance training, athletes answered immediately the level of difficulty they perceived from 1 to 10 in a way that they were not affected by other athletes and could not see each other. [18]

Heart Rate Monitoring

During the endurance training and VO_2max tests, all players' HR changes throughout the game were recorded with a GPS System (Catapult Clearsky, Canada) placed on the back of their vest, allowing satellite data communication.

Endurance Training

The endurance training programs were planned in four groups: small-sided games (SSG); Large-Sided Games (LSG); Running Without the Ball (RWB) and a Control group. The training in the SSG consisted of interval training, 4 × 4 minutes at 90–95% of VO_2max, with a 3-minute intervening jog (running at 60-70% VO_2max) with four players against four with two goalkeepers in a limited pitch (35 × 25 m).[19] The training in the LSG group consisted of interval training, 2 × 10 minutes at 80–85% of VO_2max, with a three-minute intervening jog (running at 60-70% VO_2max) with eight players against eight with two goalkeepers in a limited pitch (60 × 45 m).[19] The training in the RWB group consisted of eight players, 15-second running (110-120% of VO_2max), and 4 sets × 5 repetitions with 15-second active rest between repetitions and two-minute passive rest between sets. CG did not participate in additional endurance training. All groups continued their routine football training.

Football Training

The football training program (Table 2) for this study was planned and carried out as follows during the 14-day national break:

Table 2. The football training program

	Day	Contents	Duration (min)	Intensity (%)
0	Sunday	The last game before the national break	90	Max
1	Monday	Off day	-	-
2	Tuesday	Off day	-	-
3	Wednesday	Technical and set-piece drills	60-70	50-60
4	Thursday	Endurance Training (SSG/ LSG/ RWB)	40-50	80-Max
5	Friday	Shooting and set-piece drills	60-70	60-70
6	Saturday	Endurance Training (SSG/ LSG/ RWB)	40-50	80-Max
7	Sunday	Regeneration	45	30
8	Monday	Tactical drills	45-55	50
9	Tuesday	Endurance Training (SSG/ LSG/ RWB)	40-50	80-Max
10	Wednesday	Tactical drills	45-55	50
11	Thursday	Endurance Training (SSG/ LSG/ RWB)	40-50	80-Max
12	Friday	Technical and set-piece drills	60-70	60-70
13	Saturday	Tactical drills	45-55	40-50
14	Sunday	Friendly Match	90	Max

Note: running without a ball (RWB), small-sided games (SSG), large-sided game (LSG).

Statistical Analysis

Statistical analyses were performed with the SPSS (version 25.0, SPSS Inc, Chicago, IL, USA) statistical package program. The suitability of the data for normal distribution was evaluated with the Shapiro-Wilk W test. Participants were divided into four groups: SSG, LSG, RWB, and CG. If the sphericity assumption was not met during variance analysis, Greenhouse-Geisser data was used. A 4 × 2 mixed design analysis of variance (ANOVA) was applied for the pre-post test results of the participants, and a 3 × 4 repeated measures of ANOVA was applied for the four repeated training data, excluding the CG. Whether there was a difference within the groups during the pre-and post-tests was analyzed using one-way ANOVA. The LSD method was used in post-doc analyses. Comparison of VO_2max test results measured in the laboratory and the field determined by paired sample t-test. The effect size of the differences was reported according to partial eta squared (ηp^2) values. Data are presented as mean and standard deviation. A value of $P < .05$ was accepted for significance.

Table 3. Comparison of pre and post-test on body mass, body fat, and balance test results of the groups

	Body Mass (kg)				Body Fat (%)				Y Balance Right (a.u.)				Y Balance Left (a.u.)			
Group	**Pre-post**	***t***	***P***	**ES**	**Pre-post**	**t**	***P***	**ES**	**Pre-post**	**t**	***P***	**ES**	**Pre-post**	**t**	***P***	**ES**
CG	69.6 ± 4.37 69.5 ± 4.34	6.532	**.003***	.04	11.1 ± 1.96 10.9 ± 1.86	2.746	.052	.07	84.8 ± 3.68 84.8 ± 3.62	.552	.610	1.06	84.3 ± 7.69 88.7 ± 8.07	3.607	**.023***	.55
RWB	68.3 ± 4.39 68.1 ± 4.41	6.177	**< .001***	1.32	9.91 ± 1.76 9.75 ± 1.78	5.017	**.002***	.09	82.8 ± 7.36 83.2 ± 7.68	2.501	**.041***	.04	84.5 ± 8.65 84.7 ± 8.88	2.297	.055	.02
SSG	69.0 ± 3.37 68.8 ± 3.36	6.530	**< .001***	.05	9.77 ± 1.91 18.9 ± 29.6	0.988	.349	.43	85.6 ± 5.57 86.7 ± 5.44	5.508	**< .001***	.19	87.2 ± 5.99 88.1 ± 5.82	6.985	**< .001***	.15
LSG	72.3 ± 6.79 72.1 ± 6.78	5.795	**< .001***	.02	11.2 ± 2.43 11.1 ± 2.37	7.432	**< .001***	.08	82.3 ± 5.54 82.7 ± 5.54	5.137	**< .001***	.06	82.7 ±6.98 83.0 ±6.94	5.983	**< .001***	.05

