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Research article

The Effects of Small Vs. Large-Sided Games on Physical Fitness Adaptations: A Randomized Controlled Design in Female Soccer Players

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Abstract

Research comparing the effects of different small-sided soccer game (SSG) training formats on physical adaptations remains scarce. This study aimed to compare small-format SSGs (SSG_{SF}: 1v1 to 3v3) with large-format SSGs (SSG_{LF}: 6v6 to 8v8) on vertical jump, change-of-direction (COD), linear speed and aerobic capacity adaptations in youth female soccer players over a six-week training period. Using a simple randomized, parallel, controlled design, players were assigned to one of two experimental groups (SSG_{SF} or SSG_{LF}) or a control group. Forty-five female youth players (15.7 ± 0.5 years old) competing at a developmental level participated in the study. All participants had a minimum of two years of playing experience and adhered to at least 90% of the intervention protocol. The experimental groups received two additional SSG sessions per week, while the control group maintained their regular training routines. Baseline and post-intervention assessments included countermovement jump height (CMJ), change of direction deficit in the 5-0-5 test (COD deficit), 30-meter linear speed, and final velocity in the 30-15 intermittent fitness test (VIFT). The SSG_{SF} group exhibited a significantly smaller CODdeficit compared to the control group (p = 0.026; d = 1.032, moderate) after the intervention. The SSG_{LF} group exhibited a significantly smaller 30-m sprint time compared to the control group (p = 0.044; d = 0.303, small). Both the SSG_{SF} (p = 0.039; d = 0.880, moderate) and SSG_{LF} (p = 0.026; d = 1.043, moderate) groups exhibited a significantly greater V_{IFT} compared to the control group. In conclusion, the findings suggest that SSG_{SF} may be more beneficial for improving COD ability, while SSG_{LF} could potentially be more effective for enhancing linear sprint performance. Both formats appear to have a positive impact on aerobic performance, though the extent of their effects might be similar. Coaches might consider these differences when selecting SSG formats, as each format could contribute differently to physical performance adaptations.

Key words: Football, physical performance, sports training, women.

Introduction

Small-sided games (SSGs) are modified versions of soccer with fewer players, played on smaller fields, and often with adjusted rules (Fernández-Espínola et al., 2020). They are widely used in training contexts to enhance player engagement, target specific tactical behaviors and technical actions, and fit the physical and physiological demands to match training objectives (Clemente et al., 2024a). SSGs are particularly well-suited to the constraints-led approach, a framework in which training tasks are designed to preserve the representative dynamics of the game while guiding skill acquisition through the manipulation of task, environmental, and individual constraints. This approach promotes learning by encouraging players to self-organize and adapt their behavior in response to game-relevant conditions. By maintaining perceptual and action couplings, SSGs provide both specificity and representativeness in training. They simplify real-game scenarios, allowing coaches to structure the game format to match the intended learning outcomes and the players' developmental levels (Davids et al., 2013). By preserving the dynamics of full-scale play - specifically maintaining the cooperation-opposition interaction - while encouraging greater involvement, SSGs provide more enjoyment than traditional drills (Selmi et al., 2020). They also promote active technical and tactical involvement while imposing significant physical and physiological demands, making them well-suited for simultaneously addressing multiple training objectives within a focused, game-representative context (Hill-Haas et al., 2011; Bujalance-Moreno et al., 2019; Clemente et al., 2020; Borges et al., 2022).

Changing task conditions in SSG, such as the format of play (e.g., number of players involved), playing field dimensions, task objectives (e.g., method of scoring), and task rules (e.g., ball touch limitations), significantly influence both physiological and physical responses during play (Halouani et al., 2014; Bujalance-Moreno et al., 2019; Dios-Álvarez et al., 2022). Changes in the format of play, such as the number of players per side, can alter work-to-rest ratios and affect both metabolic and muscular demands (Rampinini et al., 2007; Rebelo et al., 2016). For example, reducing the number of players increases individual workload, resulting in higher-intensity physiological efforts, reflected in intensified heart rate responses, higher blood lactate levels, and increased ratings of perceived exertion (Rampinini et al., 2007). This is particularly beneficial for targeting aerobic power (Lacome et al., 2018). Moreover, alterations in field dimensions directly impact movement patterns: smaller fields typically lead to more frequent accelerations, while larger fields promote greater total distance covered and more demanding movements, such as sprints (Clemente et al., 2023). Physiologically, players often exhibit higher heart rates, elevated lactate concentrations, and increased perceived exertion in larger fields (Casamichana and Castellano, 2010). These changes collectively influence energy system contributions, with certain task constraints favoring anaerobic systems and others supporting aerobic conditioning, depending on their structure and intensity. This can promote positive adaptations in

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physiological outcomes relevant to meeting the sustained demands of soccer.

