©Journal of Sports Science and Medicine (2025) **24**, 495-502
http://www.jssm.org DOI: https://doi.org/10.52082/jssm.2025.495

Research article

Using Game-Based Compensatory Strategies in Non-Starter Soccer Players: Analyzing The Impact on Physical Fitness Development

TongZheng Liu [1], Mingbang Li [2] and XiaoYan Pu [1]✉
[1] Nanchong Vocational College of Culture and Tourism, Nanchong, China
[2] College of physical education and health, Geely University of China, Chengdu, China

Abstract

The purpose of this study was to compare the effects of small-sided game-based compensatory strategies (CS) versus non-compensatory (NCS) strategies on the aerobic and repeated sprint ability development of non-starter soccer players. A controlled crossover experimental design was used, consisting of two 4-week phases separated by a 2-week washout period. Nineteen male non-starter soccer players (age: 18.1 ± 0.7 years) participated in the study. Each player experienced both an NCS and a specific CS, the latter involving six 3-minute bouts of 2v2 small-sided games performed the day after the match. CS indicates that additional training was introduced to compensate for the lack of playing time. This intervention was applied to players who either did not participate in the match or played less than 15 minutes. Physical fitness was assessed using the Yo-Yo Intermittent Recovery Test Level 1 (YYIRT) and the Running-Based Anaerobic Sprint Test (RSAmean). Significant interactions were found for YYIRT ($p < 0.001$, $\eta p^2 = 0.587$, large effects) and RSAmean ($p < 0.001$, $\eta p^2 = 0.739$, large effects). CS presented better results than NCS in YYIRT at both mid (mean difference: 84.4m, $p = 0.040$) and post-assessment (mean difference: 64.7m, $p = 0.042$). RSAmean was smaller under CS at mid (mean difference: -0.078 s, $p = 0.012$) and post-assessment (mean difference: -0.058s, $p = 0.045$). In conclusion, the results suggest that the CS condition leads to better YYIRT performance and reduced RSAmean compared to NCS. Practically, incorporating CS into training protocols for players who do not regularly participate in matches - such as unselected players or non-starters with limited playing time - may help maintain physical capacities, particularly endurance and repeated sprint ability, as these players are often exposed to lower physical demands during matches.

Key words: Compensatory training, football, athletic fitness, sports training.

Introduction

Research suggests that non-starter soccer players - those who either do not participate in matches or play only limited minutes as substitutes - may experience some decline or impairment in physical fitness compared to starting players, who consistently play the majority of match time (Clemente et al., 2024). For example, official matches appear to play a key role in maintaining and enhancing players' physical fitness (Sporis et al., 2011). Starters who accumulated more than 1,000 minutes in official matches showed significant improvements in 21 out of 24 physical fitness variables compared to non-starters (Sporis et al., 2011). However, the study design does not allow for determining whether these improvements were directly caused by the accumulated playing time. Similarly, a previous study (Varjan et al., 2023) reported that non-starters tend to experience lower weekly training loads - especially in high-intensity activities - compared to starters. This discrepancy may progressively impact their physical capacities over time. Supporting this, a study (Anderson et al., 2016) also reported that non-starters exhibited lower physical fitness levels, likely due to reduced exposure to high-intensity efforts during matches. However, evidence is still scarce regarding the contexts in which these effects may occur - specifically, whether factors such as competitive level, age, or playing position can influence these impacts.

Non-starters typically experience reduced match exposure, necessitating additional training to maintain readiness and physical fitness (Teixeira et al., 2022). Studies have explored various compensatory approaches, including running-based drills and small-sided games (SSG), which can reproduce match demands for non-starters (Díaz-Serradilla et al., 2023). However, the effectiveness of these strategies in enhancing physical fitness and reducing injury risks remains unclear (Clemente et al., 2024), largely because the existing studies are often observational, non-comparative, and highly context-specific. Thus, further research is needed to fully understand the impact of compensatory training on non-starters' performance and readiness.