Note: kilogram (kg), percentage (%), effect size (ES), control group (CG), running without a ball (RWB), small-sided games (SSG), large-sided game (LSG).

Table 4. Comparison of pre (1)-and post (2)-test 20m- 30m sprint, agility, and VO_2max tests results of the groups

	CG				RWB				SSG				LSG			
Measurements	**Pre-post**	***t***	***P***	**ES**	**Pre-post**	***T***	***P***	**ES**	**Pre-post**	***t***	***P***	**ES**	**Pre-post**	***t***	***P***	***ES***
20m (sec)	3.06 ± .08 3.17 ± .10	1.977	.119	1.21	3.05 ± .09 3.00 ± .10	3.613	**.009***	.52	3.05 ± .09 3.11 ± .12	1.873	.094	.56	2.96 ± .20 2.87 ± .17	4.736	**< .001***	.48
30m (sec)	4.43 ± .16 4.41 ± .16	2.667	.056	.12	4.45 ± .18 4.39 ± .17	3.384	**.012***	.34	4.13 ± .31 4.07 ± .25	2.352	**.043***	.21	4.47 ± .23 4.40 ± .23	4.669	**< .001***	.30
T drill (sec)	9.73 ± .08 9.69 ± .80	4.472	**.011***	.07	9.79 ± .24 9.57 ± .44	1.630	.147	.62	9.65 ± .47 9.48 ± .20	1.942	.084	.47	9.72 ± .25 9.62 ± .22	2.688	**.016***	.42
30-15 IFT (ml·kg·min^{-1})	52.2 ± 1.59 52.2 ± 1.79	.097	.927	.00	54.7 ± 3.21 54.9 ± 3.19	1.048	.330	.05	54.4 ± 3.44 55.3 ± .28	6.397	**< .001***	.26	53.7 ± 2.76 54.7 ± 2.86	3.212	**.005***	.35
VO_2max_{LAB} (ml·kg·min^{-1})	53.1 ± 1.79 53.1 ± 1.83	.938	.401	.02	68.3 ± 4.39 68.1 ± 4.41	6.177	**< .001***	.09	55.2 ± 3.51 55.6 ± 3.59	3.200	**.011***	.12	54.0 ± 3.00 54.3 ± 3.09	3.363	**.004***	.10

Note: effect size (ES), second (sec), agility test (T drill), intermittent fitness test (IFT), Maximal oxygen consumption (VO_2max), control group (CG), running without a ball (RWB), small-sided games (SSG), large-sided game (LSG).

Results

Pre- and post-balance test results of right and left foot (Y test), body mass, and fat percentage belonging to each group were shown in Table 3. The results of the pre-test and post-test of CG were compared and significant improvements were found in body mass (P = .003) and balance of the left leg (P= .023). The pre-test and post-test results of the RWB group were compared and significant improvements were found in body mass (P= .001), fat percentage (P= .002), and balance of the right foot (P= .041). The pretest and posttest results of the SSG group were compared and significant improvements were found in body mass (P=.001), balance of right foot (P= .001), and balance of left foot (P= .001). The pretest and posttest results of the LSG group were compared and significant improvements were found in body mass (P= .001), fat percentage (P= .001), the balance of the right foot (P= .001), and balance of the left foot (P= .001).

