©Journal of Sports Science and Medicine (2024) **23**, 487-494
http://www.jssm.org DOI: https://doi.org/10.52082/jssm.2024.487

Research article

Can The Pitch Dimension Influence the Physical Fitness Adaptations Induced by Small-Sided Training Programs Added to Regular In-Field Training? A Randomized Controlled Study in Youth Soccer Players

Liang Wang [1]✉, YuHua Kang [2], LiXin Wei [1], MingBang Li [1] and Tao Wang [1]
[1] Geely University of China, Chengdu, China; [2] Chengdu Dongchenggen Primary school, Chengdu, China

Abstract

Small-sided games (SSGs) are frequently utilized in training settings to elicit specific stimuli that can promote physical fitness adaptations over time. However, various task constraints, such as pitch dimensions, can significantly influence both the acute external and internal load responses. Thus, understanding the impact of different pitch dimensions on physical fitness adaptations is crucial. This study sought to compare the physical adaptations induced by an SSG-based program utilizing more elongated pitches (SSGlw2; length-to-width ratio: 2.0) versus less elongated pitches (SSGwl1; length-to-width ratio: 1.0) on the Yo-Yo intermittent recovery test level 1 (YYIRT), and 30-meter sprint. This study employed a randomized controlled design. Forty-eight male soccer players (16.4 ± 0.6 years) participated. These players were randomly allocated to two experimental groups (N = 16, SSGlw1; N = 16, SSGlw2) and underwent two weekly additional training sessions over an 8-week period, while a group of 16 players continued with their regular in-field sessions as a control group. Evaluations were conducted before and after the intervention period. Significant interactions time × group were observed in regards YYIRT (F = 15.857; p < 0.001; η_p^2 = 0.413) and 30-m sprint test (p < 0.001). Between-group differences on YYIRT were found in post-intervention (p < 0.001), on which SSGlw2 (p < 0.001) and SSGlw1 (p < 0.001) were significantly greater in comparison to control group. Additionally, between-group differences on 30-m sprint were found in post-intervention (p < 0.001), on which SSGlw2 was significantly better than SSGlw1 (p < 0.001) and control group (p < 0.001). Coaches are advised to prioritize the use of more elongated pitch sizes to promote adaptations in sprint performance, while still acknowledging that aerobic capacity improvements remain significant compared to other pitch shapes.

Key words: Soccer; aerobic fitness; physical fitness; athletic performance; youth.

Introduction

Small-sided games (SSGs) are typically designed to target multiple objectives in youth soccer players, encompassing physical, physiological, technical, and tactical aspects (Hill-Haas et al., 2011; Halouani et al., 2014; Ferreira-Ruiz et al., 2022). Various task conditions are employed to achieve these objectives, including changes in the format of play, pitch dimensions and shape, and other rules such as scoring methods, feedback provision, and action limitations (Bujalance-Moreno et al., 2019; Praca et al., 2022). For instance, altering the dimensions of the pitch can significantly impact the acute demands of the drill on players, including external and internal load demands (Praca et al., 2022). It is well-established that elongated and larger pitch dimensions tend to encourage more high-intensity running actions and contribute to a greater accumulation of distance covered in high-speed running or sprinting compared to smaller pitch dimensions (Riboli et al., 2020; 2022). Moreover, the shape of the pitch can also influence player performance (Casamichana et al., 2018). Even when the total area of the pitch remains constant, different shapes can affect gameplay differently. For instance, pitches with a greater length-to-width ratio may favor more linear and curvilinear speed running actions, while those with a more balanced ratio (equally balancing length and width) might encourage more exploration of the wings and frequency of accelerations and decelerations (Fradua et al., 2013; Casamichana et al., 2018).

The utilization of SSGs as a training intervention has been progressively gaining traction in the realm of sports science (Clemente et al., 2021a). The evidence consistently supports the positive impact of SSGs on enhancing aerobic fitness, analogous to other methods such as high-intensity interval training (Moran et al., 2019; Clemente et al., 2024). However, the effects of SSGs on certain aspects of training interventions, particularly acceleration and sprinting, remain inconsistent (Faude et al., 2014; Jastrzebski et al., 2014; Arslan et al., 2020). Available evidence fails to conclusively support the effectiveness of SSGs in enhancing acceleration and sprinting, suggesting that they are less effective compared to high-intensity interval training (Faude et al., 2014; Jastrzebski et al., 2014; Arslan et al., 2020). One methodological gap in utilizing SSGs as training interventions is the lack of exploration into the acute demands of various task constraints and their influence on structured programs (Praca et al., 2022). For instance, studies focusing on sprint adaptations through SSG often neglect to compare different SSG approaches (e.g., bigger vs. smaller pitch sizes; longer vs narrow) (Faude et al., 2014; Jastrzebski et al., 2014; Arslan et al., 2020).

Given the scarcity of studies considering task constraints as independent variables influencing training interventions (Clemente et al., 2021b), understanding how to manage these constraints - specifically, pitch dimensions and shape (length per width ratio) - becomes crucial for innovative approaches and practical applications aimed at tailoring SSG training interventions to enhance potential positive adaptations across multiple levels. Therefore, employing different pitch dimensions not just for evaluating acute effects (as commonly done in existing literature) but

Received: 14 April 2024 / Accepted: 29 May 2024 / Published (online): 01 June 2024

also for investigating the impact of repeated exposure on physical fitness adaptation is innovative. Thus far, only one experimental study has been reported (Faga et al., 2022), comparing small (75m²) versus large (300m²) pitch sizes on the maximal aerobic speed and anaerobic speed reserve of male soccer players. However, further research is needed, particularly in other crucial outcomes such as sprinting. Such research can offer practical insights for coaches striving to understand the genuine influence of these constraints while designing training programs to foster enhancements in vital physical attributes.