Implementing compensatory strategies to maintain both aerobic and anaerobic capacities may be important for sustaining soccer players' performance throughout the competitive season (Bekris et al., 2016). High aerobic capacity allows players to maintain work intensity, cover greater distances, and perform more sprints during matches and be ready for such exposure if the case (Strauss et al., 2012). In specific aerobic capacity is particularly important for young players' performance (Çobaj et al., 2024). Moreover, higher intermittent-aerobic capacity offers greater injury protection when soccer players are exposed to rapid changes in workload (Malone et al.). Moreover, anaerobic power influence performance and injury risk in professional and junior elite soccer players (Lehance et al., 2009). Anaerobic fitness is important for soccer performance, as it is correlated with repeated sprint ability, while aerobic fitness is important for maintaining intensity during a game (Meckel et al., 2009).

Despite the growing interest in compensatory strategies for non-starter soccer players, current research remains limited and contains several important gaps (Clemente et al., 2024). There is a lack of experimental, controlled intervention studies that directly compare the ef-

Received: 22 April 2025 / Accepted: 11 June 2025 / Published (online): 01 September 2025

fects of implementing compensatory strategies versus not using them, particularly in terms of physical adaptation outcomes. Additionally, no study has employed crossover designs, which are valuable for determining the practical applicability and individual responsiveness to such strategies in mitigating the potential fitness decline associated with limited match participation. Given these research gaps, it is important to advance the current understanding by investigating the effectiveness of compensatory strategies in preserving or enhancing physical fitness in non-starters. Therefore, the purpose of this study was to compare the effects of small-sided game-based compensatory (CS) strategies versus non-compensatory (NCS) strategies on the aerobic and anaerobic development of non-starter soccer players.

Methods

Experimental approach to the problem

A randomized crossover controlled study design was implemented. The study was conducted during the first half of the in-season period, spanning 12 weeks. This period was chosen because 12 weeks is generally sufficient to observe either detraining effects or, conversely, positive adaptations resulting from sports science interventions. Physical fitness assessments were carried out during the 1st, 6th, and final (12th) weeks. The intervention was divided into two phases: Phase 1 took place from weeks 2 to 5, and Phase 2 from weeks 8 to 11. The study design is illustrated in Figure 1.

Convenience sampling was used to recruit soccer players from two regional-level clubs competing in an under-19 competition. Blinding was applied only to the evaluators conducting the physical assessments at the three designated time points.

Randomization was performed on half of each team, as it was not feasible to determine in advance which players would be starters or non-starters. Opaque envelopes were used to ensure a 1:1 allocation ratio within each team. Once assigned to a group, players remained in that group throughout the study.

Participants

To determine the necessary a priori sample size for your repeated measures ANOVA with a two-group crossover design and three time points, it was executed the G*Power software (version 3.1.9). Specifically, under the ANOVA: Repeated measures, within-between interaction test family, it was specified the following parameters: a statistical power of 0.80, a significance level (α) of 0.05, two groups, and three measurements. For the effect size, given the novelty of our intervention, we conservatively estimated a medium effect size (Cohen's f = 0.30). Based on these parameters, G*Power calculated a total required sample size of 20.

Eligibility criteria were defined as follows: (i) male players competing in the under-19 category; (ii) outfield players only; (iii) a minimum of three years of soccer experience; (iv) non-starters or players not selected for any matches during the study period; (v) average match participation of less than 15 minutes throughout the observation period; and (vi) full participation in all assessment sessions. Exclusion criteria included: (i) goalkeepers; (ii) injuries lasting more than three days during the study period; (iii) being a starter in any match; (iv) playing more than 15 minutes in any match during the study period; (v) missing any of the compensatory intervention sessions; and (vi) missing any of the assessment sessions.

Among the 51 volunteers from the two regional-level under-19 soccer teams, 32 were excluded: 5 were goalkeepers, and 27 were either starters or played more than 15 minutes per match during the study period. This left 19 players eligible for inclusion in the analysis. Figure 2 illustrates the participant flow throughout the study.

