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COMPARING SPEED-AGILITY-QUICKNESS AND SMALL-SIDED GAMES TRAINING EFFECTS ON SPEED AND POWER PERFORMANCE IN YOUNG SOCCER PLAYERS

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Abstract
Introduction. Soccer is a demanding sport that requires rapid and explosive movements. Enhancing speed and power is crucial for optimal performance in soccer players. Two training methods, Speed, Agility, and Quickness (SAQ) training and Small-Sided Games (SSG) training, are commonly used to improve these physical attributes. This study aimed to compare the effects of SAQ training versus SSG training on performance measures in young soccer players. ***Material and Methods.*** Twenty-four soccer players were randomly assigned to either an SAQ training group (n = 12) or an SSG training group (n = 12). An 8-week training program was implemented, and pre- and post-training assessments included 10-m and 20-m sprint tests, Zigzag Change of Direction Speed (CODS), Repeated Sprint Ability, Squat Jump (SJ), Counter-movement Jump tests. Statistical analysis involved paired t-tests to compare pre- and post-test results within groups and ANOVA to examine interactions between time and group effects. ***Results.*** SAQ and SSG training groups showed significant improvements across all measures (all $p < 0.05$). Time effects were significant (all $p < 0.05$), indicating overall effectiveness, with small time x group interactions (all $p < 0.05$; $\eta 2$ ranging from 0.001 to 0.055). However, the percentages indicated a slight advantage for SAQ training in 10- and 20-meter speed and SJ, as well as for SSG training in RSAmean. ***Conclusions.*** Both SAQ and SSG training programs effectively enhance speed and power performance in young soccer players. Selection between programs can align with specific training goals, highlighting potential for further optimization in athletic development.

Key words: speed-agility-quickness, small-sided games, speed and power, repeated sprint ability, soccer

Introduction

Soccer is a highly demanding sport that requires significant physical effort with rapid and explosive movements [1]. It is characterized by alternating between numerous high- and low-intensity activities, including walking, jogging, high-speed running, sprinting, jumping, and changes of direction [2]. It is well-known that the ability of soccer players to produce various high-speed movements affects the performance of a soccer match [3]. Although high-speed movements only contribute to 11% of the total distance covered, they actually constitute the most crucial moments in the match and directly contribute to winning ball possession and scoring or conceding goals [4]. These movements necessitate overall strength, power generation, speed, agility, balance, stability, flexibility, and an adequate level of endurance [5].

Linear sprint is a crucial physical quality in soccer [6]. It refers to a maximum forward speed for a given straight line distance [7]. The 10 meters and 20 meters distances are the most frequent when performing sprinting during a match. This was confirmed by a study conducted by Andrzejewski et al. [8], which found that during a match, a professional soccer player runs at a speed of 7% between 0-10 meters, 48% between 10-20 meters, and 45% over 20 meters. Di Salvo et al. [9] also confirmed that sprints with an average distance of 18-20 meters are executed in a professional soccer game.

In soccer, players with higher acceleration rates are also capable of accelerating, decelerating, and re-accelerating more quickly when changing directions [10]. This ability is known as CODs, and it is essential for soccer players, especially when soccer is a multidirectional sport [11]. CODs primarily involves three distinct phases: an acceleration phase, a deceleration phase, and a subsequent acceleration in a different direction [12]. Popowczak et al. [13] showed that CODs movements in soccer involve movements in various directions (right, left, back, forward) and at various angles. Akenhead et al. [14] found that elite players can perform an average of over eight changes of direction per minute during a match, emphasizing the importance of speed and power in optimizing performance.

In intermittent sports, lower-body strenght, explosive power and speed are considered fundamental factors for athletic performance. Soccer players demonstrate higher values for high-

-intensity running, which necessitates the use of methods that enhance strength performance in these athletes. In this regard, a study by Cronin and Hansen [15] showed that faster athletes had higher values in SJ and CMJ tests. Additionally, the results of a study by Wing et al. [16] demonstrated a direct relationship between the height of both SJ and CMJ and the player's ability to successfully head the ball.

Given these demands, it is crucial to continuously seek modern training methods and strategies that guide coaches in improving these physical abilities. Numerous studies have confirmed the effectiveness of the SAQ training method in enhancing soccer-specific physical abilities [5, 17, 18]. This method involves high-intensity motor tasks performed over short periods, incorporating both linear and multi-directional speeds with and without cognitive stimuli [19]. Azmi and Kusnanik [20] found that SAQ program effectively improved sprinting, agility, reaction time, and strength in soccer players.