Therefore, the present study aims to compare the effects of two additional SSG-based training interventions (one with a length per width ratio of 2.0 and another with a ratio of 1.0, both utilizing the same pitch area) on the aerobic fitness, acceleration, and linear sprint performance of youth male soccer players, in comparison to a control group participating only in in-field sessions. We hypothesize that the more elongated pitch will significantly promote positive adaptations in sprinting compared to the less elongated SSG experimental group (Castagna et al., 2017). Additionally, we anticipate that both experimental groups based on SSG will induce effective positive adaptations in aerobic fitness and acceleration (Faga et al., 2022).

Methods

This study adhered to the CONSORT guidelines for reporting experimental studies (Turner et al., 2012).

Study design

This study employed a randomized controlled design. Two male soccer teams voluntarily participated, and their players were randomly assigned to one of three groups: (i) additional SSGs training intervention using a length per width ratio of 2.0 (SSGlw2); (ii) additional SSGs training intervention using a length per width ratio of 1.0 (SSGlw1); and (iii) a control group that only participated in regular in-field training sessions. Randomization occurred before the initial evaluation to ensure allocation concealment. The randomization method involved using opaque envelopes with an equal probability for each group. Each team had an equal number of participants in the three groups. Researchers conducting evaluations were blinded to the groups to minimize bias.

Participants

The a priori sample size was estimated using a power of 0.85, considering three groups and two evaluation moments, a p-value of 0.05, and an effect size of 0.25. Utilizing G*power (version 3.1.9.6., Universität Düsseldorf, Germany) to execute the F test for within-between factors, it recommended a sample size of 48 participants. The eligibility criteria defined for this study included: (i) outfield players only; (ii) players who participated in both pre and post-intervention assessments; (iii) players free from injury and/or illness; and (iv) players who attended at least 90% of the training interventions.

Convenience sampling was utilized to select the two teams participating in the study. The teams granted permission for their players to participate, and the players were informed about the study design and agreed to participate voluntarily, with the option to withdraw at any time without penalty. From a potential sample of 53 players, five were excluded for serving as goalkeepers, leaving 48 male soccer players who participated in the study (Figure 1).

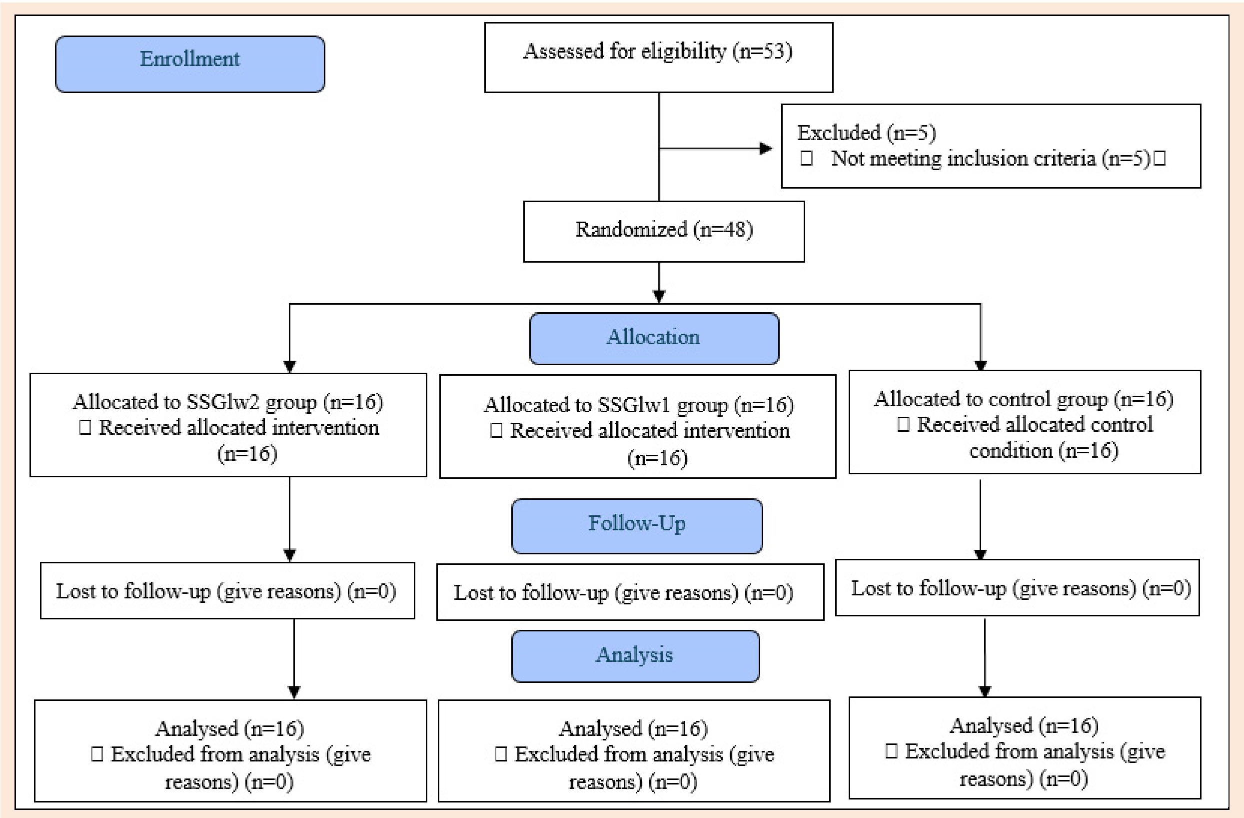

Figure 1. Participants flowchart.