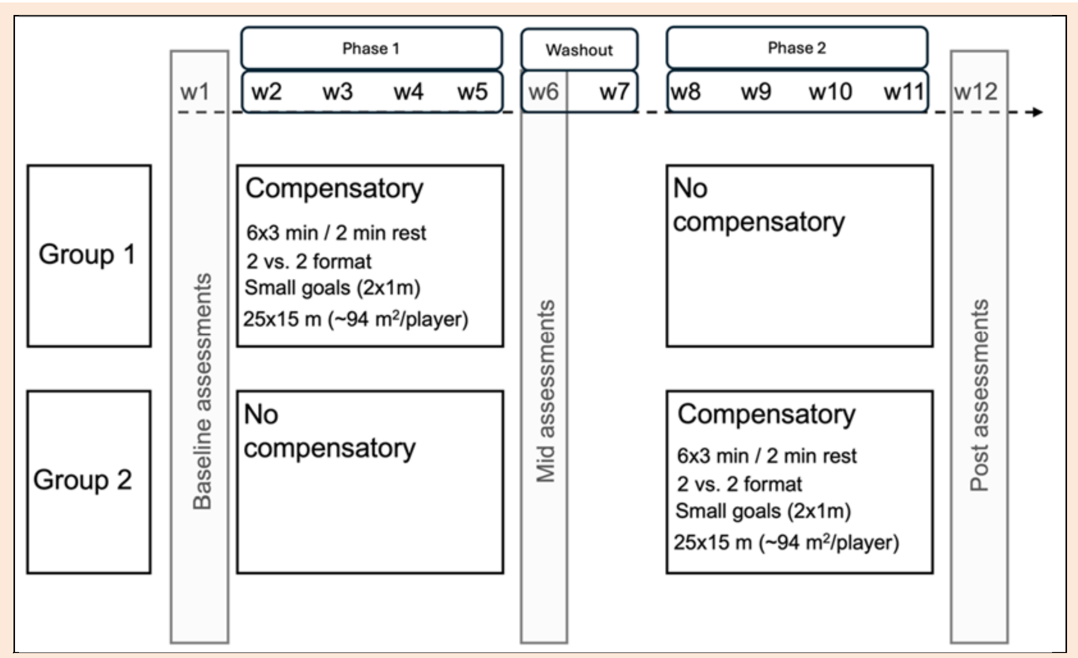

Figure 1. Design of the study.