Pre-and post-test results of VO_2max (with 30-15 IFT on the field and with Bruce protocol in the lab), 10-20-30 m sprint, and agility (T-test), belonging to each group were shown in Table 4. The results of the pre-test and post-test of CG were compared and significant improvements were T-drill (P= .011). The pre-test and post-test results of the RWB group were compared and significant improvements were found in 10 m sprint (P= .043), 20 m sprint (P= .009), 30 m sprint (P= .012) performances, and VO_2maxlab values measured in the laboratory (P= .035). The pretest and posttest results of the SSG group were compared and significant improvements were found in the 30 m sprint (P= .043), 30-15 IFT (P= .001), and VO_2maxlab (P= .011). The pretest and posttest results of the LSG group were compared and significant improvements were found in 20 meters (P= .001) and 30 meters (P= .001) sprint, agility (P= .016), 30-15 IFT (P= .005) and VO_2maxlab (P= .004).

The interaction of the four training sessions between the groups (SSG, LSG, RWB) related to the total distance covered (TD), total number of accelerations/decelerations (ACC/DEC), mean HR, and RPE at the end of each training session were analyzed by 3 × 4 repeated measures ANOVA. There was no significant interaction between the groups and training for TD ($F(6, 14421.45)$=.407, P= .846, η_p^2= .024). The mean and standard deviation of the TD data are given in Table 3. In the post-doc analysis, a significant difference was found between all groups at the same level (P< .01). There was no significant interaction between the groups and training for ACC/DEC ($F(6, 2.922)$= .094, P= .997, η_p^2= .006). The mean and standard deviation of the ACC/DEC data are given in Table 3. In the post-doc analysis, a significant difference was found between all groups at the same level (P< .01). There was no significant interaction between the groups and training for the mean HR during training ($F(6, 5.490)$=1.597 P= .163, η_p^2= .088). The mean and standard deviation of the HR test data are shown in Table 3. In the post-doc analysis, a significant difference was found between all groups at the same level (P< .01). For RPE during training, there was no significant interaction between groups and training ($F(6, 5.005)$= .646 P= .693, η_p^2= .038). The mean and standard deviation of the RPE test data are shown in Table 3. In the post-doc analysis, a significant difference was found between the SSG and RWB groups and between LSG and SSG groups (P< .05).

Table 5. Parameters of different endurance training sessions

Group	Training	TD (meter)	ACC/DEC (count)	HR (pulse/min)	RPE (0-10)
RWB	First Training	1278.8 ± 34.0	10.6 ± 1.92	171 ± 7.25	6.12 ± 0.99
	Second Training	1278.0 ± 31.7	10.8 ± 1.28	168 ± 11.4	6.38 ±0.74
	Third Training	1289.9 ± 56.8	10.8± 1.03	166 ± 8.92	6.25 ± 1.03
	Fourth Training	1290.1± 43.3	11.8 ± 0.70	164 ±10.2	6.75 ± 0.70
SSG	First Training	1897.6 ±126	48.5 ± 20.5	167 ± 9.64	164 ± 9.73
	Second Training	1925.7 ±149	49.4 ± 18.9	167 ± 6.80	161 ± 8.22
	Third Training	1989.8 ± 90.4	47.8 ± 14.9	171 ± 4.75	165 ± 8.66
	Fourth Training	1977.7 ± 66.0	50.4 ± 15.1	163 ± 5.91	163 ± 5.91
LSG	First Training	2933.5 ± 531	31.3 ±15.8	164 ± 9.73	5.89 ± 1.13
	Second Training	2923.7 ± 508	31.6 ±11.8	161 ± 8.22	5.67 ± 1.32
	Third Training	2892.3 ± 718	31.6 ± 11.9	165 ± 8.66	5.89 ± 1.32
	Fourth Training	2906.5 ± 377	33.3 ± 12.0	163 ± 5.91	5.67 ± 1.28

Note: total distance (TD), acceleration/deceleration (ACC/DEC), heart rate (HR), rate of perceived exertion (RPE), control group (CG), running without a ball (RWB), small-sided games (SSG), large-sided game (LSG).