Participants had an average age of 16.4 ± 0.6 years, weight of 62.4 ± 1.9 kg, height of 173.5 ± 2.5 cm, and 4.7 ± 0.7 years of experience. Since two teams participated in the study, the randomization of participants was conducted to ensure that each team had a similar number of players in each of the three groups. Consequently, each team had 8 players in SSGlw2 group, 8 in SSGlw1 group, and 8 players in the control group.

The youth players competed at a trained/developmental level, participating in the same regional competitive competition. Furthermore, both teams engaged in three to four training sessions per week, each session lasting between 80 and 100 minutes, in addition to one match. As a result, they were very similar in terms of the type and structure of their training process.

Participants and their legal guardians were briefed on the study design and protocol. Following verbal explanation, they read and signed a voluntary informed consent form. The study protocol was approved by the Institutional Ethical Review Board of XXX Institute of Physical Education under reference code 2023#145. The study adhered to the principles outlined in the Declaration of Helsinki.

Small-sided games intervention

The SSG interventions served as a supplement to the regular in-field training sessions. The control group solely engaged in the regular in-field sessions, while players assigned to the experimental groups received additional two weekly SSG intervention sessions, spaced 48 hours apart. The intervention spanned eight consecutive weeks. These interventions took place immediately before the regular in-field sessions and were conducted on synthetic turf.

The players assigned to SSGlw2 completed three sets of 4-minute bouts in a 4v4 format, with 3 minutes of rest between each set. The pitch dimensions were 40 × 20 m, providing a relative area per player of $100m^2$, with a length-to-width ratio of 2:1. Players in SSGlw1 also participated in three sets of 4-minute bouts in a 4v4 format, with 3 minutes of rest between each set, although the pitch dimensions were 28 × 28 m, with a relative area per player of $98m^2$, and a length-to-width ratio of 1:1. The objective of the task was to score in a small goal (2 × 1 m) centered on the endline, while the rules of the game mirrored the official ones, except for the non-application of the offside rule and the omission of cards. It is worth noting that throughout the games, no instances of unethical or aggressive behavior were observed. The ball was manually repositioned when it crossed the boundaries.

Players were assigned to the teams for the 4v4 formats based on a balanced distribution of one defender, two midfielders, and one forward. This assignment was made by the coach, taking into account perceptual analysis to ensure competitive balance during the games. However, exploratory analysis was conducted to examine differences in fitness levels within the teams, aiming to ensure balance. It was observed that variations in sprint performance among teams were approximately 1.6%, while variations in aerobic performance were around 1.9%. This indicates that fitness levels were similar across team members. Players remained on the same team throughout the intervention. The coach did not provide instructions regarding tactical or strategic approaches. Additionally, no verbal encouragement was given during the games. Balls were positioned closer to the pitches to ensure quicker ball repositioning. Throughout the generated reports, none of the observed matches during the experiment exhibited a difference in score greater than two goals over the duration of the games. It was noted that draws between teams occurred in 38% of the instances following the conclusion of the games.

Physical fitness evaluations

The physical fitness evaluations were conducted one week before the start of the intervention and again in the week following the intervention's conclusion. These evaluations occurred on the same day of the week to ensure a 24-hour rest period following the previous training session. They took place in the afternoon on a synthetic field, approximately two hours after the participants' last meal. The average temperature during the assessments was 19.2 ± 1.3ºC and relative humidity of 47.5 ± 3.1%.

The evaluations began with the collection of demographic information, followed by anthropometric measurements. A standardized warm-up protocol was then implemented, comprising 10 minutes of jogging, 8 minutes of dynamic stretching, and 5 minutes of neuromuscular activation exercises such as reactive jumps and accelerations.

The order of the tests was consistent for all players. After five minutes of the end of warm-up, the players completed the 30-meter sprint test three times, with three minutes of rest between each sprint. Following the final sprint trial, the players rested for five minutes. The five-minute period was allowed to maximize recovery. Previous studies on neuromuscular efforts recommend a five-minute recovery instead of a shorter one to ensure maintaining a high volume of effort without compromising muscular ability (Willardson and Burkett, 2005). Finally, they undertook the Yo-Yo intermittent recovery test level 1 (YYIRT).

30-m linear sprint test

The 30-m linear sprint test was utilized to evaluate sprint performance. Consistently noted as valid and reliable for evaluating sprint performance in soccer players (Altmann et al., 2019), this test used two pairs of photocells (SmartSpeed, Fusion Sport, Queensland, Australia): one at the starting line, and the second pair at the endline (30 meters). Participants assumed a split position, leading with their preferred leg, which remained consistent throughout the trials. They began their sprint 30 centimeters before the first pair of photocells and were instructed to sprint at maximum speed, decelerating only after passing the last pair of photocells. The photocells height was adjusted to align with the participants' hips. Each player completed three trials with three-minute intervals between each. The fastest time recorded in seconds was then selected for further data analysis.