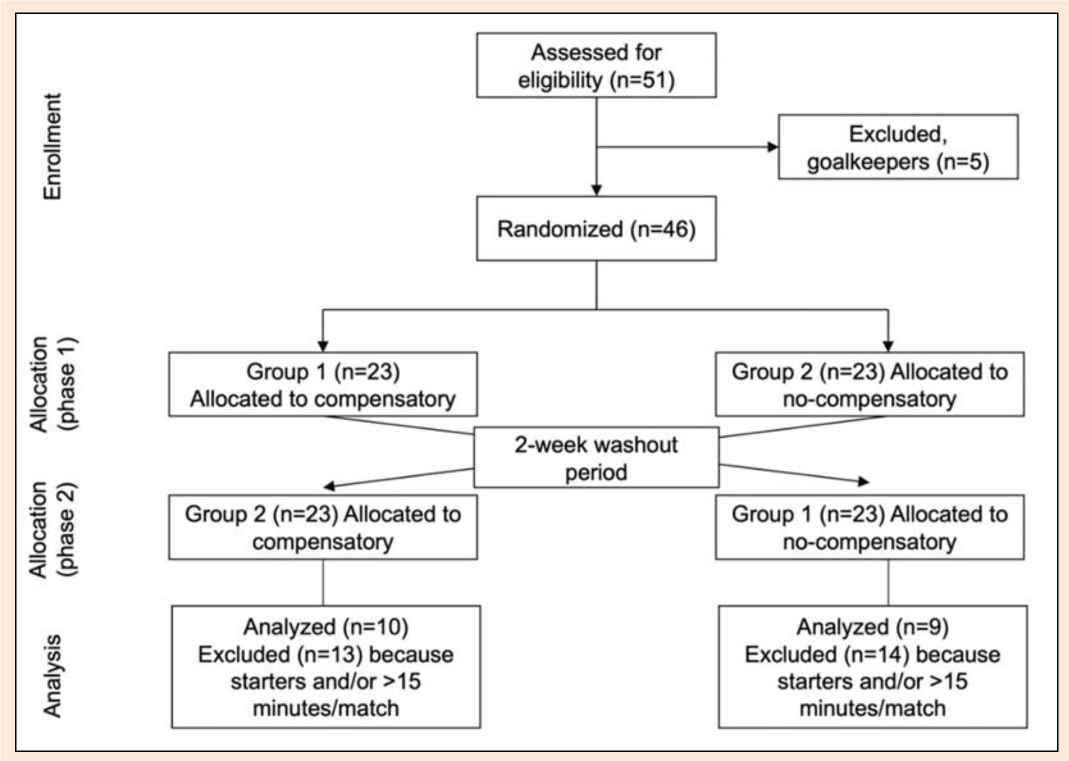

Figure 2. Participant's flowchart.

The 19 players had an average age of 18.1 ± 0.7 years, body mass of 61.6 ± 2.8 kg, height of 173.7 ± 3.3 cm, and training experience of 6.1 ± 0.7 years. All participants were regional-level soccer players, training four times a week, in addition to a weekend match as part of their regular championship schedule. Training sessions typically lasted between 95 and 110 minutes. Training sessions varied throughout the week. The first session focused on recovery and general strength training, the next two sessions emphasized conditioning and technical/tactical development, and the final session was centered on match-specific strategies.

Ethical approval for this research was obtained from the Chengdu Sport University ethical committee with the code number 2024#161. All participants provided written informed consent prior to their involvement in the study, ensuring they were fully aware of the study's purpose, procedures, potential risks, and their right to withdraw at any time without consequence. To maintain confidentiality, all data collected were anonymized, and stored securely. Furthermore, the crossover design was carefully considered to ensure that all participants, regardless of their initial group assignment, had the opportunity to experience both the intervention and control conditions, addressing potential concerns about equitable access to the intervention.

Compensatory intervention

On match days, a specific compensatory training session was implemented for players who did not start the match, were not selected for the match squad, or played less than 15 minutes. This session was conducted post-match and consisted of small-sided games designed to maintain physical conditioning without imposing excessive load. The small-sided games were played in a 2 vs. 2 format on small pitches measuring 2 meters by 1 meter, within a larger playing area of approximately 25 meters by 15 meters (roughly 94 square meters per player). Each of the six bouts of exercise lasted 3 minutes (18 minutes of total exercise), followed by a 2-minute rest period. This format aimed to provide a high-intensity stimulus, focusing on metabolic conditioning, technical participation, and tactical awareness in confined spaces. The intensity of the efforts was monitored using the Rate of Perceived Exertion (RPE), specifically the CR10 Borg scale, to determine whether players reached values of approximately 8 to 9 arbitrary units - the target effort level for the implemented games.

During the periods assigned to the non-compensatory condition, players followed their regular training schedule but did not participate in any additional training sessions on match days, regardless of their playing time. This condition served as the baseline for comparison, allowing for the isolation of the specific effects of the post-match compensatory training intervention. The two-week washout period between the intervention phases was implemented to minimize any carry-over effects from the preceding training regimen. In general, a two-week period is sufficient to observe short-term detraining effects in aerobic fitness.

Measurements and procedures

Evaluations were consistently conducted at three distinct time points throughout the study: baseline, mid-assessment, and post-assessment. The baseline assessments occurred before the commencement of the first intervention phase. Mid-assessments were carried out following the completion of the first four-week intervention phase and the subsequent two-week washout period. Finally, post-assessments were performed after the second four-week intervention phase. At each of these time points, data collection followed the same standardized procedure and took place approximately 48 hours after the last match of the week and before the team's first training session of the week. All evaluations were scheduled in the afternoon, around 5:00 PM, and conducted on the team's regular synthetic turf field.