Similarly, the SSG training method has been proven effective in developing soccer-specific physical qualities. Hill-Haas et al. [21] noted that SSGs replicate the physical performance demands of the game, making them popular across all ages and levels. Dellal et al. [22] confirmed that SSG training is an effective method to develop aerobic and anaerobic fitness and enhance recovery ability in soccer players. Souilah and Kessouri [23] found that an SSG program in a 2v2 format significantly improved both linear speed and CODs in young soccer players.

To the best of our knowledge, very few studies have compared the effects of SAQ and SSG training in soccer. This study aims to compare the effects of SAQ and SSG training on linear speed power in young soccer players, determining which method is more effective in developing these specific qualities of soccer.

Material and Methods

Participants

Twenty-four young male soccer players from an under-17 (U17) amateur club in the Jijel league in Algeria voluntarily participated in this study (age: 15.45 ± 0.50 years; body mass: 59.41 ± 8.36 kg; body height: 171.16 ± 3.49 cm; BMI: 20.23 ± 2.44 kg/m^2). The players were randomly divided into two groups, with 12 players in the first experimental group undergoing the SAQ training program for 8 weeks (SAQ group), and 12 players in the second experimental group undergoing the SSG training program for 8 weeks as well (SSG group). Table 1 presents the characteristics of the study participants. It was ensured that all players were free from diseases or injuries before starting the experiment. The study objectives, work protocol, and potential risks were explained to the players, their guardians, and the coach. Informed written consent was obtained from all participants. This study was conducted in accordance with the Helsinki Declaration [24].

Table 1. Participants' characteristics

Variables	Overall (n = 24)	SAQ group (n = 12)	SSG group (n = 12)	p-value
	Mean ± SD			
Age (years)	15.45 ± 0.50	15.58 ± 0.51	15.33 ± 0.49	0.23
Body mass (kg)	59.41 ± 8.36	62.58 ± 7.50	56.25 ± 8.25	0.06
Height (cm)	171.16 ± 3.49	172.5 ± 3.31	169.83 ± 3.27	0.06
BMI (kg/m^2)	20.23 ± 2.44	21.01 ± 2.30	19.45 ± 2.43	0.12

Design and Procedures

This study followed a randomized pre-post parallel group design. The independent variable was SAQ training and SSG training, while the dependent variable included sprinting (10 and 20 meters), CODs, repeated sprint ability (RSA), and vertical jump (SJ and CMJ). Participants were randomly assigned to either the SAQ training group or the SSG training group using a computer-generated randomization process to ensure group equivalence at baseline.

This experiment was conducted during the competition phase, specifically during the return phase. Pre-tests for both groups were conducted on the same day and time, consisting of sprint tests at 10 and 20 meters, Zigzag CODs test, RSA test, SJ test, and CMJ test. Each group then engaged in their respective training program for 8 weeks, with two training sessions per week, supervised by qualified coaches. Post-tests for both groups were conducted immediately after the 8-week intervention period using the same testing protocols as the pre-tests (Fig. 1).

Both groups performed the same warm-up routines, technical, and tactical work, with the only difference being the physical training component (SAQ or SSG). Each group trained at the same time and on the same field throughout the intervention period to minimize potential confounding factors.

