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Combined small-sided games and resistance training: Acute impact on physical capacity in young soccer players

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ABSTRACT

Background Problems: There are not many studies concerning a method combining resistance training (RT) and small-sided games (SSG) shortly on young soccer players. **Research Objectives**: This study reveals the acute impact of the combination of resistance training with small-sided games on the physical capacity of young soccer players. **Methods**: Quasi Experiment with a pretest-posttest group design, involving sixty students of Undiksha Soccer Student Activity Unit using a simple random sampling technique. Thirty samples each entered the combined group (SSG+RT), the small-sided games only (SSG) group, and all were involved in training four times a week (four weeks). Two sessions of aerobic endurance, agility, and leg muscle power (LMP) data collection were conducted in the field. Data were analysed using one-way MANOVA assisted by SPSS 16.0 with a significance level of 5%. **Findings and Results**: One-way MANOVA test showed F value = 61.390 and sig. value 0.000 ($p < 0.05$), which means there was a significant effect on aerobic endurance, agility, and LMP in both groups. There was no difference in aerobic endurance results in the SSG+RT and SSG groups with a sig. value of 0.092 ($p > 0.05$), but there was a difference in the two groups in agility with a sig. value of 0.000 ($p < 0.05$) and LMP with a sig. value of 0.000 ($p < 0.05$). **Conclusion**: To improve aerobic endurance, agility, and LMP simultaneously, a combined training method can be implemented, namely integrating resistance training into small-sided games. The current findings can help to improve the performance of young soccer players in a short time. However, it is necessary to study more deeply other variables that have the potential to affect the results of the current findings, such as longer training times.

Keywords: Resistance training; small-sided games; physical capacity; soccer

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INTRODUCTION

Knowledge of the trends and evolution of soccer's external loads has continued to increase over the past two decades (Gabbett et al., 2017). Variables such as the distance traveled and running intensity of the players were analysed (Rago et al., 2020). Currently, soccer is included in the competitive sport with the high-intensity explosive category (Rivilla-García et al., 2019). Each player relies heavily on energy metabolism and short-time high-intensity intermittent for things like running at variable speeds, shooting, and sliding tackles, with the player's heart rate reaching around 80% to 90% of maximum herat rate (HRmax) to be able to play competitively (Arslan et al., 2021). The physical demands of each player vary depending on the player's position, opponent tactics, and team strategy (Bush et al., 2015). Young soccer players demonstrate very high running intensity (> 16 km h^{-1}) with distances reaching 9.9 km (Buchheit & Mendez-Villanueva, 2014). So researchers and soccer coaches have implemented training models that can increase the aerobic endurance capacity of young soccer players, such as through High-Intensity Interval Training (Arslan et al., 2020), sprint-based training (Marzouki et al., 2021), and small-sided games (Arcos et al., 2015; Köklü et al., 2020). However, soccer players need special physical aspects that follow the characteristics of soccer matches, such as agility, and explosiveness for short-distance sprinting, jumping, shooting, and dribbling (Sarmento et al., 2018).

One of the training methods that is fun, effective, and time efficient in improving player performance, one of which is the endurance component, is training using small-sided games (Clemente, Martins et al., 2014; Kusuma et al., 2023). Small-sided games (SSG) can improve player performance simultaneously (Clemente, Wong et al., 2014). SSG is also called small-sided and conditioned games because its characteristics are game-based conditioning by intervening in the number of players, playing space, and playing rules (Caso & van der Kamp, 2020; Davids et al., 2013). Several studies in a decade on the impact of SSG training (5 to 8 weeks) on physical (including physiological), technical, tactical, and psychophysiological aspects in young soccer players (Gonet et al., 2020; Karahan, 2020; Köklü et al., 2021; Ouertatani et al., 2022). So SSG is currently the most frequently used option because it has a better impact than conventional endurance training methods (Moran et al., 2019).

As is known that during a soccer game, players perform various actions such as running changing direction, dribbling followed by shooting, heading in the air, and body charge, all of which are based on strength. Therefore, the strength component is also an important element in supporting player performance. Previous research has revealed that strength training has a positive impact on players' balance abilities (Granacher et al., 2014), agility (Sever & Zorba, 2018), speed (Kusuma et al., 2021), and endurance (Hung et al., 2019). In other findings regarding the impact of strength training using the resistance training method, it has also been proven to be able to increase the speed, agility, strength, and power of young athletes (McQuilliam et al., 2020; Raya-González et al., 2021). In addition to the findings on the effects of strength training, combining strength training with SSG was also effective in improving the specific performance of young soccer players (Makhlouf et al., 2016; Querido & Clemente, 2020).