Upon arrival at the testing site and after the collection of anthropometric data, all participants performed the FIFA 11+ warm-up protocol. This well-established routine was implemented to standardize pre-exercise preparation across all participants and testing sessions. The FIFA 11+ warm-up was structured as a 20-minute routine divided into three parts. Part 1 involved approximately 8 minutes of slow running combined with active stretching and controlled movements, such as hamstring walks, calf raises, and torso twists. Part 2 consisted of around 10 minutes of strength, plyometric, and balance exercises, including exercises like Nordic hamstring curls, lateral hops, and single-leg stands, held for specific durations and repetitions. Part 3 concluded with approximately 2 minutes of short, game-pace running drills.

Following the FIFA 11+ warm-up, participants proceeded with the performance tests, which included a running-based anaerobic sprint test (RAST) and the Yo-Yo Intermittent Recovery Test (Level 1), with a 10-minute rest period between the two tests. Throughout all data collection sessions, environmental conditions - specifically temperature (20.5 ± 2.4ºC) and relative humidity (56.4 ± 5.9%) - were recorded.

Running-based Anaerobic Sprint Test (RAST)

To evaluate the capacity for repeated sprint ability (RSA), a running-based protocol involving six shuttle sprints over a 40-meter distance was implemented. Each sprint required participants to cover 20 meters to a designated cone before returning to the starting line. Between each of the six maximal sprints, a 20-second passive recovery period was strictly enforced. This test (Rampinini et al., 2009) is designed to assess not only the ability to sustain sprint performance across multiple efforts but also the agility involved in repeated change-of-direction movements. Participants were instructed to position themselves at the starting line five seconds prior to an auditory start signal for each subsequent sprint. The primary outcome measure for RSA was the mean sprint time (s), calculated by averaging the completion times of all six sprints. This provides a comprehensive indicator of an athlete's ability to repeatedly produce near-maximal efforts with brief recovery intervals.

Yo-Yo Intermittent Recovery Test - Level 1 (YYIRT)

To determine the participants' capacity for high-intensity intermittent exercise and aerobic endurance, the Yo-Yo Intermittent Recovery Test Level 1 (YYIR1) was administered. This test requires participants to perform repeated 2 x 20-meter shuttle runs, with a 10-second active recovery period between each shuttle. The initial running speed was set at 10 km/h, and the pace progressively increased by 0.5 km/h at each subsequent level, dictated by auditory cues. The test continued until a participant was unable to maintain the required pace on two consecutive occasions. The total distance covered by the participant before reaching this point of failure, measured in meters, served as the primary indicator of their ability to sustain high-intensity intermittent exercise. This distance reflects their aerobic fitness and their capacity to recover and repeat intense efforts.

Statistical procedures

For statistical analysis, given the randomized crossover study design with three repeated measures (baseline, mid-assessment, and post-assessment), a repeated measures analysis of variance (ANOVA) was conducted using SPSS (version 29.0, IBM, USA). This approach allowed for the examination of within-subject changes over time and between-group differences across the intervention phases. Prior to analysis, the data were screened for normality using the Shapiro-Wilk test ($p > 0.05$) and homogeneity of variances using Mauchly's test of sphericity. In cases where sphericity was violated, the Greenhouse-Geisser correction was applied to adjust the degrees of freedom. To pinpoint specific differences between time points and groups, post-hoc analyses with Bonferroni corrections were performed. Effect sizes for significant main and interaction effects were estimated using partial eta squared ($\eta p2$), with values of 0.01, 0.06, and 0.14 considered small, medium, and large effects, respectively. To quantify the effect size for pairwise comparisons, we calculated Cohen's d and interpreted the results using Cohen's thresholds, which classify effect sizes as trivial ($d < 0.2$), small ($0.2 \leq d < 0.5$), moderate ($0.5 \leq d < 0.8$), and large ($d \geq 0.8$). Statistical significance was set at an alpha level of $p < 0.05$ for all analyses.

Results

Descriptive statistics are presented in Table 1, showing YYIRT and RSAmean values at baseline, mid, and post assessments for Groups 1 and 2 (G1 and G2). Significant interactions were observed between assessment time and

Table 1. Mean and standard-deviations of the Yo-Yo Intermittent Recovery Test (YYIRT) and Repeated Sprint Ability mean (RSAmean) at baseline, mid, and post assessments for Groups 1 and 2 (G1 and G2).