Discussion

The main findings of the study where the endurance training drills were conducted at different total distances with different numbers of acceleration and deceleration, in different mean heart rates, and different RPEs had similar beneficial effects on body composition, aerobic power as measured in the lab and on the field, speed, and balance abilities. Small-sided game training differs in duration, sets, resting, and application of technical drills. It has been reported that the rules applied in training (factors such as motivational effect, the guidance of the coach, limiting the number of ball touches, including goalkeepers, and the number of wild card players not bound by the rules) can change the characteristics of SSG and cause different physical, cognitive and technical developments in the players.[19,20] Goalkeepers have started to be involved in more technical and football-specific endurance training, especially with the increase in build-up strategies). [21]

The literature shows that endurance exercises during the breaks in the competition period are generally planned for 4-12 weeks, two times a week, and at an average intensity of 85-95% of VO_2max level, with 2-8 minutes duration and up to six repeats.[21,22,23] It has been reported that there is approximately a 10-30% increase in VO_2max levels of the players after training periods including endurance exercises performed at 90-95% of HRmax and a 5-10% increase at 60-80% of HRmax.[8] As the main reason for this improvement, it is stated that the load that occurs in official or friendly competitions can be up to 25% of the load applied in weekday training, and it can affect the development of aerobic endurance in itself.[24]

In our study, as a result of the training period effect of VO_2maxlab tests in which we determined the aerobic power levels of football players in the laboratory, significant improvement was found in SSG (0.8%, *P*= .011), LSG (.6%, *P*= .004) and RWB (.5%, *P*= .035) groups. In the VO_2max test values taken in the field, significant improvement was observed in SSG (1%, *P*< .01) and LSG (0.7%, *P*= .005). Although it is stated that longer and continuously applied loading methods in VO_2max intensities will be more effective in endurance development and there may be an increase of up to 10.7% in the VO_2max values of the players due to the increase in the internal load as the field dimensions narrow, it is important in terms of training periodization that the previously developed VO_2max levels in our study were significantly increased by 1% during the season and in two weeks.[21] In addition, the higher intensities in the SSG training method we applied were in parallel with the fatigue level felt immediately after the training, and RPE values were higher in small-sided games. In addition, this situation is in parallel with the rate of HR data. In the SSG group, metabolic processes and internal loads were found to increase due to short-term high-intensity loads and more acceleration and deceleration, and it was found to affect VO_2max development.[23,24] Moreover, in the study of Rampinini et al.[25] on the number of players and field measurement effects in SSG, RPE values were found to be 7.9±0.5 and were similar to our study. When football-specific endurance methods are considered, it has been observed that SSG, LSG, and RWB endurance exercises should be applied in combination according to the need and each exercise modality affects improvements in different parameters. In the study in which the effects of different SSG configurations on HR, RPE, and running distances in football players were examined; the number of accelerations and decelerations were higher in 3 sets × 4 repetitions × 4 minutes SSG with 2 minutes rest compared to LSG, higher distance covered, HRmax and RPE values were found in LSG.[26]

Trombiero and colleagues[27] found an increase in the distance covered at speeds of 7.20-14.29 km/h and a decrease in HRmax because of the SSG with 4-minute loads of 3 vs 3 and 3 vs 4 with a goalkeeper in elite female football players. The difference in these results from male football players was attributed to the fact that more SSG was performed in women's football in the tactical sense and that female athletes did not change their positions much in these games and performed less physically. Among three different endurance loading methods, it was shown that SSG and speed endurance exercises improved endurance capacity (*P*< .05). It has been said that SSG is more beneficial in performance development, while combined endurance exercises are more efficient in time.[28] Topçuoğlu[29] showed no statistical difference in VO_2max in the SSG group (*P*= .84) whereas there was a significant improvement in the High Intensity Interval Training group (*P*= .00).

In Böge's study, it was observed that VO_2max value increased significantly from 52.93±17.18 to 61.93±17.92 ml·kg·min^{-1} in the control group and from 54.64±12.69 to 72.78±17.77 ml·kg·min^{-1} in the experimental group with SSG performed after football training for eight weeks.[30] In addition, Helgerud et al.[31] evaluated 7-week SSG and interval running loads with Yo-Yo IR1 test performance and found an increase of 17% in the SSG group and 22% in the interval running group and observed an 11% increase in VO_2max (from 58.1 to 64.3 ml·kg·min^{-1}, *P*< .01) with SSG exercises performed at 90-95% of the HRmax of 4×4 min twice a week for eight weeks. Randers et al.[32] reported that VO_2max levels increased by 5% at the end of a 12-week SSG study in elite football players, which did not exceed 30 minutes in total and was applied as one set of 2-4 minutes of loading and 1-2 minutes of rest between sets. Methodological differences such as the age of the participants, the period of the season in which the study was conducted, the selected training method, and the time of application affect the high level of improvement achieved in the studies.