Yo-Yo Intermittent recovery test

The research utilized the YYIRT level 1 as a test to evaluate the aerobic capacity of the participants. Taking place on the synthetic turf, this assessment comprised repetitive 20-meter shuttle runs governed by auditory cues signaling incremental speed adjustments. Players engaged in a shuttle run pattern between two designated lines positioned 20 meters distant from each other, with brief active recovery interspersed between each 40-m shuttle. The test commenced at a velocity of 10 km/h and progressively intensified in pace as per the auditory prompts (Krustrup et al., 2003).

Participants were instructed to maintain the pace dictated by the audio signals for as long as possible, ensuring they reached the end line before the next signal. If a participant failed to reach the line before the signal, they were given a warning. After two consecutive failures to reach the line in time, the test was terminated, and the total distance covered (in meters) was recorded as the test score.

Statistical procedures

Descriptive statistics, comprising mean and standard deviation, were presented. The Kolmogorov-Smirnov test ($p > 0.05$) was employed to assess normality, while Levene's test ($p > 0.05$) was utilized to evaluate homogeneity. Upon confirmation of both normality and homogeneity assumptions, a mixed ANOVA test (time*group) was executed to compare pre- and post-intervention outcomes across various groups. The effect size was quantified using partial eta squared. Post-hoc pairwise comparisons were conducted using the Bonferroni test, with Cohen's standardized effect size utilized to measure the magnitude of inter-group differences. Effect sizes were categorized as small (d = 0.2 to 0.5), medium (d = 0.5 to 0.8), or large (d ≥ 0.8) (Cohen, 1988). All statistical analyses were performed utilizing SPSS (version 28.0.0.0, IBM, USA), with significance threshold set at $p < 0.05$.

Results

Baseline comparisons revealed no significant differences between groups on YYIRT (F = 0.030; p = 0.971; η^2 = 0.001) and 30-m sprint time (F = 0.498; p = 0.611; η^2 = 0.022). Descriptive statistics of physical fitness outcomes pre and post-intervention can be observed in Table 1.

Significant interactions time × group were observed in regards YYIRT (F = 15.857; p < 0.001; η_p^2 = 0.413). Between-group differences were found in post-intervention (F = 13.969; p < 0.001; η_p^2= 0.383), on which SSGlw2 (+328.8 m; p < 0.001) and SSGlw1 (+280.0 m; p < 0.001) were significantly greater in comparison to control group. No significant differences were found between both experimental groups (48.8 m; p > 0.999). Within-group analysis revealed significant improvements on SSGlw2 (+333.8 m; p < 0.001) and SSGlw1 (+308.8 m; p < 0.001), while no significant differences was found on control group (+10 m; p = 0.826). Figure 2 illustrates the mean differences observed within each group, taking into account the within-player variations.

Significant interactions time × group were observed in regards 30-m sprint test (F = 43.965; p < 0.001; η_p^2 = 0.661). Between-group differences were found in post-intervention (F = 25.425; p < 0.001; η_p^2 = 0.531), on which SSGlw2 was significantly better than SSGlw1 (-0.073s; p < 0.001) and control group (-0.095s; p < 0.001). No significant differences were found between SSGlw1 and control groups (0.022s; p = 0.363). Within-group analysis revealed significant improvements on SSGlw2 (-0.092s; p < 0.001) and SSGlw1 (-0.017s; p = 0.022), while no significant differences was found on control group (-0.006s; p = 0.440).

Discussion

This study is one of the few to investigate how differences in pitch shape during SSG can influence physical fitness adaptation. Our findings revealed that the more elongated pitch (SSGlw2) significantly outperformed the other intervention group (SSGlw1) and the control group in eliciting positive adaptations in sprinting performance. Moreover, both experimental groups exhibited significantly superior improvements in enhancing aerobic capacity compared to the control group, although there was no significant difference between the two experimental groups. This evidence suggests that incorporating SSG promotes positive adaptations at such levels. However, further comparisons in future research are needed to understand whether the primary factor contributing to improvements is the training method itself (SSG) or the supplementation of exercise by adding extra training volume.

Research on acute demands induced by SSGs often highlights their limited ability to facilitate stable and significant distances covered at high-speed running and sprinting (Dello Iacono et al., 2023). However, investigations comparing larger pitches, particularly those elongated from goal-to-goal, have provided evidence that this modification significantly increases running speed actions (Castagna et al., 2017). Specifically, players achieve more actions and cover greater distances at faster speeds on larger pitches (Casamichana et al., 2018; Castagna et al., 2019). Building upon these findings, the current study innovated by examining whether this critical modification could enhance the typical adaptations induced by SSGs, which, thus far, have only marginally surpassed control groups in terms of sprint performance adaptations (Clemente et al., 2021b).

Table 1. **Descriptive statistics (mean ± standard deviation) of the physical fitness assessments performed in pre and post-intervention.**

		SSGlw2	SSGlw1	Control
YYIRT (m)	Pre	2471.3 ± 232.1	2447.5 ± 301.2	2466.3 ± 331.8
	Post	2805.0 ± 72.8$^{\#,@}$	2756.3 ± 73.1$^{\#,@}$	2476.3 ± 312.3$^{\$,*}$
	(post–pre)	+13.5%	+12.6%	+0.4%
30-m sprint (s)	Pre	4.14 ± 0.03	4.14 ± 0.03	4.15 ± 0.04
	Post	4.05 ± 0.04$^{\#,@,*}$	4.12 ± 0.03$^{\$}$	4.14 ± 0.04$^{\$}$
	(post–pre)	–2.17%	–0.48%	–0.24%

SSGlw2: small-sided games group playing in length per width ratio of 2:1; SSGlw1: small-sided games group playing in length per width ratio of 1:1; YYIRT: Yo-Yo intermittent recovery test level 1; #: post-pre significant difference (p < 0.05); @: between group difference (p < 0.05) in comparison to control; *: between-group difference (p < 0.05) in comparison to SSGlw1; $: between-group difference (p < 0.05) in comparison to SSGlw2.