While there is a substantial body of research examining the acute physiological and physical responses to variations in task conditions among youth and adult males and females (Halouani et al., 2014; Ometto et al., 2018; Dios-Álvarez et al., 2022), the literature on the use of SSGs as structured training interventions in experimental studies remains limited - particularly in female populations (Moran et al., 2019; Clemente et al., 2024b). Most existing studies focus on comparing SSG to analytical training exercises, particularly high-intensity interval training (Hammami et al., 2018; Clemente et al., 2021a). However, there is a notable gap in research that acknowledges how different SSG formats lead to significant variations in acute physiological and physical demands, and how these differences might influence long-term physical and physiological performance adaptations (Clemente et al., 2021a). Surprisingly, studies comparing the effects of different SSG formats over the long term are quite scarce.

For example, a recent study (Wang et al., 2024) compared two different SSG formats - one on a smaller field and the other on a larger, more elongated field - over an 8-week period. The results showed that while both formats significantly improved aerobic performance, only the elongated field enhanced sprint performance in the players. Another study examining the influence of field dimensions on aerobic performance adaptations found that anaerobic speed reserve was lower for the large-area-per-player group compared to the small-area-per-player group. Meanwhile, repeat-sprint ability, sprint, and aerobic performance were similarly impacted by both larger and smaller field dimensions in a 4-week intervention (Faga et al., 2022). Although these examples offer findings into how field dimensions influence performance adaptations, the effects of different playing formats are even less studied. In the only study (Makar et al., 2022) examining this factor, researchers tested extreme (1v1) and moderate (5v5) SSG formats over a 4-week intervention. They found that the extreme-sided games led to significant improvements in vertical jump height and change-of-direction performance among youth soccer players, while the impact on aerobic performance was similar across both formats (Makar et al., 2022).

Significant gaps remain in intervention studies on SSGs, especially concerning the use of different playing formats. An important limitation is the scarcity of studies; the only research (Makar et al., 2022) comparing adaptation effects between smaller and larger SSG formats lacked a control group, making it difficult to determine what adaptations would occur if players followed their usual training routines. Additionally, the 4-week intervention period used was likely too short to foster meaningful long-term adaptations. Another critical gap is the lack of SSG intervention studies involving female athletes; none of the existing studies examining various SSG task conditions on physical adaptations have included women (Dios-Álvarez et al., 2022). Therefore, in addition to the scarcity of randomized experimental studies, the methodological limitations of existing research also warrant further investigation. Addressing these gaps is essential for coaches aiming to design training plans that effectively target physical performance outcomes relevant to enhancing playing performance, such as muscular power, speed, and aerobic capacity. Including women athletes in research would also help address their underrepresentation in sports training studies, particularly in the context of SSGs. Comparing small-sided formats (e.g., 1v1 to 3v3, or SSG_{SF}) with larger formats (e.g., 6v6 to 8v8, or SSG_{LF}) could provide coaches with valuable insights into each format's specific impact on physical performance adaptations, helping them select formats that best align with targeted training outcomes. For these reasons, this study aimed to compare SSG_{SF} with SSG_{LF} on physical performance adaptations in youth female soccer players over a six-week training period.

Methods

Experimental approach

This study used a single-blind design (with evaluators blinded), employing simple randomization in a parallel, controlled format. Two experimental groups (SSG_{SF} and SSG_{LF}) received two additional weekly training interventions based on SSG over a six-week period, in addition to their regular training sessions. The control group continued with their standard training routine. The evaluators were blinded to group assignments, while participants and coaches were not. Randomization was conducted using opaque envelopes, with each participant within a team randomly assigned to one of the groups, ensuring a 1:1 allocation ratio. Randomization occurred prior to baseline assessments, and participants were not allowed to switch groups thereafter, thus ensuring allocation concealment.

The study was approved by the ethics committee of China West Normal University and was assigned the approval code (ID: CA202504003). Participants and their legal guardians were informed about the study design and were explicitly told that they were free to withdraw at any time without penalty. After receiving this information, the legal guardians signed an informed consent form.

Convenience sampling was used to select teams that shared similar competitive levels and age groups, and were also able to accommodate the training interventions. Three soccer teams, competing at the same level and with comparable training approaches, participated in the study. Within each team, participants were evenly distributed across the three groups (i.e., SSG_{SF}, SSG_{LF}, and control), ensuring that each group contained a similar number of players coming from different teams.

The study began with a baseline assessment conducted in the week prior to the start of the training intervention, which lasted for six consecutive weeks. A post-intervention assessment was then carried out in the week following the intervention. While the regular training sessions were exclusively planned and managed by the coaches of each team, the SSG interventions were added and monitored by the research team, with designated coaches specifically responsible for implementing these games. The study took place during the pre-season period.

Participants

The sample size for the study was determined using

G*Power software (version 3.1.9, Universität Düsseldorf, Germany). This calculation accounted for three groups, two measurement points, a statistical power of 0.95, a significance level of 0.05, and an effect size f = 0.839, which was derived from the partial eta squared estimate of 0.413 of a prior study examining various SSG training interventions and their impact on aerobic capacity as measured by the Yo-Yo Intermittent Recovery Test (Wang et al., 2024). Based on these parameters, a sample size of 12 participants was recommended for the ANOVA repeated measures within-between interaction.