A significant difference was found in VO_2max at the end of SSG performed in the form of four vs four with four repetitions × four minutes and running speeds corresponding to 110% of the maximum aerobic speed in young athletes in the form of two repetitions × four minutes with 15 seconds of loading and 15 seconds of rest[33] and at the end of 5 weeks SSG (3.3%) and high-intensity interval method (4.3%) exercises in 14-year-old athletes.[34] At the end of linear sprint and SSG studies by Chaouachi et al.[35] aerobic capacity was found to improve more in the SSG group compared to the control group. In 21-year-old elite football players, agility was improved significantly with three repetitions × 45 seconds of SSG at different distances.[36] Although it is stated in the literature that the number of acceleration and deceleration of athletes in SSG is higher, it was found that agility performance improved significantly in the SSG group in our study.

A previous study has shown that 96% of the runs performed at maximal speeds during a football competition were performed at a distance of less than 30 meters.[37] For this reason, 10-20-30 meter running tests of the athletes were evaluated in our study and it was found that only 10-meter sprint performance in the RWB group, 20-meter sprint performance in the RWB and SSG groups, and 30-meter sprint performance in the RWB, SSG, and LSG groups improved significantly. It was thought that football-specific sprint runs performed within the football-specific technical-tactical exercises included in the 14-day training plan may have contributed to these results. There are many studies in the literature with similar results. With the SSG, significant improvements were found in U15-16 players (pre-test 4.22±0.10 s, post-test 4.12±0.15 s),[37] in football players aged 10-14 years (pre-test 5.51±0.39 s, post-test 5.27±0.34 s)[38] in 30-meter sprint performances, in football players in U13-15 categories in a 30-meter sprint,[36] and significant improvements were found in 10-20-30 meters sprint performances in both SSG and HIIT groups at the end of a 5-week study in 14-year-old athletes.[35] It is accepted that linear sprint activations show positive development in methods applied using high-intensity interval training.[38,39,40] In parallel with this information, 15 seconds of loading and 15 seconds of rest were applied to the RWB group in our study, and improvement was observed at all tested distances. The study conducted by Topçuoğlu,[29] showed a significant difference in VO_2max in the HIIT and SSG groups. The result may be because there is not enough distance to achieve sprint speeds in SSG exercises. RWB, SSG, and LSG training, which were performed at different total distances with various numbers of accelerations and decelerations and resulting in different mean heart rates and

different perceived exertion levels during the 14-day national break may provide similar positive effects on body composition, aerobic power measured in the laboratory and on the field and speed and balance abilities. The main limitation of the study is that it was worked with a small sample; therefore, the study can be considered as a pilot study.

Conclusions

It can be concluded that RWB, SSG, and LSG exercises, which are performed by different distances with various numbers of accelerations and decelerations, and which cause different average HR and RPE, in addition to the routine football training carried out during the 14-day national team break during the football season, provide similar positive effects on body composition, aerobic power measured in the laboratory and on the field, and speed and balance abilities.

Practical Applications

As a result of our findings, coaches who want to improve the body composition, aerobic power measured in the laboratory and on the field, and speed and balance abilities of their football players during the national break in every football season are recommended to include one of the RWB, SSG or LSG exercises in addition to routine football training.

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Ethical Committee approval

The Medical Research Ethics Committee of Ege University Faculty of Medicine (number: 21-1.1T/58) approved that the research design complies with the "Declaration of Helsinki: Ethical Principles for Medical Research Involving Human Subjects". (21-1.1T/58).

ORCID

Murat Tutar ID https://orcid.org/0009-0009-1726-7581
Gülbin Rudarlı ID https://orcid.org/0000-0001-8914-7479
Bülent Kayıtken ID https://orcid.org/0009-0007-3571-3106

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The authors have no conflicts of interest to declare.

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Author-s contribution

Conceptualization, B.K., G.R., and M.T.; methodology, M.T., and G.R; software, B.K.; validation, B.K.; formal analysis, M.T.; investigation, M.T., and G.R.; resources, B.K., M.T., and G.R.; data curation, M.T., and G.R; writing—original draft preparation, B.K., M.T., and G.R.; writing—review and editing, M.T. and G.R.; visualization, B.K.; supervision, G.R.; project administration, M.T. and G.R.; All authors have read and agreed to the published version of the manuscript.

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Corresponding information:
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Correspondence to: Prof. Gülbin Rudarlı
University: Ege University, Faculty of Sport Sciences, Department of Coaching Education
Bornova Izmir, Turkiye 35040
E-mail: gulbin.rudarli@ege.edu.tr