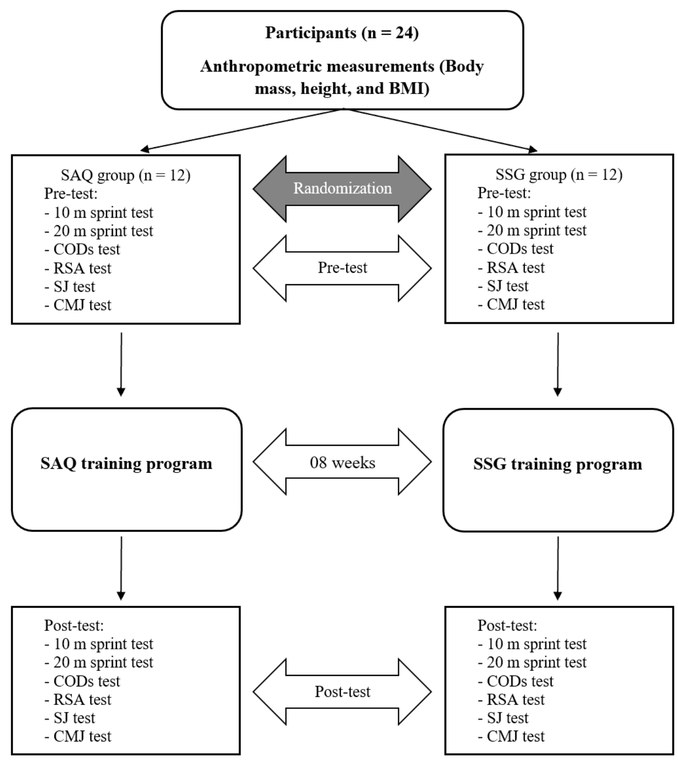

Figure 1. Experimental design

Measurements

Internal training load: to calculate training load, the Rating of Perceived Exertion (RPE) scale proposed by Foster et al. [25] was used. This scale is characterized by its validity in measuring internal training load in soccer [26]. Session RPE (sRPE) can be calculated by multiplying the player's self-reported rating after completing the exercise by the exercise duration and is expressed in arbitrary units (A.U). The rating is based on the answer to the question: "What level of intensity did you feel during the exercise?" with responses ranging from 1 to 10 (where 1 corresponds to very, very light intensity, 2 is light, 3 is moderate... and so on until 10, which represents maximum intensity).

Linear speed test: to measure linear speed, researchers used the 20-meter sprint test, which is considered one of the most important speed tests in soccer known for its high validity and reliability [27]. The test was conducted over a distance of 20 meters, split into two halves (10 + 10 meters), with the starting line set 0.5 meters before the beginning of the 20-meter distance. The test was conducted using a photocell system (Microgate). Photocells were positioned at the start, mid-point (10 meters) and finish lines, set at a height of 1 meter to align with the player's waist level, ensuring accurate detection. Each player was given two separate attempts with a 5-minute rest between them, and the best attempt was used for analysis.

Change of direction speed test: the Zigzag test was applied to measure CODs. The protocol of this test requires the player to sprint as fast as possible over a distance of 20 meters divided into four parts, changing direction every 5 meters at an angle of 100°, with the starting point set at 0.3 meters before the starting line [3]. This test assesses CODs elements, including acceleration, deceleration, and balance control abilities. It is considered valid and reliable for measuring CODs in soccer [27]. The Microgate photocell system was also employed here, with photocells positioned at the start and finish lines of the Zigzag course. The photocells were set at 1 meter above ground to detect player movements as they crossed the start and finish lines. Each player was given two separate attempts with a 5-minute rest between them, and the best attempt was used for analysis.

Repeated sprint ability test: since soccer is characterized by repeated sprints and changes of direction, RSA test 6 x (40 m (20 + 20)) [was adopted [28]. The test involves performing 6 sprints at maximum speed over a distance of 40 meters (20 + 20), meaning the player runs 20 meters forward at maximum speed, places their foot on the line, changes direction 180°, and returns to run another 20 meters. Players start each sprint from a distance of 0.5 meters before the starting line. There is a passive rest period of 20 seconds between the six repetitions, and the player must be in a ready position to perform the next sprint when there are about 5 seconds remaining of the rest period. The RSAmean for the six repetitions was calculated and used for analysis. In this test, photocells were positioned at the start and finish lines, as shown in figure 2.