Participants were recruited by directly reaching out to teams and their head coaches and directors, followed by contacting the players and their legal guardians. The eligibility criteria for inclusion in the study were as follows: (i) participants had to be female players with a minimum of two years of competitive soccer experience; (ii) attendance of at least 90% of the experimental intervention sessions and at least 85% of total team training sessions throughout the study period; (iii) no injuries or illnesses in the month preceding or during the study period; and (iv) completion of all evaluation tests and attendance at all measurement points. Exclusion criteria included (i) being a goalkeeper, and (ii) participation in any dietary or supplemental training program (e.g., strength training) that could influence the study results.

Out of an initial pool of 68 available players, 10 were excluded for being goalkeepers, and 11 were excluded due to injuries at the time of the baseline assessments. Additionally, 2 more players were excluded during the intervention period for missing more than 40% of the team training sessions (Figure 1).

A total of 45 female youth soccer players (age: 15.7 ± 0.5 years; height: 165.2 ± 5.2 cm; weight: 57.6 ± 5.9 kg; experience: 3.6 ± 0.8 years in competitive soccer) participated in this study. More detailed information, broken down by groups, is presented in Table 1. All players were from teams competing at the same level, classified as tier 2 (trained/developmental) according to the Participants Classification Framework (McKay et al., 2022). The three teams had 3 training sessions a week with an average of 109 ± 11 minutes of duration per session. As part of their regular training routine, the teams begin with a general warm-up lasting about 10 minutes. This is followed by a specific conditioning session, focused either on aerobic power or speed, lasting 15 to 25 minutes depending on the day of the week. Next, they often engaged in targeted training activities involving positional games, specific offensive or defensive tactics, or dedicated technical drills for 30 to 40 minutes. The session commonly concluded with a formal game lasting 15 to 20 minutes, followed by a 5-minute cooldown.

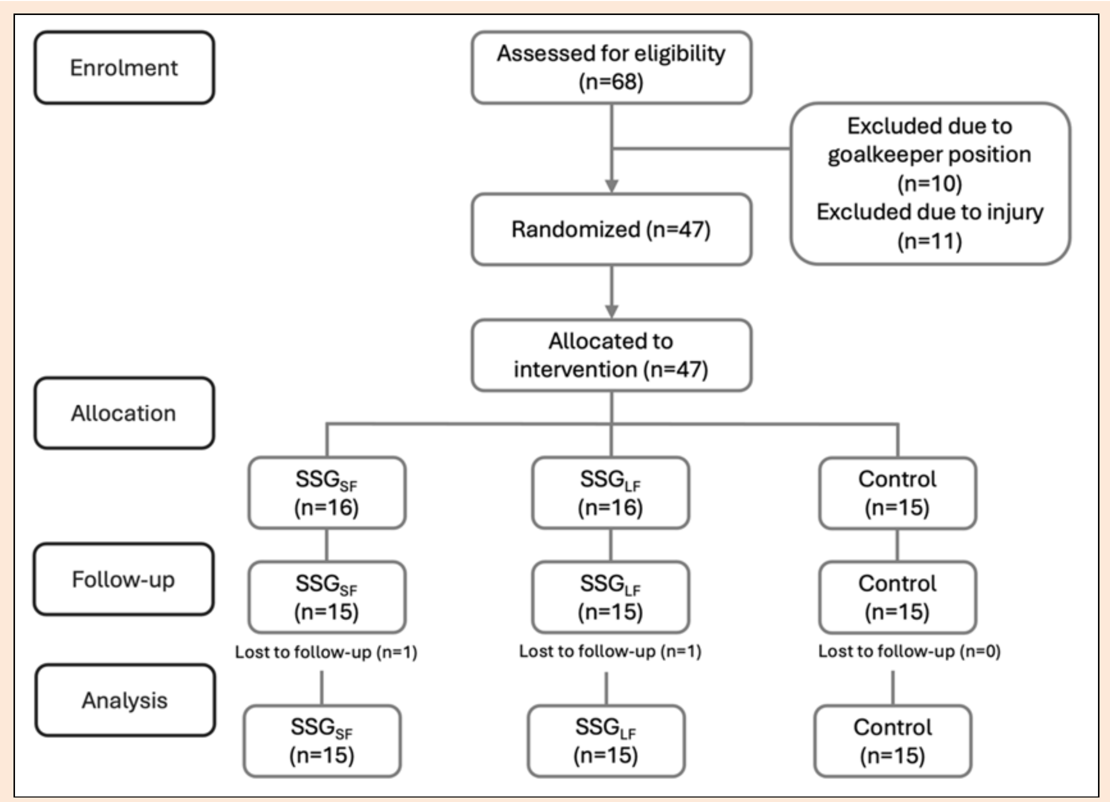

Figure 1. Participant flow throughout the study.

Table 1. Player characteristics by group. Data are means ± SD.