Outcome	Group	Baseline	Mid	Post	Mid-Baseline diff.	Post-Baseline diff.	Post-mid diff.
RSAmean (s)	G1 (P1-CS; P2-NCS)	7.60 ± 0.10	7.58 ± 0.07	7.65 ± 0.07	p = 0.041*; d = -0.235	p = 0.002*; d = 0.588	p < 0.001*; d = 1.000
RSAmean (s)	G2 (P1-NCS; P2-CS)	7.63 ± 0.05	7.66 ± 0.05	7.59 ± 0.03	p = 0.008*; d = 0.600	p < 0.001*; d = -1.000	p < 0.001*; d = -1.750
YYIRT (m)	G1 (P1-CS; P2-NCS)	1510.0 ± 112.8	1540.0 ± 81.1	1462.0 ± 67.6	p = 0.148; d = 0.309	p = 0.048*; d = -0.532	p < 0.001*; d = -1.049
YYIRT (m)	G2 (P1-NCS; P2-CS)	1493.3 ± 111.4	1455.6 ± 84.7	1526.7 ± 60.0	p = 0.065; d = -0.384	p = 0.286; d = 0.390	p < 0.001*; d = 0.983

P1: phase 1; P2: phase 2; CS: compensatory strategy; NCS: non-compensatory strategy; diff: difference; *: significant different.