A study combining strength training and SSG to see the impact on the performance of young soccer players over a long period (6 to 12 weeks) (Arslan et al., 2021; Karsten et al., 2016; Lagodimos et al., 2024). In the 7 week physical education process, it was also revealed that SSG training combined with strength training had a better internal load impact than training with SSG alone (Sierra-Ríos et al., 2021). Until now, there has been no short-term effect (4 weeks) of combined strength training using resistance training and SSG methods on the physical performance response of young soccer players during the off-competition period. Therefore, this study aims to reveal the acute impact of the combination of resistance training with small-sided games on the physical capacity of young soccer players.

The physical capacity referred to in this study includes endurance, agility, and leg power muscle. The assumption is that the increase in player power is obtained in resistance training, and agility and endurance abilities increase through SSG training. Although there are reports stating that the negative impact of the combination is the inhibition of protein formation in mitochondria due to endurance training (Murach & Bagley, 2016; Wilson et al., 2012), this study tries to regulate the training volume and intensity so that the combination of these training methods has a positive impact. The training volume setting in this study was

arranged low but fast (no more than 10 minutes) and still with high intensity. Determining the dose like that has been proven to have little negative impact on weight training adaptation (Methenitis, 2018). So combining these two methods, also known as concurrent training, have a significant impact on the overall physical capacity of young soccer players.

METHOD

This is descriptive research in the form of quasi-experiments. The research design used was the pretest-posttest group design (figure 1). The sample in this study amounted to 60 players from the Undiksha Soccer Student Activity Unit with the following requirements: age under 23 years (20.50 ± 0.51 years), male, and a minimum of 2 years of training experience. The sampling technique used was simple random sampling so that 30 samples were included in the combined SSG and RT (SSG+RT) group and 30 samples were included in the SSG group.

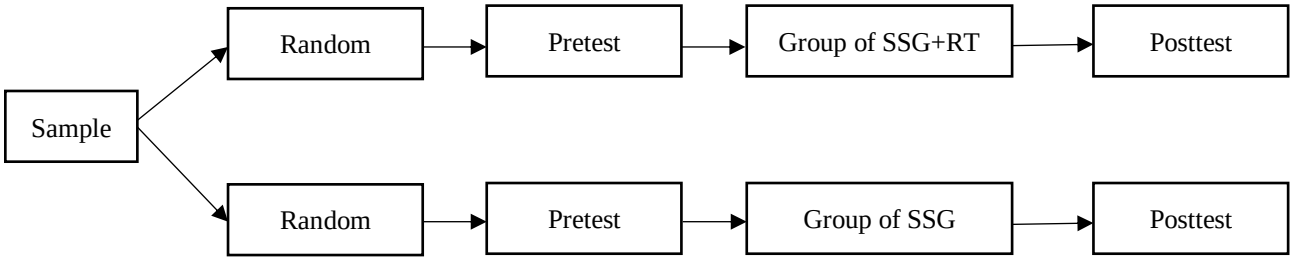

Figure 1. Pretest-Posttest Group Design

The sample underwent training for 4 weeks with 4 meetings during a week. The training protocol was divided into three sessions, namely the first opening session consisting of prayer, a short explanation, and a warm-up using the RAMP protocol (Jeffreys, 2019; Racinais et al., 2017). The second session was the core training session, namely the SSG+RT group did strength training using resistance bands (in-and-out run; side shuffle right; side shuffle left; resisted backpedal; resisted sprint; resisted broad jump; lateral reach w/shuffle right; lateral reach w/shuffle left) and kettlebells (swing; deadlift and row; clean to press; back lunges; squat to press; side squat; single-leg deadlift; alternating row) with a dose of 3 sets, 20 to 30 seconds per set, and active recovery between sets of 40 seconds, then continued with 3-a-side small-sided games and 5-a-side small-sided games with a target of 85% -100% HRmax (Table 1). Before conducting training at the first meeting, a pretest was conducted and after the sixteenth training, a posttest was conducted to obtain physical capacity data in the form of agility, muscle leg power, and aerobic endurance. Agility data was obtained using the illinoist agility test instrument (Da Cruz et al., 2020), standing broad jump was used to obtain muscle leg power data (Merino-Marban et al., 2021), and aerobic endurance was measured using the Yo-Yo Intermittent Recovery Test Level 1 (Bangsbo et al., 2008; Castagna et al., 2020). Pretest and posttest data from the sample were analysed using one-way MANOVA assisted by the SPSS 16.0 application with a significance level of 0.05.