	SSG$_{SF}$ (n = 15)	SSG$_{LF}$ (n = 15)	Control (n = 15)
Age (years)	15.7 ± 0.6	15.7 ± 0.5	15.7 ± 0.5
Experience (years)	3.7 ± 0.8	3.5 ± 0.7	3.7 ± 0.9
Height (cm)	162.5 ± 4.5	167.3 ± 4.7	165.9 ± 4.9
Weight (kg)	54.3 ± 3.8	58.7 ± 4.4	59.7 ± 7.6

SSG$_{SF}$: small-sided games in formats ranging from 1v1 to 3v3; SSG$_{LF}$: small-sided games in formats ranging from 6v6 to 8v8.

Table 2. Description of the training intervention for both experimental groups.

	SSG_{SF} – session1	SSG_{SF} – session 2	SSG_{LF} – session 1	SSG_{LF} – session 2
Week 1	2×6×1 min of 1v1/2 min rest Small goals (2×2) / no GK 15×8 m (60 m^2/player)	2×6×1 min of 1v1/2 min rest Small goals (2×2) / no GK 15×8 m (60 m^2/player)	2×6 min of 6v6/2 min rest Small goals (2×2) / no GK 40×30 m (100 m^2/player)	2×6 min of 6v6/2 min rest Small goals (2×2) / no GK 40×30 m (100 m^2/player)
Week 2	2×4×2 min of 2v2/2 min rest Small goals (2×2) / no GK 20×14 m (70 m^2/player)	2×4×2 min of 2v2/2 min rest Small goals (2×2) / no GK 20×14 m (70 m^2/player)	2×8 min of 7v7/2 min rest Small goals (2×2) / no GK 45×35 m (113 m^2/player)	2×8 min of 7v7/2 min rest Small goals (2×2) / no GK 45×35 m (113 m^2/player)
Week 3	8×2 min of 3v3/2 min rest Small goals (2×2) / no GK 30×18 m (90 m^2/player)	8×2 min of 3v3/2 min rest Small goals (2×2) / no GK 30×18 m (90 m^2/player)	2×8 min of 8v7/2 min rest Small goals (2×2) / no GK 45×35 m (105 m^2/player)	2×8 min of 8v7/2 min rest Small goals (2×2) / no GK 45×35 m (105 m^2/player)
Week 4	3×6×1 min of 1v1/2 min rest Small goals (2×2) / no GK 15×8 m (60 m^2/player)	3×6×1 min of 1v1/2 min rest Small goals (2×2) / no GK 15×8 m (60 m^2/player)	3×6 min of 6v6/2 min rest Small goals (2×2) / no GK 40×30 m (100 m^2/player)	3×6 min of 6v6/2 min rest Small goals (2×2) / no GK 40×30 m (100 m^2/player)
Week 5	3×4×2 min of 2v2/2 min rest Small goals (2×2) / no GK 20×14 m (70 m^2/player)	3×4×2 min of 2v2/2 min rest Small goals (2×2) / no GK 20×14 m (70 m^2/player)	3×8 min of 7v7/2 min rest Small goals (2×2) / no GK 45×35 m (113 m^2/player)	3×8 min of 7v7/2 min rest Small goals (2×2) / no GK 45×35 m (113 m^2/player)
Week 6	8×3 min of 3v3/2 min rest Small goals (2×2) / no GK 30×18 m (90 m^2/player)	8×3 min of 3v3/2 min rest Small goals (2×2) / no GK 30×18 m (90 m^2/player)	3×8 min of 8v7/2 min rest Small goals (2×2) / no GK 45×35 m (105 m^2/player)	3×8 min of 8v7/2 min rest Small goals (2×2) / no GK 45×35 m (105 m^2/player)

GK: goalkeeper; SSG_{SF}: small-sided games in formats ranging from 1v1 to 3v3; SSG_{LF}: small-sided games in formats ranging from 6v6 to 8v8.

Training intervention

The groups assigned to either SSGSF or SSGLF received the supplementary training intervention with a 48-hour rest between sessions. These interventions were conducted during the first and second training sessions of the week. The training was implemented prior to the team's regular training, with sessions led by coaches selected by the research team. Each intervention began with a general warm-up protocol, which included 4 minutes of jogging, 5 minutes of dynamic stretching for the lower limbs, and 5 minutes of ballistic drills focused on the lower body. A detailed description of the training interventions is provided in Table 2.

The intervention was organized into two blocks, each lasting three weeks. In the first block, players progressed by increasing the playing formats within each group. In the second block, while the variation in game formats was maintained, the overall volume of play was increased. During the first block, the intervention sessions lasted between 12 and 16 minutes, while in the second block, the session duration ranged from 18 to 24 minutes. The volume was consistently balanced between the two groups, with the main variations focusing on the game formats, and consequently, the field dimensions and training regimens.

Players were grouped according to the coaching staff's qualitative assessment of competitiveness, with the aim of maintaining balanced teams during the drills. This assessment considered not only players' technical and tactical abilities, but also their regular inclusion in the starting lineup and positional roles. Team groupings were adjusted based on the specific ormat employed. To ensure the games ran smoothly and to maintain game dynamics, 2 to 3 balls were placed around the field to speed up ball retrieval after going out of bounds. Coaches provided verbal encouragement to keep the players engaged and motivated throughout the games. All games were played on synthetic turf.