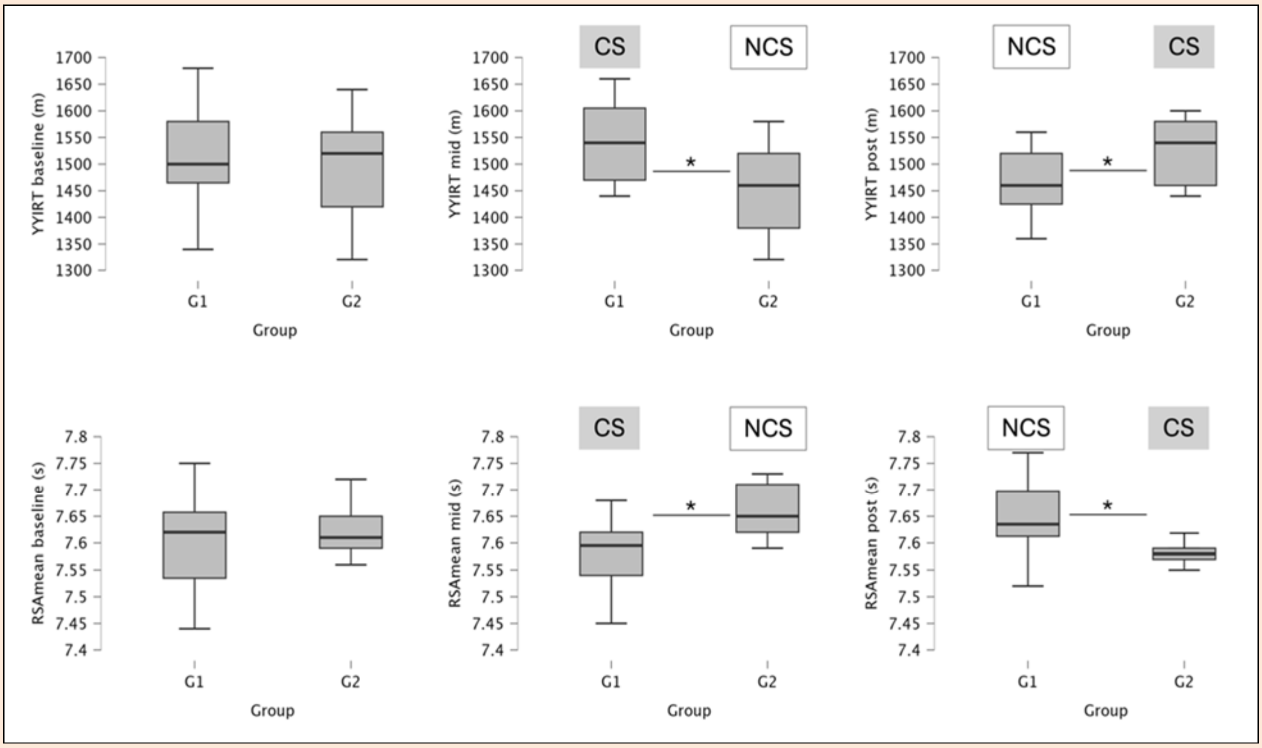

Figure 3. **Boxplots of the Yo-Yo Intermittent Recovery Test (YYIRT) and Repeated Sprint Ability mean (RSAmean) at baseline, mid, and post assessments for Groups 1 and 2 (G1 and G2), under compensatory strategy (CS) and non-compensatory strategy (NCS) conditions. *: significant differences between groups ($p < 0.05$).**

group for both the YYIRT ($F = 24.139$, $p < 0.001$, $\eta p^2 = 0.587$, large effect) and RSAmean ($F = 48.231$, $p < 0.001$, $\eta p^2 = 0.739$, large effect).

In the within-group comparisons for YYIRT, it was observed that Group 1, which began with the CS and then switched to the NCS in Phase 2, did not show significant changes from baseline to the mid assessment (mean difference: -30 m (decline in performance); $p = 0.148$). However, significant declines were noted after returning to the NCS condition when comparing mid to post assessment (mean difference: -78 m; $p < 0.001$). Additionally, a significant decline was observed from baseline to post-assessment (following the NCS phase) (mean difference: -48 m; $p = 0.048$). In Group 2, which started with the NCS and then switched to the CS in Phase 2, no significant differences were observed between the baseline and mid assessment (mean difference: -37.8 m; $p = 0.065$), nor between the baseline and post assessment (after CS) (mean difference: +33.3 m; $p = 0.286$). However, a significant improvement in YYIRT performance was found when comparing NCS to CS within Group 2 (mean difference: +71.1 m; $p < 0.001$).

Regarding RSAmean, Group 1, which began with the CS and then switched to the NCS in Phase 2, showed significant improvements from baseline to the mid assessment (mean difference: -0.024 s (A minus sign denotes faster performance times); $p = 0.041$), followed by significant declines from mid to post assessment (after the NCS phase) (mean difference: +0.067 s; $p < 0.001$). Furthermore, RSAmean time at the post-assessment (following NCS) was significantly higher than at baseline ($p = 0.043$; $p = 0.002$). Similar trends were observed in Group 2, which started with the NCS and then switched to the CS in Phase 2. At the mid assessment, RSAmean values were significantly higher than at baseline (mean difference: +0.032 s; $p = 0.008$) and also higher than at the post-assessment (i.e., after CS) (mean difference: +0.069 s; $p < 0.001$). Following the CS phase, RSAmean values were significantly lower compared to baseline (mean difference: -0.037 s; $p = 0.009$).

Figure 3 shows the boxplots of the YYIRT and RSAmean at baseline, mid, and post assessments for Groups 1 and 2, under CS and NCS conditions. Between-group comparisons for the YYIRT revealed no significant differences at baseline ($F = 0.105$; $p = 0.750$; $\eta p^2 = 0.006$, trivial effects), but significant differences were observed at the mid assessment ($F = 4.924$; $p = 0.040$; $\eta p^2 = 0.225$, large effects) and post-assessment ($F = 4.813$; $p = 0.042$; $\eta p^2 = 0.221$, large effects). Specifically, the CS resulted in significantly greater YYIRT performance compared to the NCS at both the mid assessment (mean difference: 84.4 m; $p = 0.040$) and the post-assessment (mean difference: 64.7 m; $p = 0.042$).

Regarding RSAmean, no significant differences were found between groups at baseline ($F = 0.355$; $p = 0.559$; $\eta p^2 = 0.020$, small effects). However, significant differences emerged at the mid assessment ($F = 7.863$; $p = 0.012$; $\eta p^2 = 0.316$, large effects) and at the post-assessment ($F = 4.664$; $p = 0.045$; $\eta p^2 = 0.215$, large effects). Specifically, the CS resulted in significantly smaller RSAmean time compared to the NCS at both the mid assessment (mean difference: -0.078 s; $p = 0.012$) and the post-assessment (mean difference: -0.058 s; $p = 0.045$).