Table 1. The 4 Week Training Program

Training	Sessions	Training Program															
		1-week				2-week				3-week				4-week			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Resistance Training	Exercise Type	Dynamic (Circuit)				Dynamic (Circuit)				Dynamic (Circuit)				Dynamic (Circuit)			
	Set x Dur	3 x 20 seconds				3 x 20 seconds				3 x 30 seconds				3 x 30 seconds			
	Work: Rest Ratio	1:2				1:2				1:1				1:1			
	Rest Interval	40 seconds															

Training	Sessions	Training Program															
		1-week				2-week				3-week				4-week			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Small-Sided Games	Exercise	Kettlebell	Resistance band	Kettlebell	Resistance band	Kettlebell	Resistance band	Kettlebell	Resistance band	Kettlebell	Resistance band	Kettlebell	Resistance band	Kettlebell	Resistance band	Kettlebell	Resistance band
	SSG Format	5-a-side	3-a-side	5-a-side	3-a-side	5-a-side	3-a-side	5-a-side	3-a-side	5-a-side	3-a-side	5-a-side	3-a-side	5-a-side	3-a-side	5-a-side	3-a-side
	Pitch Dimension (m x m)	30 x 40	18 x 30	30 x 40	18 x 30	30 x 40	18 x 30	30 x 40	18 x 30	30 x 40	18 x 30	30 x 40	18 x 30	30 x 40	18 x 30	30 x 40	18 x 30
	Duration (min)	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3
	Number of Bout	4															
	Resting Duration (min)	3															
	Goalkeeper	Yes															
	Coach Encouragement	Yes															

RESULTS AND DISCUSSION

The acute impact of combined SSG + RT training on leg muscle power (LMP), agility, and endurance is presented in Table 2. The SSG+RT training method applied to young soccer players has proven effective in increasing aerobic endurance, agility, and leg muscle power. This can be seen from the mean score obtained by young soccer players before and after being given training with the SSG+RT method.

Table 2. The Result of Descriptive Analysis with SSG + RT Training

		Pretest LMP SSG+RT (m)	Pretest Agility SSG+RT (second)	Pretest VO_2 max SSG+RT (ml/kg/min)	Posttest LMP SSG+RT (m)	Posttest Agility SSG+RT (second)	Posttest VO_2 max SSG+RT (ml/kg/min)
N	Valid	30	30	30	30	30	30
	Missing	0	0	0	0	0	0
Mean		2.20	17.52	66.35	2.41	15.48	68.42
Median		2.20	17.51	66.80	2.40	15.21	67.00
Std. Deviation		.18	.83	5.06	.14	.43	5.00
Variance		.032	.69	25.58	.02	.19	25.02
Range		.70	3.27	21.90	.60	1.17	21.20
Minimum		1.80	16.15	58.60	2.10	15.05	60.30
Maximum		2.50	19.42	80.50	2.70	16.22	81.50
Sum		66.10	525.79	1990.50	72.30	464.54	2052.70

The mean score before being given training with the SSG+RT method obtained a leg muscle power value of 2.20 meters, and after being given treatment, the average post-test value was 2.41 meters. It shows that after being given treatment with the SSG+RT training method, there was an increase of 0.21 meters. For agility, before being given treatment with the SSG+RT training method, the mean score was 17.52 seconds; after being given SSG+RT training, the mean score was 15.48 seconds. This shows that there was an increase of

2.04 seconds. While for VO_2 max as a parameter of endurance level, the mean score before being given SSG+RT training was 66.35 ml/kg/min; after being given SSG+RT training, it was 68.42 ml/kg/min. This shows that there was an increase in VO_2 max of 2.07 ml/kg/min. The following graphically presents the average pretest and posttest values for aerobic endurance, agility, and LMP (figure 2).