Assessment procedures

The players were assessed on two occasions: once before the intervention and once after. Both evaluations occurred with 72 hours of rest prior. The assessments took place in the afternoon in indoor facility (temperature of 21.5 ± 0.9º and relative humidity of 56 ± 2%). The assessments were conducted by a team of four experienced evaluators, who were blinded to the participants' group assignments.

In addition to the demographic and anthropometric assessments, the players began with a generalized warm-up protocol, identical to the one used in the intervention sessions. Following the warm-up, all participants proceeded through the same sequence of tests, which remained consistent for both evaluation moments: (i) countermovement jump height (CMJ); (ii) change of direction deficit in the 5-0-5 test (COD deficit); (iii) 30-meter linear speed; and (iv) final velocity in the 30-15 intermittent fitness test (V_{IFT}). The rest period between tests was 3 minutes.

Countermovement jump height (CMJ)

For the CMJ, participants began by positioning themselves in a squat with their knees at a 90° angle and feet shoulder-width apart, while keeping their hands on their hips to prevent using their arms for assistance. The objective was to achieve the highest possible jump while maintaining this position.

Jump height was recorded using the My Jump 2 app on an iPhone X, which was selected due to its proven accuracy and reliability in measuring vertical jumps (Bogataj et al., 2020). Each participant performed two attempts, separated by a 2-minute rest period. The average jump height (in centimeters) from the two trials was then used for the analysis.

Change of direction deficit in the 5-0-5 test (COD deficit)

For this study, the 5-0-5 change-of-direction (COD) test was conducted in its standard form. Participants started in a split stance, with their dominant leg in front. They began by sprinting 10 meters, with the first 5 meters, the 180° turn, and the return 5 meters each timed separately (Ryan et al., 2022). The time for the two 5-meter segments was recorded as the COD time, which was then subtracted from the total 10-meter sprint time to calculate the COD deficit.

Participants were asked to use the same leg for the 180° turn in both trials. The COD times were captured using the COD timer app on an iPhone X, a validated and reliable tool that delivers measurements consistent with those taken by timing gates (Chen et al., 2021). Each player performed two trials, with a 2-minute rest interval in between. The average COD deficit (in seconds) from both attempts was then used for the analysis.

30-meter linear speed

The 30-meter linear sprint test was carried out to evaluate sprint performance. Participants started from a split stance, with their preferred leg forward. They positioned themselves behind the starting line and were instructed to maintain the same starting posture, with the same leading leg, throughout the trials. Each player performed two trials, with a 2-minute rest interval in between. The assessment was conducted using the MySprint mobile application on an iPhone X, which has previously been validated for its reliability and accuracy when compared to photocells (Romero-Franco et al., 2017). The average 30-meter sprint time (in seconds) from both attempts was then used for the analysis.

Final velocity in the 30-15 intermittent fitness test (V_{IFT})

The 30-15 Intermittent Fitness Test, in its original format, was used to assess the players' capacity to sustain progressively intense intermittent efforts until exhaustion (Buchheit, 2008). The test involved a series of 30-second shuttle runs, with 15 seconds of passive recovery between each, following an audio cue that indicated the required pace (Buchheit, 2008). The test began at a speed of 8 km/h, which increased by 0.5 km/h after each 30-second round. The test ended when the participant could no longer keep up with the pace or chose to stop due to fatigue. The final result was based on the highest running speed achieved during a completed 30-second round, which was recorded as the final velocity in the 30 - 15 Intermittent Fitness Test (VIFT) in kilometers per hour. All players were already familiar with the test due to their regular assessment routines within their training programs.

Statistical procedures

The normality of the sample was assessed using the Kolmogorov-Smirnov test, which yielded $p > 0.05$. To check for homogeneity of variances, Levene's test was applied, also resulting in $p > 0.05$. To examine the interaction between time and group, a mixed ANOVA was conducted. Effect sizes for comparisons between pre- and post-intervention measurements were determined using partial eta squared (η_p^2) and Cohen's d. Since η_p^2 and Cohen's d have different magnitude scales, the effect sizes were interpreted according to their respective criteria (Hopkins et al., 2009): for η_p^2, small ($\geq$ 0.01), moderate ($\geq$ 0.06), and large ($\geq$ 0.14); for Cohen's d, small ($\geq$ 0.10), moderate ($\geq$ 0.30), large ($\geq$ 1.2), and very large ($\geq$ 2.0). The Bonferroni test was used for post-hoc analyses. All statistical analyses were conducted using JASP software (version 0.18.3, University of Amsterdam, The Netherlands), with a significance threshold of $p < 0.05$.