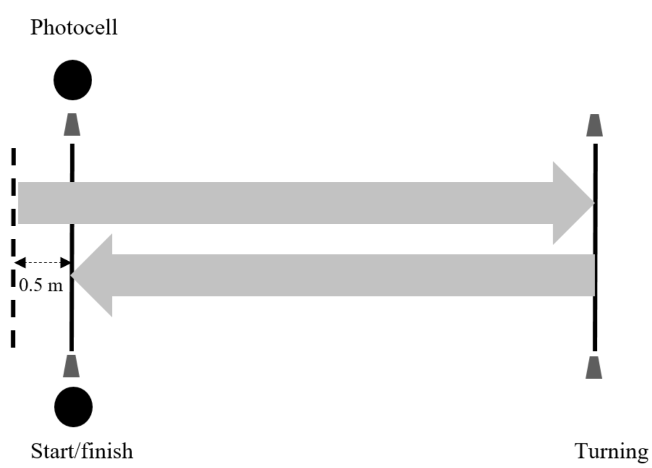

Figure 2. Photocell placement for RSA test

*Squat jump test: t*his test aims to assess vertical jump height and lower limb power. The player starts from a static squat position with knees flexed at a 90-degree angle, then jumps upward with maximum force possible. This test does not represent the full stretch-shortening cycle; hence, it aims to measure the athlete's ability to generate power solely through concentric muscle contractions [29]. This test is characterized by validity and reliability in measuring jump height and power [30]. The My Jump 2 Android application (version v1.0), known for its validity and reliability in squat jump and countermovement jump measurement [31], was used on an android system (Xiaomi Poco X3, Android 10). The phone was set to record at 240 frames per second (fps) with a resolution of 1080 pixels to maximize accuracy. The device was placed 1.5 meters from the athlete, aligned at knee height to capture optimal jump motion. Each player was given two attempts, and the best attempt was taken for analysis.

Countermovement jump test: the test aimed to evaluate jump height and lower extremity power. Players executed a countermovement to a 90-degree knee angle followed by a jump, keeping their hands on their hips to prevent their involvement in the jumping process. This test utilized the complete stretch--shortening cycle [29], and it had a strong correlation with Power (r = 0.87) compared to other jump tests like long jump, Sargent, Abalakov, and Squat jump [30]. The test was also conducted using the My Jump 2 Android application. Players made two maximal attempts with a 5-minute rest between attempts, and the best attempt was used for analysis.

Interventions

SAQ and SSG training programs were designed considering the characteristics of the target age group, their levels, and the principles of sports training. The training programs were implemented twice a week for 8 weeks (16 training sessions for each program), during the competition phase. The first five weeks were characterized by a progressive increase in training load (volume and intensity), followed by a sudden increase in training load in the sixth week (choc microcycle). The seventh and eighth weeks saw a decrease in training load (tapering) to ensure optimal performance in the post-measurement physical tests [32].

The team trained three times a week, in addition to the match on either Friday or Saturday. Each program was applied in the first and second training sessions of the Microcycle, immediately after dynamic warm-up routines, and both groups practiced the same technical and tactical work during the program application period.

Previous studies and reviews assisted in the development of the SAQ and SSG training programs [5, 19, 33]. Tables 2 and 3 outline the contents of each program.

Statistical Analysis

Statistical analysis in this study utilized SPSS version 26. Data were presented as mean ± SD. Normality of data distribution was confirmed using the Shapiro-Wilk test. To compare pre-test scores between groups, an independent samples t-test was employed. Within-group differences from pre-test to post-test were analyzed using a paired samples t-test. Percentage change between pre- and post-tests was calculated using the formula ((post-test – pre-test) / pre-test) x 100. Hedges' g effect size (ES) was determined following Hopkins et al.'s guidelines [34], considering both the smallest worthwhile change (SWC) and the standardized difference in effect size (ES) with a 90% confidence interval: trivial (<0.20), small (0.20-0.59), moderate (0.60-1.19), large (1.20-2.00), and very large (>2.00).

Table 2. Speed-Agility-Quickness training program

W	Stage one	Stage two	Number of exercises in each stage	Exercise duration (min)	Rest between exercises (s)	Stage duration (min)	Rest between stages (min)	Load (A.U)	
	Agility and Quickness	Speed, COD and Agility						S	sRPE
1-2	Footwork exercises using hoops, such as split steps, linear drills, linear and multi-directional side jumps.	Short sprints with slight changes of direction, for example, from 1 to 3 change of directions, at different angles (30 degrees and 45 degrees).	4	2’	30”	10’	5’	1	200
								2	200
								3	200
								4	200
3-4	Agility ladder exercises with a set of basic exercises (for example, one or two jumps in front of the ladder, then jumping and hooping).	Short sprints with multiple changes in direction, for example, from 3 to 5 changes, at different angles (30 degrees, 45 degrees, and 90 degrees).	4	2’	30”	10’	5’	5	232
								6	232
								7	232
								8	200
5-6	Ladder exercises with a set of advanced exercises (for example: carioca on the ladder, cha-cha on the ladder or between the cones, slalom exercises using poles or cones, with and without the ball).	Agility exercises responding to different commands or stimuli (for example, color, number, and directional cues), in addition to short multiple-direction sprint exercises.	4	2’	30”	10’	5’	9	264
								10	200
								11	297
								12	225
7-8	Agility ladder exercises combined with agility drills, for example, reaction to a visual stimulus.	Agility training with partner, designed to be competitive between players, such as chase drill and mimicking opponent's movements (mirror drills).	4	2’	30”	10’	5’	13	200
								14	175
								15	175
								16	175

W – week; S – Session; sRPE – Session RPE; A.U – Arbitrary Unit.