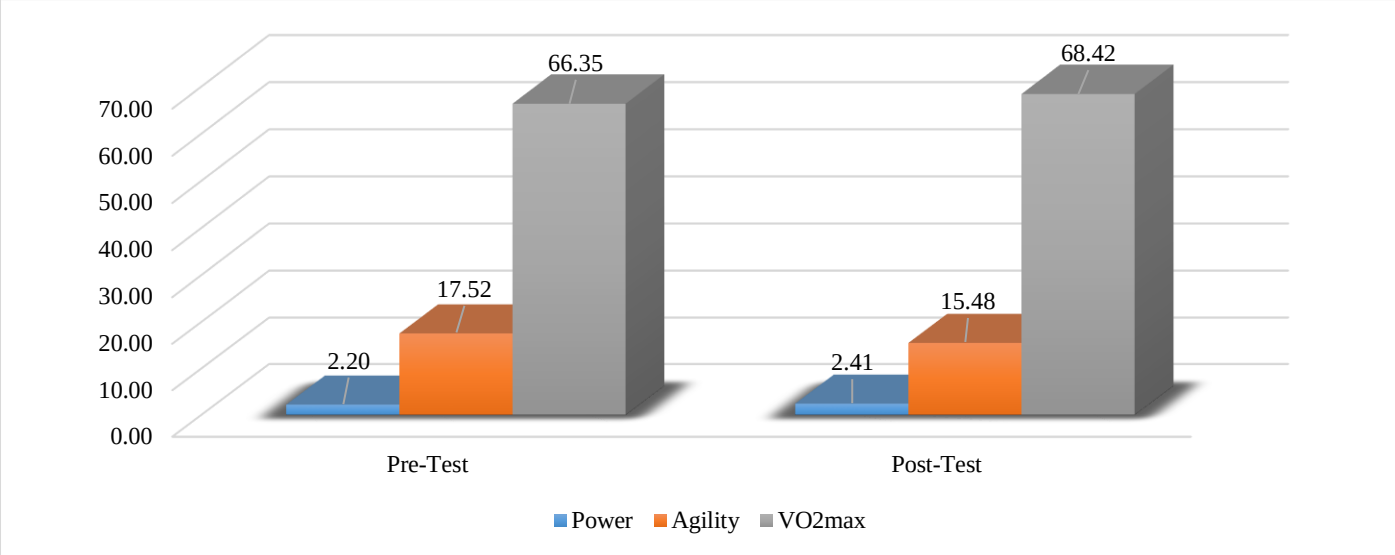

Figure 2. Mean Score of the Pretest-Posttest of the SSG+RT Group

Meanwhile, the results of descriptive data analysis for training with the SSG model on young soccer players obtained results as in Table 3. Based on the results of data analysis as in Table 3, SSG training applied to young soccer players has proven effective in increasing aerobic endurance, agility, and leg muscle power. This can be seen from the mean score obtained by young soccer players before and after being given SSG training.

Table 3. The Result of Descriptive Analysis of the SSG Training

		Pretest LMP SSG (m)	Pretest Agility SSG (second)	Pretest VO_2 max SSG (ml/kg/min)	Posttest LMP SSG (m)	Posttest Agility SSG (second)	Posttest VO_2 max SSG (ml/kg/min)
N	Valid	30	30	30	30	30	30
	Missing	0	0	0	0	0	0
Mean		2.23	17.55	65.53	2.25	17.22	68.25
Median		2.20	17.51	65.70	2.20	17.28	68.80
Std. Deviation		.18	.81	4.62	.16	.66	4.18
Variance		.03	.66	21.34	.02	.44	17.47
Range		.70	3.27	21.90	.65	2.45	21.40
Minimum		1.80	16.15	58.60	1.90	16.07	60.10
Maximum		2.50	19.42	80.50	2.55	18.52	81.50
Sum		66.80	526.52	1966.00	67.75	516.70	2077.70

The mean score before being given SSG training was obtained for LMP of 2.23 meters, and after being given treatment, the mean score of the posttest was obtained of 2.25 meters. It shows that after being given SSG training, there was an increase of 0.02. The agility value before being given SSG training obtained a mean score of 17.55 seconds, and after being given SSG training, it obtained a mean score of 17.22 seconds; this shows that there was an increase of 0.33 seconds. For VO_2 max, the mean score before being given SSG training was 65.53 ml/kg/min, and after being given SSG training, it was 68.25 ml/kg/min; this shows that there was an increase in VO_2 max of 2.72 ml/kg/min. The following is a graph of the mean scores of the pre-test and post-test for aerobic endurance, agility, and LMP as shown in figure 3.