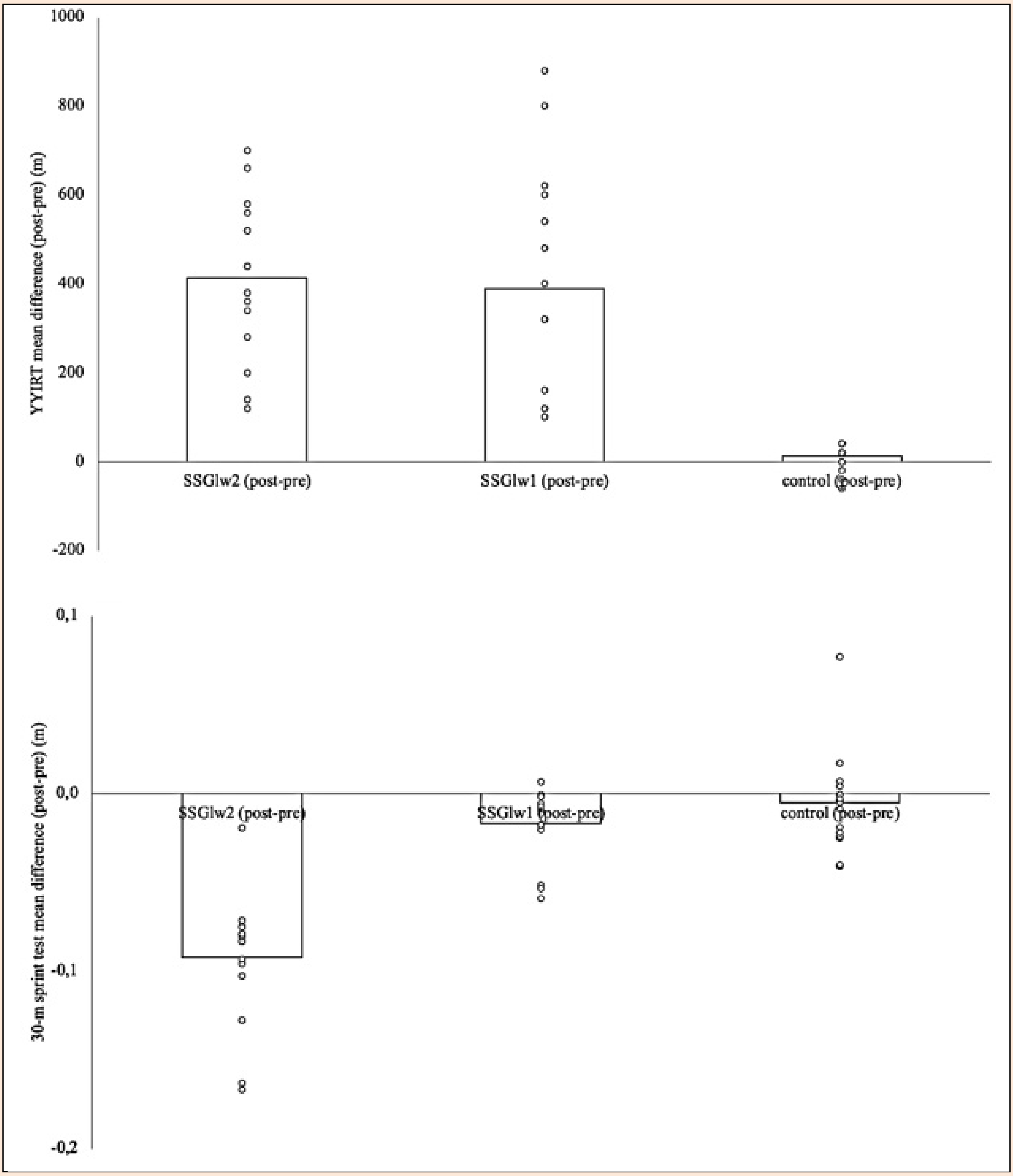

Figure 2. Mean differences (post-pre) observed in the three groups. SSGlw2: small-sided games group playing in length per width ratio of 2:1; SSGlw1: small-sided games group playing in length per width ratio of 1:1; YYIRT: Yo-Yo intermittent recovery test level 1.

Interestingly, and in line with our hypothesis, the more elongated condition implemented in the SSGlw2 group significantly improved sprinting performance, surpassing the adaptations induced by both SSGlw1 and control groups. Despite SSGlw1 and SSGlw2 having the same relative area per player, the elongated nature of SSGlw2 likely facilitated more continuous running periods, leading to greater speeds (Casamichana et al., 2018). This contrasts with games played in smaller spaces, where running demands are more associated with frequent changes of direction, acceleration, and deceleration, typically linked to possession-oriented tactics and circulation along the wings (Fradua et al., 2013; Casamichana et al., 2018).