Table 3. Small-Sided-Game training program

W	S	Format	Field dimension (m)	APP (m^2)	Set duration (min)	Number of sets	Rest duration (min) and type	Load (A.U)
1	1	3v3	12 × 20	40	3’	4	2’ (Semi active)	126
	2	2v2	10 × 15	38	2’	6	1’ 30” (Semi active)	156
2	3	3v3	15 × 20	50	2’ 30”	6	2’ (Semi active)	175
	4	2v2	10 × 15	38	1’ 30”	8	1’ (Semi active)	152
3	5	3v3	15 × 25	63	3’	5	3’ (Semi active)	189
	6	2v2	15 × 20	75	2’	6	2’ (Semi active)	176
4	7	3v3	15 × 25	63	2’ 30”	6	3’ (Semi active)	210
	8	2v2	15 × 20	75	1’ 30”	8	2’ (Semi active)	208
5	9	3v3	18 × 30	90	3’	6	3’ (Semi active)	264
	10	2v2	20 × 25	125	1’ 30”	6	2’ (Semi active)	152
6	11	3v3	15 × 20	50	2’ 30”	6	2’ (Semi active)	272
	12	2v2	10 × 15	38	1’ 30”	8	1’ (Semi active)	171
7	13	3v3	12 × 20	40	3’	4	2’ (Semi active)	133
	14	2v2	10 × 15	38	2’	6	1’ 30” (Semi active)	156
8	15	3v3	15 × 25	63	2’ 30”	4	3’ (Semi active)	133
	16	2v2	15 × 20	75	1’	8	2’ (Semi active)	176

W – week; S – session; APP – area per player; A.U – Arbitrary Unit.

For comparisons of post-test scores between groups, a two-way mixed analysis of variance (ANOVA) was used, considering factors for time (pre-test and post-test) and group (SAQ and SSG). Bonferroni post hoc tests were applied when a significant group x time interaction was observed, aiding interpretation of these interactions. Partial eta-squared (η^2) was utilized to assess the differences between groups, with η^2 values indicating effect size: small (0.01), moderate (0.06), and large (0.14). The significance level was set at $p < 0.05$ for all analyses.

Table 4. Comparison of changes in speed and power between SAQ and SSG training

Variables	SAQ training group (n = 12)				SSG training group (n = 12)				Main time effect	Time x group
	Pre-test	Post-test	%Δ	p-values [g] Magnitude	Pre-test	Post-test	%Δ	p-values [g] Magnitude	p-values [η^2] Magnitude	p-values [η^2] Magnitude
	Mean ± SD				Mean ± SD					
10-m sprint times (s)	1.72 ± 0.72	1.61 ± 0.72	6.39 %	0.000* [0.15] Trivial	1.74 ± 0.50	1.64 ± 0.55	5.74 %	0.000* [0.19] Trivial	0.000# [0.814] Large	0.758 [0.004] Small
20-m sprint times (s)	3.11 ± 0.12	2.93 ± 0.10	5.78 %	0.000* [1.62] Large	3.10 ± 0.08	2.97 ± 0.09	4.19 %	0.001* [1.52] Large	0.000# [0.736] Large	0.270 [0.055] Small
CODS time (s)	6.51 ± 0.20	6.36 ± 0.21	2.30 %	0.001* [0.73] Moderate	6.59 ± 0.36	6.44 ± 0.29	2.27 %	0.015* [0.45] Small	0.000# [0.529] Large	0.914 [0.001] Small
RSA_{mean} time (s)	7.64 ± 0.29	7.43 ± 0.17	2.74 %	0.002* [0.88] Moderate	7.74 ± 0.32	7.48 ± 0.18	3.35 %	0.006* [1.00] Moderate	0.000# [0.543] Large	0.595 [0.013] Small
SJ (cm)	25.61 ± 4.89	29.70 ± 5.13	15.97 %	0.000* [0.81] Moderate	25.76 ± 5.09	29.21 ± 5.42	13.39 %	0.000* [0.65] Moderate	0.000# [0.970] Large	0.427 [0.029] Small
CMJ_{height} (cm)	27.38 ± 4.52	31.93 ± 5.86	16.61 %	0.000* [0.86] Moderate	28.30 ± 4.95	32.99 ± 4.73	16.57 %	0.000* [0.96] Moderate	0.000# [0.838] Large	0.875 [0.001] Small
CMJ_{power} (Watt)	1438.67 ± 258.08	1683.74 ± 345.08	17.03 %	0.000* [0.80] Moderate	1362.95 ± 355.10	1592.64 ± 373.56	16.85 %	0.000* [0.63] Moderate	0.000# [0.826] Large	0.743 [0.005] Small