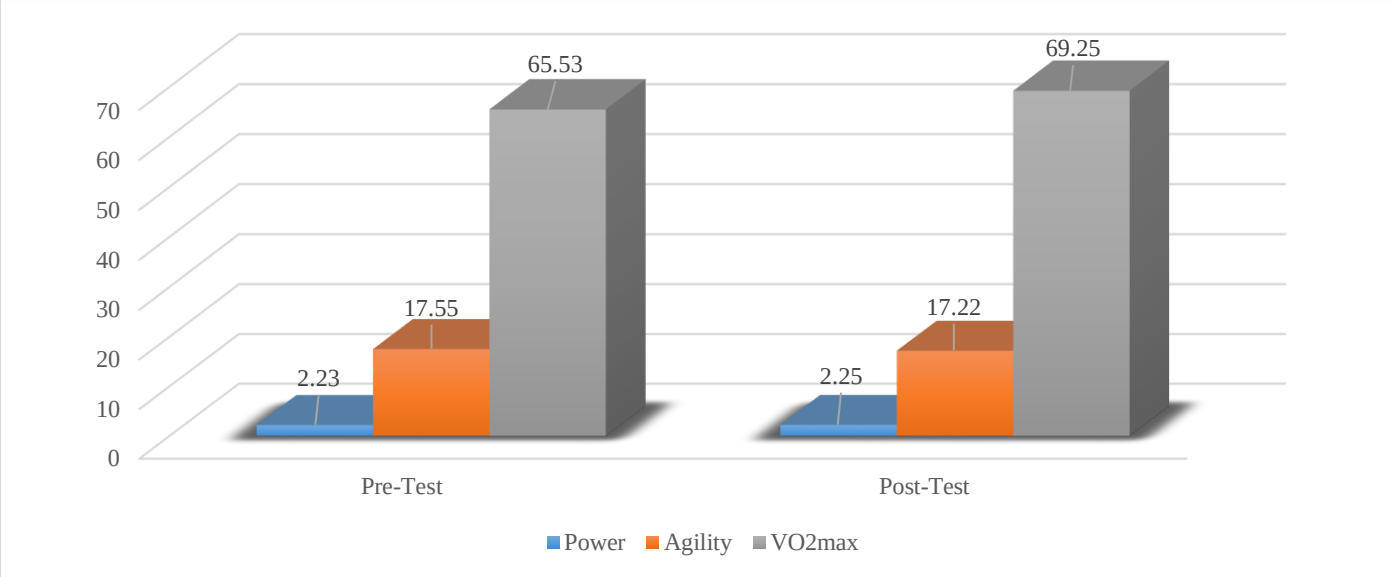

Figure 3. Mean Score of the Pretest-Posttest of the SSG Group

The SSG+RT and SSG training methods were also proven to have a significant effect on endurance, agility, and LMP. The level of significance through Pillai's Trace, Wilks' Lambda, Hotelling's Trace, and Roy's Largest Root tests (Table 4) each with an F value = 61.390, and all were smaller than 0.05 ($p < 0.05$).

Table 4. The Result of the Manova Test for the Effect of Training Method on the LMP, Agility, Endurance

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	0.854	108.774b	3.000	56.000	0.000
	Wilks' Lambda	0.146	108.774b	3.000	56.000	0.000
	Hotelling's Trace	5.827	108.774b	3.000	56.000	0.000
	Roy's Largest Root	5.827	108.774b	3.000	56.000	0.000
Training Method	Pillai's Trace	0.767	61.390b	3.000	56.000	0.000
	Wilks' Lambda	0.233	61.390b	3.000	56.000	0.000
	Hotelling's Trace	3.289	61.390b	3.000	56.000	0.000
	Roy's Largest Root	3.289	61.390b	3.000	56.000	0.000

The next test was to analyse the differences in endurance results, LMP, and agility of the two groups (Table 5). The results of the MANOVA calculation on the leg muscle power variable, the statistical values of Pillai's Trace, Wilk's Lambda, Hotelling's Trace, and Roy's Largest Root each with $F = 93.133$ and $p < 0.05$, which means that there was a significant difference in LMP between the group of young soccer players who participated in training with SSG+RT and the SSG group. In the agility variable ($F = 130.477$ and $p < 0.05$) there was also a significant difference between the group of young soccer players who participated in training with SSG+RT and the SSG group. Analysis of the endurance variable ($F = 2.937$ and $p > 0.05$) shows that there was no difference between the group of young soccer players who participated in training with SSG+RT and the SSG group. Based on this analysis, the SSG+RT group showed better results than the SSG group in terms of increasing LMP and agility.