Results

Table 3 shows the descriptive statistics of baseline and post-intervention physical performance values for the three groups. Significant interactions (time*group) were observed in CMJ ($F = 24.804$; $p < 0.001$; $\eta_p^2 = 0.542$, large effect), CODdeficit ($F = 19.480$; $p < 0.001$; $\eta_p^2 = 0.481$, large effect), 30-m sprint time ($F = 18.427$; $p < 0.001$; $\eta_p^2 = 0.467$, large effect), and VIFT ($F = 16.503$; $p < 0.001$; $\eta_p^2 = 0.440$, large effect). No significant differences were observed between the groups at baseline for CMJ ($F = 0.671$; $p = 0.573$; $\eta_p^2 = 0.037$, small effect), CODdeficit ($F = 0.633$; $p = 0.536$; $\eta_p^2 = 0.029$, small effect), 30-m sprint time ($F = 0.089$; $p = 0.915$; $\eta_p^2 = 0.004$, negligible effect), and VIFT ($F = 0.010$; $p = 0.990$; $\eta_p^2 = 0.000$, no effect).

No significant differences were observed between the groups at post-intervention for CMJ ($F = 2.693$; $p = 0.079$; $\eta_p^2 = 0.114$, moderate effect). However, significant differences were observed between the groups at post-intervention for CODdeficit ($F = 4.018$; $p = 0.025$; $\eta_p^2 = 0.161$, large effect), 30-m sprint time ($F = 3.381$; $p = 0.044$; $\eta_p^2 = 0.139$, large effect), and VIFT ($F = 4.792$; $p = 0.013$; $\eta_p^2 = 0.186$, large effect).

Specifically, the SSGSF group exhibited a significantly smaller CODdeficit compared to the control group (mean difference: 0.16 s; $p = 0.026$; $d = 1.032$, large effect size) after the intervention. The SSGLF group exhibited a significantly smaller 30-m sprint time compared to the control group (mean difference: 0.06 s; $p = 0.044$; $d = 0.303$, small effect size) after the intervention.

Table 3. Mean ± standard deviation of baseline and post-intervention physical performance values for three groups.

		SSG_{SF} (n = 15)	SSG_{LF} (n = 15)	Control (n = 15)
CMJ (cm)	Baseline	21.6 ± 3.3	19.8 ± 4.6	20.1 ± 3.6
	Post-intervention	23.0 ± 3.6	20.0 ± 4.8	20.2 ± 3.5
	p and *d* (post-pre)	**p* < 0.001; *d* = 0.406	*p* = 0.150; *d* = 0.043	*p* = 0.481; *d* = 0.028
5-0-5 COD deficit (s)	Baseline	0.57 ± 0.15	0.63 ± 0.16	0.60 ± 0.14
	Post-intervention	0.42 ± 0.14	0.53 ± 0.16	0.58 ± 0.17
	p and *d* (post-pre)	**p* < 0.001; *d* = -1.034	**p* < 0.001; *d* = -0.625	**p* = 0.045; *d* = -0.129
30-m sprint time (s)	Baseline	5.14 ± 0.22	5.15 ± 0.25	5.18 ± 0.27
	Post-intervention	5.12 ± 0.20	4.98 ± 0.20	5.18 ± 0.22
	p and *d* (post-pre)	*p* = 0.376; *d* = -0.095	**p* < 0.001; *d* = -0.756	*p* = 0.929; *d* = 0.000
V_{IFT} (km/h)	Baseline	15.0 ± 1.5	15.0 ± 1.3	15.1 ± 1.5
	Post-intervention	16.6 ± 1.2	16.7 ± 1.0	15.5 ± 1.3
	p and *d* (post-pre)	**p* < 0.001; *d* = 1.185	**p* < 0.001; *d* = 1.478	**p* = 0.015; *d* = 0.286

CMJ: countermovement jump; COD: change of direction; V_{IFT}: Final velocity in the 30-15 intermittent fitness test; *p*: p-value within-group (post-pre); *d*: Cohen's effect size within-group (post-baseline); *: significantly different from post to baseline (within-group).