The specific tactical behavior observed in SSGs on elongated pitches emphasizes mobility actions, transitions, and exploitation of the longitudinal axis (Silva et al., 2014). By allowing players to explore this axis more frequently, they are exposed to intense running actions, particularly in counter-attacks (Fradua et al., 2013), which may benefit the adaptations observed in this research. Notably, the

SSGlw1 group also demonstrated improved sprint performance in within-group analysis, although not significantly surpassing the control group, which only participated in regular in-field sessions.

Considering the effects of both SSG training interventions on aerobic capacity, our findings revealed that both significantly promote capacity enhancement, surpassing the control group. The 4v4 format of play, commonly associated with a more metabolic stimulus, effectively targets aerobic and anaerobic metabolisms, favoring aerobic power training (Lacome et al., 2018). Regardless of pitch shape, our results demonstrated that both interventions were equally effective in significantly enhancing aerobic capacity. These findings are consistent with existing literature on SSG interventions, which show comparable adaptations in aerobic capacity to other intense and intermittent methods such as high-intensity interval training (Moran et al., 2019; Clemente et al., 2024). On the other hand, our results contradict a study (Faga et al., 2022) that examined the effects of small (75 m^2) and large (300 m^2) pitches on maximal aerobic speed. In that study (Faga et al., 2022), it was found that only the largest pitch led to significant improvements in this capacity.

The intermittent nature of SSGs, characterized by repeated bursts of high-intensity activity interspersed with brief rests, closely mirrors the demands of aerobic interval training, known for its efficient improvement of cardiovascular fitness (Clemente et al., 2021c). Additionally, the high intensity and varied movement patterns inherent in SSGs, including intense accelerations, decelerations, and changes of direction, engage a larger muscle mass, resulting in greater energy expenditure and cardiovascular demand (Gaudino et al., 2014) compared to traditional continuous exercise. Moreover, the social and competitive aspects of these games often enhance motivation and enjoyment (Selmi et al., 2020; Farhani et al., 2022), further facilitating physiological adaptations associated with improved aerobic capacity.

Despite implementing innovative and adhering to recommended practices for randomized experimental studies, our research is not without limitations. One such limitation is the absence of progression in task challenges throughout the study weeks. It would be advisable to explore the potential benefits of incorporating progressive periodization in SSGs, as this may lead to varied adaptations in players. Furthermore, due to methodological limitations, we did not have access to microelectromechanical systems that could aid in monitoring the acute locomotor and mechanical impact during the use of SSGs, nor did we have heart rate sensors to provide information about the players' physiological responses to the games. This lack of instrumentation hindered our ability to gain a comprehensive understanding of the mechanisms contributing to the observed adaptations. Additionally, our study overlooked other physical fitness variables that could be influenced by modifications in pitch size, such as change of direction ability or jumping performance. Furthermore, we chose to conduct in-field tests rather than examining competitive performance measures. While competitive performance is undoubtedly important, some match running performance measures are highly dependent on the context of the game, rather than solely representing specific physical qualities (Buchheit and Simpson, 2017). This led us to focus on a capacity that is not contingent upon the playing dynamics. However, we acknowledge that future studies should also consider employing tests that evaluate performance in matches, while controlling for the influence of game dynamics on these outcomes. Moreover, we only examined a single format of play, neglecting the potential impact of different training formats on the interaction with pitch size. Finally, the experimental groups received an additional 24 minutes of training per week compared to the control group. Therefore, future research should explore alternative training approaches for control groups to match the same training volume. This would ensure that improvements are not solely due to the additional training volume but also to the specific training method employed. Future research should also aim to establish dose-response relationships between accumulated external load demands during games and the resulting adaptations in physical fitness.

Despite these limitations, our study is, to the best of our knowledge, the first to investigate the hypothesis that different pitch shapes influence physical fitness adaptations during SSG interventions. Our findings suggest that, from a practical standpoint, coaches should consider employing more elongated games to create conditions conducive to improving sprint performance over time. Merely reducing pitch size along the longitudinal axis may not guarantee to achieve significant improvements in this regard.

Conclusion

Our study findings indicate that employing more elongated pitch sizes during SSG training interventions significantly enhances sprint performance compared to less elongated pitches and control groups. However, regardless of the pitch shapes utilized in this study, coaches can effectively utilize SSG training interventions to significantly improve aerobic capacity in youth male soccer players, as both approaches outperformed the control group. Coaches are advised to prioritize the use of more elongated pitch sizes to promote adaptations in sprint performance, while still acknowledging that aerobic capacity improvements remain significant compared to other pitch shapes.

Acknowledgements

The authors declare no potential or actual conflicts of interest. The datasets generated and analyzed during the current study are not publicly available, but are available from the corresponding author who was an organizer of the study. The experiments comply with the current laws of the country where they were performed.