%Δ – Percentage change between pre- and post-tests; g – Hedges' g effect size; η^2 – Partial eta-squared; * – significant difference between pre- and post-tests; # – significant main time effect.

Results

Table 4 shows significant improvements across various performance measures for both training groups. For the SAQ training group, the 10-m sprint times improved by 6.39% (p = 0.000, g = 0.15), 20-m sprint times improved by 5.78% (p = 0.000, g = 1.62), CODs time improved by 2.30% (p = 0.001, g = 0.73), and RSA_{mean} time improved by 2.74% (p = 0.002, g = 0.88). In addition, vertical jump measures such as SJ and CMJ_{height} increased by 15.97% and 16.61% respectively (p = 0.000, g = 0.81 and g = 0.86), and CMJ_{power} improved by 17.03% (p = 0.000, g = 0.80).

Similarly, the SSG training group showed a 5.74% improvement in 10-m sprint times (p = 0.000, g = 0.19), a 4.19% improvement in 20-m sprint times (p = 0.001, g = 1.52), a 2.27% improvement in CODs time (p = 0.015, g = 0.45), and a 3.35% improvement in RSA_{mean} time (p = 0.006, g = 1.00). Improvements in vertical jump measures were also observed, with SJ and CMJ_{height} increasing by 13.39% and 16.57% respectively (p = 0.000, g = 0.65 and g = 0.96), and CMJ_{power} increasing by 16.85% (p = 0.000, g = 0.63).

The main time effects were significant across all variables (p = 0.000), with large effect sizes (η^2 ranging from 0.529 to 0.970). However, the time x group interactions were small (η^2 ranging from 0.001 to 0.055), indicating that while both training programs were effective, there were no significant differences between the effects of the SAQ and SSG training programs.

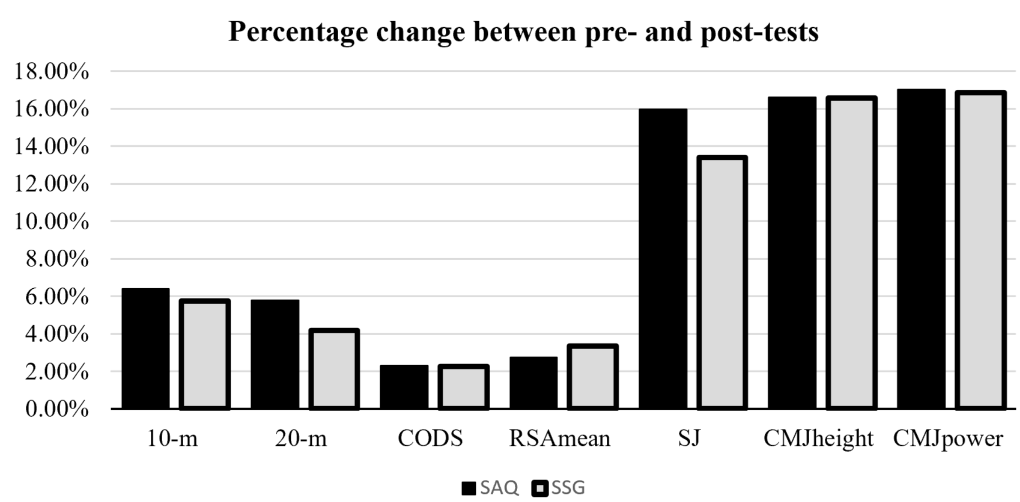

Figure 3. Percentage change between pre- and post-tests in all measurements

Discussion

The aim of this study was to compare the effects of SAQ training and SSG training on speed and power performance in young soccer players. The main findings indicated a statistically significant improvement in all studied speed and power variables when both training methods were applied for 8 weeks (all $p < 0.05$), with no statistically significant difference between the two methods (all $p > 0.05$).