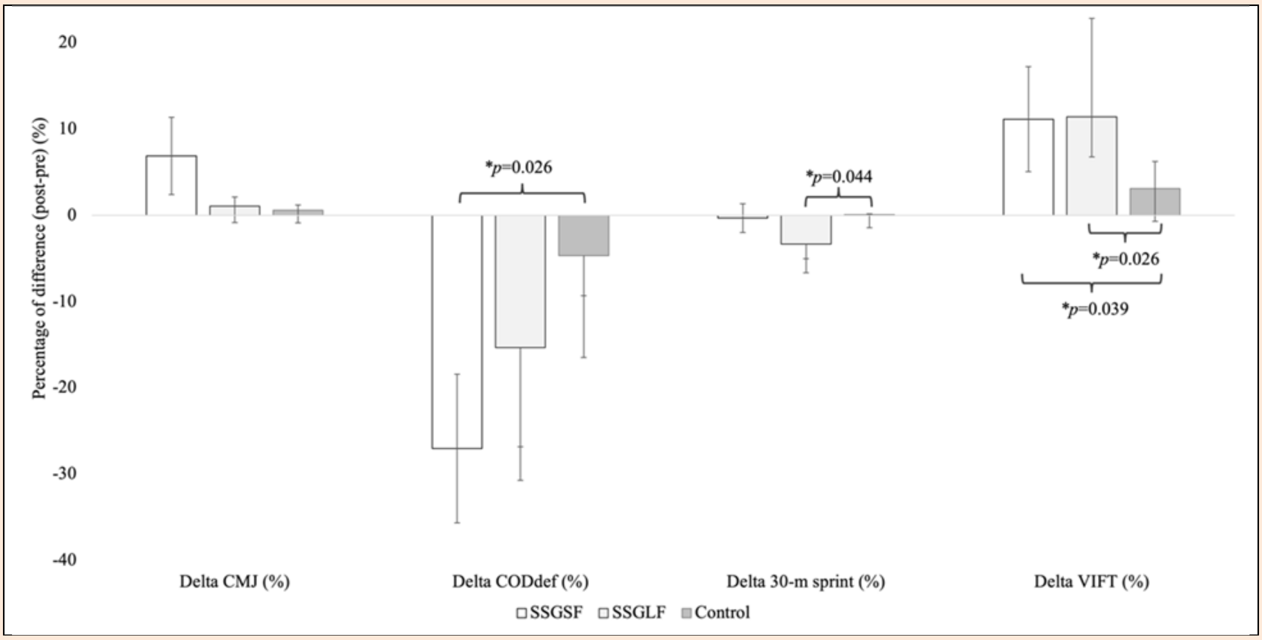

Figure 2. Percentage difference for the observed measures. *: significantly different between groups ($p < 0.05$).

Finally, both the SSGSF (mean difference: 1.1 km/h; p = 0.039; d = 0.880, moderate effect size) and SSGLF (mean difference: 1.2 km/h; p = 0.026; d = 1.043, large effect size) groups exhibited a significantly greater VIFT compared to the control group after the intervention. Figure 2 shows the percentage of differences between post-intervention and baseline for the physical performance variables observed.

Discussion

The current research revealed that while both SSG_{SF} and SSG_{LF} significantly improve aerobic performance as measured by V_{IFT}, only SSG_{SF} effectively enhanced the COD deficit, whereas only SSG_{LF} significantly improves 30-meter linear sprint time. However, neither SSG_{SF} nor SSG_{LF} were effective in promoting significant adaptations in CMJ performance. These findings suggest that specific playing formats influence adaptations in speed-related measures, while both formats can be used with similar effectiveness when the primary goal is aerobic development.

The results of our study indicated that, after the intervention period, the SSG_{SF} group showed significantly greater improvement in the COD deficit compared to the control group, reflected in lower COD deficit scores. However, no significant difference was found between the SSG_{SF} and SSG_{LF} groups. In contrast, the SSG_{LF} group did not show a significant difference from the control group, suggesting that only SSG_{SF} was effective in improving this measure. The only previous study (Makar et al., 2022) similar to ours that compared the use of 1v1 versus 5v5 formats also found a tendency for the smaller format to be more effective than the larger one in enhancing COD performance, although that study did not include a control group.

The reasons for these findings may lie in two factors. First, in smaller formats, limited space requires a more diverse range of accelerations, decelerations, and COD actions due to a higher degree of individual involvement and variability in individual actions (Young and Rogers, 2014). This increased exposure likely enhances neuromuscular stimulation, supporting rapid acceleration, deceleration, and re-acceleration (Konefal et al., 2023). Second, the smaller space and greater individual involvement may improve players' ability to quickly recognize optimal moments for changing direction, potentially benefiting both physical performance and perceptual reaction speed (Mota et al., 2022). In larger play formats, which naturally associates with larger fields, individual involvement in these actions may decrease, with movements becoming more elongated and linear and less frequent in directional changes, reducing the multidimensional movement seen in smaller formats (Castagna et al., 2017). However, possibly because changes in direction can still occur frequently even in larger formats, this may explain why the specific differences between smaller and larger formats were not significant.

Based on this rationale, it may help explain the findings of our study, where only SSG_{LF} significantly enhanced 30-meter sprint performance compared to the control group, while SSG_{SF} did not. However, no significant differences were observed between SSG_{SF} and SSG_{LF}. Our results align with two previous studies (Faga et al., 2022; Wang et al., 2024) that compared smaller and larger field dimensions, although those studies were conducted with youth males. These studies (Faga et al., 2022; Wang et al., 2024) found that only games played on larger fields (which naturally involve a greater number of players, i.e., larger formats) resulted in significant improvements in linear speed, outperforming games played in smaller spaces at this level. Previous studies (Castagna et al., 2017; Clemente et al., 2019) report that sprint actions are suboptimal in smaller formats and small spaces during SSGs. This, coupled with the evidence that only near-maximal and maximal sprint actions can lead to improvements in sprint performance (Haugen et al., 2014), may explain why smaller formats are less effective in driving improvements at this level. Thus, larger formats, which provide greater and more elongated dimensions, may facilitate improvements by allowing players to achieve near-maximal sprint speeds due to the additional space available to reach these speeds (Wang et al., 2024).