References

Altmann, S., Ringhof, S., Neumann, R., Woll, A. and Rumpf, M.C. (2019) Validity and reliability of speed tests used in soccer: A systematic review. *Plos One* **14**, e0220982. https://doi.org/10.1371/journal.pone.0220982

Arslan, E., Orer, G. and Clemente, F. (2020) Running-based high-intensity interval training vs. small-sided game training programs: effects on the physical performance, psychophysiological responses and technical skills in young soccer players. *Biology of Sport* **37**, 165-173. https://doi.org/10.5114/biolsport.2020.94237

Buchheit, M. and Simpson, B.M. (2017) Player-Tracking Technology: Half-Full or Half-Empty Glass? *International Journal of Sports Physiology and Performance* **12**, 35-41.

https://doi.org/10.1123/ijspp.2016-0499

Bujalance-Moreno, P., Latorre-Román, P.Á. and García-Pinillos, F.(2019) A systematic review on small-sided games in football players: Acute and chronic adaptations. *Journal of Sports Sciences* **37**, 921-949. https://doi.org/10.1080/02640414.2018.1535821

Casamichana, D., Bradley, P.S. and Castellano, J. (2018) Influence of the Varied Pitch Shape on Soccer Players Physiological Responses and Time-Motion Characteristics During Small-Sided Games. *Journal of Human Kinetics* **64**, 171-180. https://doi.org/10.1515/hukin-2017-0192

Castagna, C., D'Ottavio, S., Cappelli, S. and Póvoas, S.C.A. (2019) The Effects of Long Sprint Ability-Oriented Small-Sided Games Using Different Ratios of Players to Pitch Area on Internal and External Load in Soccer Players. *International Journal of Sports Physiology and Performance* **14**, 1265-1272. https://doi.org/10.1123/ijspp.2018-0645

Castagna, C., Francini, L., Póvoas, S.C.A. and D'Ottavio, S. (2017) Long-sprint abilities in soccer: Ball versus running drills. *Int J Sports Physiol Perform* **12**, 1256-1263. https://doi.org/10.1123/ijspp.2016-0565

Clemente, F.M., Afonso, J. and Sarmento, H. (2021a) Small-sided games: An umbrella review of systematic reviews and meta-analyses. *Plos One* **16**, e0247067. https://doi.org/10.1371/journal.pone.0247067

Clemente, F.M., Ramirez-Campillo, R., Afonso, J. and Sarmento, H. (2021b) Effects of Small-Sided Games vs. Running-Based High-Intensity Interval Training on Physical Performance in Soccer Players: A Meta-Analytical Comparison. *Frontiers in Physiology* **12**, 642703. https://doi.org/10.3389/fphys.2021.642703

Clemente, F.M., Ramirez-Campillo, R., Nakamura, F.Y. and Sarmento, H. (2021c) Effects of high-intensity interval training in men soccer player's physical fitness: A systematic review with meta-analysis of randomized-controlled and non-controlled trials. *Journal of Sports Sciences* **39**, 1202-1222. https://doi.org/10.1080/02640414.2020.1863644

Clemente, F.M., Moran, J., Ramirez-Campillo, R., Beato, M. and Afonso, J. (2024) Endurance performance adaptations between SSG and HIIT in soccer players: A meta-analysis. *International Journal of Sports Medicine* **45(03**), 183-210. https://doi.org/10.1055/a-2171-3255

Cohen, J. (1988) *Statistical Power Analysis for the Behavioral Sciences.* 2nd edition. Hillsdale, NJ: Lawrence Erlbaum Associates.

Dello Iacono, A., McLaren, S.J., Macpherson, T.W., Beato, M., Weston, M., Unnithan, V.B. and Shushan, T. (2023) Quantifying Exposure and Intra-Individual Reliability of High-Speed and Sprint Running During Sided-Games Training in Soccer Players: A Systematic Review and Meta-analysis. *Sports Medicine* **53**, 371-413. https://doi.org/10.1007/s40279-022-01773-1

Faga, J., Bishop, C. and Maloney, S.J. (2022) Does size matter? Effects of small versus large pitch small-sided game training on speed and endurance in collegiate soccer players. *International Journal of Sports Science and Coaching* 18, 2033-2043. https://doi.org/10.1177/17479541221126955

Farhani, Z., Hammami, R., Gene-Morales, J., Chortane, S.G., Bouassida, A., Juesas, A. and Colado, J.C. (2022) Bout duration and number of players of soccer small-sided games affect perceived enjoyment, physiological responses, and technical-tactical performance. *Science and Medicine in Football* **6**, 503-510. https://doi.org/10.1080/24733938.2021.2009123

Faude, O., Steffen, A., Kellmann, M. and Meyer, T. (2014) The effect of short-term interval training during the competitive season on physical fitness and signs of fatigue: a crossover trial in high-level youth football players. *International Journal of Sports Physiology and Performance* **9**, 936-944. https://doi.org/10.1123/ijspp.2013-0429

Ferreira-Ruiz, Á., García-Banderas, F. and Martín-Tamayo, I. (2022) Systematic Review: Technical-Tactical Behaviour in Small-Sided Games in Men's Football. *Apunts. Educacion Fisica y Deportes* **148**, 42-61. https://doi.org/10.5672/apunts.2014-0983.es.(2022/2).148.06

Fradua, L., Zubillaga, A., Caro, O., Fernandez-Garcia, A.I., Ruiz-Ruiz, C. and Tenga, A. (2013) Designing small-sided games for training tactical aspects in soccer: Extrapolating pitch sizes from full-size professional matches. *Journal of Sports Sciences* **31**, 573-581. https://doi.org/10.1080/02640414.2012.746722

Gaudino, P., Alberti, G. and Iaia, F.M. (2014) Estimated metabolic and mechanical demands during different small-sided games in elite soccer players. *Human Movement Science* **36**, 123-133. https://doi.org/10.1016/j.humov.2014.05.006