The study results concluded that both SSG in the formats (2v2, 3v3) and SAQ training programs were effective in improving linear speed over distances of 10 meters and 20 meters. This aligns with numerous studies, including Owen et al. [35], which found that implementing a training program with SSG (3v3+-goalkeepers) during a 4-week off-season period improved the physical fitness characteristics of soccer players. Chaouachi et al. [36] confirmed that a training program including SSG (1v1, 2v2, and 3v3) for 6 weeks significantly improved linear speed in 15m and 30m tests. These results can be supported by Katis and Kellis [37], who noted that SSG are included in soccer training because they provide more space, allowing players to be creative and increase their movements. This is especially true for SSG drills aimed at developing speed, which are conducted with a small number of players (2v2, 3v3) in large spaces, allowing for repeated accelerations and sprints. Previous data analysis of player performance during SSG training showed that 8 sets of 3v3 SSG, totaling 24 minutes of work per training week, resulted in approximately 9 high-intensity and maximal accelerations and decelerations. Players also performed about 13 very high-intensity runs (zone five) and 11 high-intensity runs (zone four) [38]. Similarly, during 4v4 SSG format, players performed about 18 maximum accelerations and 18 maximum decelerations during each of the 6 sets of three minutes [39], demonstrating the effectiveness of SSG in improving this physical quality.

Some studies have also confirmed the effectiveness of training programs that include SAQ training in improving speed performance in soccer players. Azmi and Kusnanik [20] reported that an 8-week SAQ training program effectively improved 30 m speed and 10m acceleration in soccer players. Trecroci et al. [19] found that a short 4-week training program with SAQ training effectively improved 5 m and 20 m linear speed in pre-adolescent soccer players. It can be said that SAQ training is an effective method for improving short-distance speed times over 5 and 10 meters, but not more than 20 meters [18]. This was also observed in female soccer players, where an 8-week SAQ training program effectively improved 5m and 10m linear acceleration in the U20 category [40].

The study results also concluded that both training programs were effective in improving the level of CODs without the ball over a distance of 20 meters. This aligns with the results of many studies in this field [22, 36]. Arslan et al. [41] confirmed that SSG (2v2) may be a more effective training system for improving CODs in soccer players. Dello Iacono et al. [42] emphasized that incorporating SSG during the competitive season is effective in developing various physical abilities in soccer players, particularly CODs abilities. Hill Haas et al. [21] explained the effectiveness of SSG in developing soccer-specific abilities by highlighting that they provide numerous practical advantages, seeming to replicate movement demands such as sprinting, jumping, and CODs. However, our study results differed from those of Katis & Kellis [37], which found a significant decrease in CODs performance after the intervention of SSG (3v3) in 13 years old soccer players.

Concerning SAQ training, previous studies have confirmed its effectiveness in improving CODs abilities in soccer players [36, 43]. Milanović et al. [17] demonstrated that SAQ training is an effective method for improving agility with and without the ball in young soccer players. Since SAQ training includes short, high-speed exercises with CODs, this explains the achieved results. Additionally, linear speed training can also have an impact on improving CODs speed, especially since linear speed is an integral part of most CODs tasks, aiding in achieving faster times during CODs performance [44]. This can be attributed to the improvement in this quality.

Regarding RSA_{mean} results, the study results concluded that both training programs were effective in improving RSA. This aligns with the results of Owen et al. [35], which found that implementing a small-sided games training program (3v3 + goalkeepers) during the off-season for 4 weeks was able to improve RSA in soccer players. In their study on the impact of SSG on high-intensity actions in soccer, Calderón Pellegrino et al. [45] stated that the number of sprints was higher during SSG training. Brandes et al. [46] also found that there were clear demands on anaerobic energy supply after the intervention of SSG (2v2) during soccer training, which can be interpreted physiologically concerning the results achieved. However, our study results differed from those of Gabbett & Mulvey [47], who found that SSG training matches movement patterns during soccer competitions but provides insufficient training stimulus to replicate the demands of RSA during competitions.