Both groups, however, were equally effective in significantly enhancing V_{IFT} compared to the control group. Our results do not align with a previous study (Makar et al., 2022) that compared 1v1 and 5v5 formats, which did not reveal any significant improvements in this measure. However, their study (Makar et al., 2022) was conducted over only 4 weeks, which may not have been enough time for the necessary adaptations to occur. Therefore, longer periods are likely required to provide sufficient stimulus for adaptation. In fact, a recent meta-analysis comparing SSGs and high-intensity interval training revealed that both are similarly effective in enhancing aerobic performance in soccer players (Clemente et al., 2024b). Additionally, the moderate analysis showed that SSGs, regardless of whether small or large formats are used, are also similarly beneficial in improving aerobic performance (Clemente et al., 2024b).

Although smaller formats, such as 1v1 and 3v3, ensure significantly higher physiological intensities (Hill-Haas et al., 2011), leading to greater cardiovascular and metabolic demands (Lacome et al., 2018), larger formats, such as 6v6, still provide substantial intensity due to the increased duration of play and the need to maintain a high level of work throughout the game. Larger formats stress the aerobic system through sustained moderate to high-intensity efforts with occasional bursts (Bujalance-Moreno et al., 2019), thereby possibly enhancing cardiovascular capacity. Both intervention groups likely resulted in increased mitochondrial density (Mendham et al., 2016), and enhanced oxygen delivery and utilization (Delextrat et al., 2018), all possibly contributing to the observed improvements in V_{IFT} performance.

Neither of the experimental groups was able to produce significantly better results in the CMJ compared to the control group. Interestingly, the previous study (Makar et al., 2022) comparing 1v1 and 5v5 training interventions found that the 1v1 group significantly improved their CMJ, while no significant differences were observed in the 5v5 group. In our study, the SSG_{SF} group also showed a significant improvement from baseline to post-intervention, although there were no significant differences when compared to the other groups. SSGs may not provide sufficient stimulus to significantly enhance the strength and power required for maximal jumping performance (Clemente et al., 2021b). The CMJ is predominantly influenced by muscular strength, particularly in the lower limbs, and involves both explosive power and neuromuscular coordination (Nuzzo et al., 2008). Thus, SSGs may not be optimal for increasing maximal force production during a vertical jump, as these actions involve different neuromuscular stimuli. Further research is needed to understand how specific reactive strength training or maximal strength training can be integrated to target these adaptations, rather than relying solely on specific training drills.

This study has some limitations, including a restricted competitive level, which may limit the generalizability of the findings to other levels, such as professional or adult athletes, as well as a relatively short intervention period (6 weeks), which may not provide insights into potential plateaus after longer durations. Additionally, further research is needed to explore the underlying mechanisms that may drive these adaptations. Future studies should consider including a broader range of competitive levels, extending the intervention period, and investigating the potential benefits of combining SSG formats with strength training. Another limitation is that, although validated mobile applications were used, they are not considered gold-standard measurement tools. This should be seen as an area for improvement in future research. Finally, more mechanisms of adaptation remain to be explored, including detailed analysis and monitoring of training load, as well as the impact on biomechanics and muscular recruitment patterns - particularly during COD movements.

Despite its limitations, this study suggests that SSGs can be an effective complementary training modality for improving aerobic performance in female players, as both small- and large-sided formats were shown to enhance V_{IFT}. Coaches can use these formats interchangeably, depending on their specific goals, as both were similarly effective in boosting aerobic capacity. However, for improvements in COD deficit, smaller formats like 1v1 or 3v3 may be more beneficial due to the greater individual involvement and diversity of actions they promote. Conversely, larger formats (e.g., 6v6, 7v7) may be more suitable for enhancing sprint performance, as they provide more space for players to achieve near-maximal sprint speeds. Coaches should consider integrating different SSG formats into training sessions based on specific performance objectives, while also recognizing that more specific strength and conditioning interventions may be necessary to improve explosive power and speed-related variables, as SSGs alone may not suffice depending on the context and the athletes' training needs.

Conclusion

In conclusion, while both SSG_{SF} and SSG_{LF} were similarly effective in improving aerobic performance, as measured by V_{IFT}, their impact on other speed-related measures was different. SSG_{SF} was more effective in enhancing the COD deficit, whereas SSG_{LF} had a greater impact on 30-meter sprint performance. Neither group showed significant improvement in CMJ, suggesting that SSGs may not provide the necessary stimulus for developing this measure. These findings imply that coaches should be cautions in selecting SSG formats based on specific training objectives - whether improving aerobic capacity, COD performance, or sprint speed - while also considering the need for supplementary strength training to enhance explosive power. However, such findings are context-dependent, and analyzing other competitive levels, contexts, and longer study durations may be important for making broader generalizations.

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Key points

- SSGSF (1v1–3v3) significantly improved change of direction (COD) ability.
- SSGLF (6v6–8v8) led to greater improvements in linear sprint performance.
- Both formats effectively enhanced aerobic fitness (VIFT) compared to the control.

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