Halouani, J., Chtourou, H., Gabbett, T., Chaouachi, A. and Chamari, K. (2014) Small-sided games in team sports training: a brief review. *Journal of Strength and Conditioning Research* **28**, 3594-3618. https://doi.org/10.1519/JSC.0000000000000564

Hill-Haas, S. V., Dawson, B.T., Impellizzeri, F.M. and Coutts, A.J. (2011) Physiology of small-sided games training in football: A systematic review. *Sports Medicine* **41**, 199-220. https://doi.org/10.2165/11539740-000000000-00000

Jastrzebski, Z., Barnat, W., Dargiewicz, R., Jaskulska, E., Szwarc, A. and Radzimiński, L. (2014) Effect of in-season generic and soccer-specific high-intensity interval training in young soccer players. *International Journal of Sports Science and Coaching* **9**, 1169-1179. https://doi.org/10.1260/1747-9541.9.5.1169

Krustrup, P., Mohr, M., Amstrup, T., Rysgaard, T., Johansen, J., Steensberg, A., Pedersen, P.K. and Bangsbo, J. (2003) The Yo-Yo Intermittent Recovery Test: Physiological Response, Reliability, and Validity. *Medicine & Science in Sports & Exercise* **35**, 697-705. https://doi.org/10.1249/01.MSS.0000058441.94520.32

Lacome, M., Simpson, B.M., Cholley, Y., Lambert, P. and Buchheit, M. (2018) Small-Sided Games in Elite Soccer: Does One Size Fit All? *International Journal of Sports Physiology Performance* **13**, 568-576. https://doi.org/10.1123/ijspp.2017-0214

Moran, J., Blagrove, R.C., Drury, B., Fernandes, J.F.T., Paxton, K., Chaabene, H. and Ramirez-Campillo, R. (2019) Effects of Small-Sided Games vs. Conventional Endurance Training on Endurance Performance in Male Youth Soccer Players: A Meta-Analytical Comparison. *Sports Medicine* **49**, 731-742. https://doi.org/10.1007/s40279-019-01086-w

Praca, G.M., Chagas, M.H., Bredt, S.D.T. and de Andrade, A.G.P. (2022) Small-Sided Soccer Games with Larger Relative Areas Result in Higher Physical and Physiological Responses: A Systematic and Meta-Analytical Review. *Journal of Human Kinetics* **81**, 163-176. https://doi.org/10.2478/hukin-2022-0013

Riboli, A., Coratella, G., Rampichini, S., Cé, E. and Esposito, F. (2020) Area per player in small-sided games to replicate the external load and estimated physiological match demands in elite soccer players. *Plos One* **15**, e0229194. https://doi.org/10.1371/journal.pone.0229194

Riboli, A., Olthof, S.B.H., Esposito, F. and Coratella, G. (2022) Training elite youth soccer players: area per player in small-sided games to replicate the match demands. *Biology in Sport* **39**, 579-598. https://doi.org/10.5114/biolsport.2022.106388

Selmi, O., Ouergui, I., Levitt, D.E., Nikolaidis, P.T., Knechtle, B. and Bouassida, A. (2020) Small-Sided Games are More Enjoyable Than High-Intensity Interval Training of Similar Exercise Intensity in Soccer. *Open Access Journal of Sports Medicine* **11**, 77-84. https://doi.org/10.2147/OAJSM.S244512

Silva, P., Duarte, R., Sampaio, J., Aguiar, P., Davids, K., Araújo, D. and Garganta, J. (2014) Field dimension and skill level constrain team tactical behaviours in small-sided and conditioned games in football. *Journal of Sports Science* **32**, 1888-1896. https://doi.org/10.1080/02640414.2014.961950

Turner, L., Shamseer, L., Altman, D.G., Weeks, L., Peters, J., Kober, T., Dias, S., Schulz, K.F., Plint, A.C. and Moher, D. (2012) Consolidated standards of reporting trials (CONSORT) and the completeness of reporting of randomised controlled trials (RCTs) published in medical journals. *Cochrane Database of Systematic Reviews* https://doi.org/10.1002/14651858.MR000030.pub2

Willardson, J.M. and Burkett, L.N. (2005) A Comparison of 3 Different Rest Intervals on the Exercise Volume Completed During a Workout. *The Journal of Strength and Conditioning Research* **19**, 23. https://doi.org/10.1519/R-13853.1

Key points

- Coaches are advised to prioritize the use of more elongated pitch sizes to promote adaptations in sprint performance during SSG training programs.
- Both smaller and more elongated SSG pitch sizes have been found to significantly enhance aerobic performance.

AUTHOR BIOGRAPHY

Liang WANG
Employment
Geely University of China, Chengdu, China
Degree
University Teachers
Research interests
Sports training and fitness
E-mail: 23747951@qq.com

YuHua KANG
Employment
Chengdu Dongchenggen Primary school, Chengdu, China
Degree
Primary School Teachers
Research interests
Physical education
E-mail: 10887652@qq.com

LiXin WEI
Employment
Geely University of China, Chengdu, China
Degree
University Teachers
Research interests
Sports training and fitness
E-mail: 26315077@qq.com

MingBang LI
Employment
Geely University of China, Chengdu, China
Degree
University Teachers
Research interests
Sports training and fitness
E-mail: limingbang@guc.edu.cn

Tao WANG
Employment
Geely University of China, Chengdu, China
Degree
University Teachers
Research interests
Sports training and fitness
E-mail: wangtao@guc.edu.cn

✉ **Liang Wang**
Geely University of China, 641423 Chengdu, China