There are few studies that have confirmed the effectiveness of training programs that include SAQ training in improving RSA in soccer players. It has been emphasized that explosive training that combines jumping and sprinting exercises helps improve RSA [48]. SAQ training is a modern training system that results in integrated effects on various physical abilities within a single training program. Polman et al. [49] also supported these findings, stating that SAQ training enables soccer players to become better at responding to stimuli, improving acceleration, moving effectively in multiple directions, and quickly changing direction or stopping to play in a fast, effective, smooth, and repeatable manner, which explains the results obtained in our study. SAQ training can be considered to integrate qualities of speed, agility, and quickness simultaneously through a set of soccer-specific exercises, with all exercises being performed with optimal biomechanical movement structures repeatedly [5], which may explain the results obtained after the intervention of the SAQ training program.

Considering power performance, which was measured using the CMJ and SJ tests for the lower limbs that are strongly associated with this physical quality [30], the results indicated significant improvement after implementing both SAQ and SSG training. The findings of this study are consistent with previous results regarding SAQ training, where Jovanovic et al. [5] observed improvements in muscle power through the CMJ test and continuous jumping with leg extension test in elite soccer players. Since SAQ training consists of speed, agility and change of direction drills and quickness, it has been confirmed that speed training or change of direction speed training, or a combination of both, helps improve power in 14-18-year-old male soccer players [36, 50, 51].

Similarly, the results of the current study are in agreement with previous findings regarding SSG training methods. It was reported that 3v3 SSG contributed to improving vertical jump performance in young soccer players [52]. The results of this study also align with findings for young female soccer players, where power significantly improved after an 8-week training program of 2v2 and 3v3 SSG [53] and 2v2 and 4v4 SSG training program [54]. Additionally, it was confirmed that applying 2v2 SGG three times a week for 4 weeks after a four-week detraining improved muscle power in U17 soccer players [55]. Conversely, the current findings differ from the study by Los Arcos et al. [56], which found no improvement in the CMJ test after applying 4v4 small-sided games for 6 weeks, as well as the study by Chaouachi et al. [36] after applying 1v1, 2v2, and 3v3 small-sided games for 6 weeks.

As previously confirmed, performing repeated accelerations, sprints, changes of direction, and jumps during SAQ [5] and SSG [38] training sessions helped improve the muscular power of players. Those movements are considered explosive actions that utilize the stretch-shortening cycle (SSC) during their execution [57]. This cycle involves a muscular action where a lengthening of the muscle is followed immediately by a shortening [58]. Accelerations and sprints are fast expressions of the SSC (<250 milliseconds) [59], thus sprint training effectively trains the muscles to produce force rapidly and helps improve power output [60] and consequently enhances the performance of explosive movements.

The results of this study also showed that there was no statistically significant difference between SAQ and SSG methods in enhancing these variables. These findings are consistent with the study by Trecroci et al. [19], which found no difference between SAQ and SSG training in linear speed and change of direction speed among pre-adolescent soccer players. However, the percentages represented in Table 4 and Figure 3 indicated a slight advantage for SSG training in repeated sprint ability compared to SAQ training (3.35% vs. 2.74%, respectively). Conversely, SAQ training showed a slight advantage in 10- and 20-meter sprint speed and vertical jump (SJ) performance over SSG training (6.39%, 5.78%, 15.97% vs. 5.74%, 4.19%, 13.39%, respectively). This finding is also supported by Chaouachi et al. [36], where multi-directional sprint training showed superior improvement in sprinting and jumping over SSG training. These results can be attributed to the total external load of each training method. SSG training resembles game performance, but the number of explosive activities during the performance is lower than in SAQ training, especially since SAQ training involves a controlled and calculated number of repetitions and focuses on these activities only [5, 38].

Limitations and future research

The current study compared two training methods frequently used in soccer to physically prepare players: SAQ and SSG training. Despite addressing many physical performance measures, the study did not consider some important physical elements, such as reactive agility, 30-meter sprint, and Vo2max. Therefore, this study serves as a starting point for future research that might compare these two methods across various physical performance measures. Another limitation of this study is that, despite relying on SAQ and SSG training only as physical training, as well as technical and tactical training during team training, including a control group could help isolate the potential impact of technical and tactical training on physical performance.

Conclusions

In conclusion, the study demonstrates that both SAQ and SSG training programs are effective in significantly improving performance measures such as sprint, change of direction speed, repeated sprint ability, and vertical jump metrics in soccer players. The lack of significant differences between the two training methods suggests that either program can be effectively implemented to enhance athletic performance in soccer. Coaches and fitness coaches can select either training regimen based on specific training goals and player needs.

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