Table 5. The Result of the Manova Test for the Variables of LMP, Agility, and Endurance Between the Two Groups

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	Power	.459a	1	.459	93.133	.000
	Agility	44.084b	1	44.084	130.477	.000
	VO_2 max	23.188c	1	23.188	2.937	.092
Intercept	Power	.852	1	.852	172.741	.000
	Agility	84.182	1	84.182	249.157	.000
	VO_2 max	435.782	1	435.782	55.191	.000
Training SSG	Power	.459	1	.459	93.133	.000
	Agility	44.084	1	44.084	130.477	.000

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
	VO_2 max	23.188	1	23.188	2.937	.092
	Power	.286	58	.005		
Error	Agility	19.596	58	.338		
	VO_2 max	457.960	58	7.896		
	Power	1.598	60			
Total	Agility	147.863	60			
	VO_2 max	916.930	60			
	Power	.745	59			
Corrected Total	Agility	63.680	59			
	VO_2 max	481.148	59			

The purpose of this study was to analyse the acute impact of two SSG-based training programmes, namely SSG+RT and SSG, on the physical capacity of young soccer players, such as leg muscle power, agility, and endurance, after a 4-week intervention with a frequency of 16 meetings. The analysis showed that there was a significant effect in both groups on the components of leg muscle power, agility, and endurance. Inter-group analysis showed a greater increase in leg muscle power and agility in SSG+RT than in SSG, but there was no significant difference in the endurance component.

Combined training methods have been extensively researched in the previous decade (Loturco et al., 2017; Pardos-Mainer et al., 2020; Tayebi et al., 2019). More specifically, several articles describe the effects of combining small-sided games training with high-intensity running-based training on aerobic endurance capacity (Harrison et al., 2015; Rabbani et al., 2019), and anaerobic endurance (Fahrudin et al., 2024; Nayıroğlu et al., 2022; Nobari et al., 2022). Some of the studies mentioned used parallel designs and were almost the same as the research design we conducted, namely testing the combination of SSG with resistance training and using only SSG. The current findings show an increase in the aerobic performance of players in both groups. This increase in performance is in line with previous findings, both in the meta-analysis (Clemente et al., 2021; Moran et al., 2019), and field research (Hammami, Randers et al., 2018; Bharlaman et al., 2024). During SSG, players engage in very high activity through rule modifications such as the number of players involved and the number of touches on the ball by each player (Kusuma & Kardiawan, 2018), with short recovery time (Sabag et al., 2022). Each player runs at maximum speed and accelerates continuously, interspersed with jogging or walking for a short time, and then runs again with or without the ball (Kusuma et al., 2023). The situation in SSG is of course very relevant to the situation and demands during a soccer match. The SSG+RT group did not experience a decrease in endurance performance. This reinforces previous findings that combining resistance training with SSG does not affect physical demands with recovery between two sessions performed on the same day (Sparkes et al., 2020).

Concerning the measurement of neuromuscular or musculoskeletal-based biomotor components, players who received SSG+RT treatment received better benefits in terms of agility and leg muscle power compared to those who only trained with SSG. The addition of strength training to field-based training such as SSG was reported to have a large correlation with vertical jump (Kabacinski et al., 2022; Śliwowski et al., 2018), and benefits to player performance (Prieske et al., 2016). The increase in agility was also significant between the SSG+RT group compared to the SSG group. This finding reinforces previous findings that stated that there is a relationship between the two variables (Comfort et al., 2014). It has also been reported that the muscular strength and explosive power possessed by young soccer players can improve their ability to change direction quickly or agility (Hammami, Negra et al., 2018; Köklü et al., 2015).

CONCLUSION

The current findings are very interesting because they can show a significant effect on endurance, agility, and leg muscle power in young soccer players after receiving a combined training method between SSG and Resistance Training (SSG+RT) in a short time. The current findings can provide innovations about the acute impact on the physical performance of young soccer players in the short term from the combination of endurance and strength training. However, this study has limitations regarding the absence of a control group as a comparison of the results of the other two treatment groups. This field-based strength training dose can

also be considered in further research. Because in the endurance variable between the SSG+RT and SSG groups, no significant differences were found. So further research is open to answering the problem to find the latest theory about the effectiveness of a more effective combined training method. Thus, the direction of future research is to determine the dose of training in the combined training method that can provide a better impact on endurance than SSG training. Some findings on strength training are beneficial to the neuromuscular fitness of young soccer players. Current findings also confirm that this short-term resistance-based strength training has an impact on the performance of leg muscle agility and power. The advantages of implementing SSG+RT are that it saves time, is cost-effective, and the results are very effective so that soccer coaches can apply this method without expensive equipment, special strength, or aerobic training rooms, to improve the performance of soccer players in the pre-season.

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CONFLICT OF INTEREST

The author believes that there is no conflict of interest from data collection to the preparation of this academic manuscript, either between the authors or between related institutions.

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