Discussion

Our findings revealed that CS was effective in maintaining both aerobic and repeated sprint capacities, mitigating the significant declines observed in players who are consistently non-starters and seldom used in matches. YYIRT and RSAmean were significantly better after the CS intervention compared to the NCS condition, providing insights for practical strategies tailored to these specific players. Additionally, both outcomes showed a tendency for significant declines without CS intervention after baseline, highlighting the potential importance of compensating these players with short, targeted training interventions, as exhibited in this study.

While one study found non-starter soccer players do not suffer declines in aerobic capacity compared to starters during competition (Castillo-Rodríguez et al., 2023), another (Sporis et al., 2011) reported that non-starters do suffer declines in aerobic capacity and other physical fitness measures relative to starters. These differences may be influenced by factors such as training context, level of competition, or the intensity of effort experienced by non-starters - although these factors are not often explored as potential contributors to the observed outcomes. Our results showed that YYIRT significantly declined from baseline in one group, while no such decline was observed in the other group. However, in both groups, after exposure to CS, YYIRT was significantly better compared to the NCS condition. Although there is limited information on the actual physical fitness adaptations resulting from compensatory training interventions, our results align with recommendations suggesting that compensatory training can influence accumulated load and stimulus (Díaz-Serradilla et al., 2023), particularly when using game-based formats like the 2v2 format employed in our study.

Our results also align with a previous study (Brandes et al., 2012) which has found the 2v2 format also produces the highest heart rate and blood lactate concentrations among various SSG formats, making it suitable for improving aerobic fitness. The repeated bouts of high-intensity activity interspersed with brief recovery periods place a significant demand on the cardiovascular system (Lacome et al., 2018). Simultaneously, the sustained metabolic stress encourages mitochondrial biogenesis and enhances the activity of oxidative enzymes within the muscle fibers, improving their capacity to utilize oxygen efficiently (Fransson et al., 2018). This form of training, while intermittent, necessitates a substantial aerobic contribution to both sustain the high-intensity efforts and facilitate recovery, thus maintaining and potentially slightly improving the body's overall capacity for oxygen uptake, transport, and utilization. However, it is important to note that, while the 2v2 format can be particularly effective, comparisons with other formats and training modalities (e.g., running) are necessary. This is especially relevant because, in some contexts, implementing game-based drills may not be appropriate due to specific situational factors.

Regarding anaerobic capacity, the RSAmean time followed a similar trend to YYIRT, showing significant declines in performance after periods of NCS, while exhibiting an improvement in RSAmean time following the CS period. In this regard, the current state of the art is highly limited, potentially due to the greater impact that RSA tests may have on team schedules. The lack of match-specific stimuli can lead to a detraining effect on the anaerobic energy systems. However, when CS was implemented, these declines could be annulled because SSGs inherently involved repeated bouts of short, intense actions, interspersed with brief recovery periods (Buchheit and Laursen, 2013). This format eventually stimulates intermittent bursts and periods of high-intensity match play, possibly engaging the anaerobic pathways to provide rapid energy through the phosphagen and glycolytic systems. This may help maintain or even improve glycolytic power and capacity, thereby enhancing the ability to tolerate and recover from metabolic byproducts such as lactate (Köklü, 2012; Köklü and Alemdaroglu, 2016).

Despite the findings of this study, there are several limitations that should be considered when interpreting the results. First, the sample size was relatively small, which may limit the generalizability of the findings. Additionally, the duration of the intervention was relatively short, making it unclear whether the observed benefits would be sustained over a longer training period or throughout the competitive season. The use of convenience sampling may also limit the generalizability of the findings, particularly given the specific context of data collection, which could be influenced by training approaches and individual differences in player trainability. Furthermore, the limited range of fitness assessments restricts our ability to fully understand the breadth of physical adaptations that may result from compensatory training. Future research should address these limitations by using larger, more diverse samples, incorporating longitudinal designs, and including a wider range of physiological and performance measures to gain a deeper understanding of the long-term effects of compensatory training. Furthermore, investigating the optimal frequency, intensity, and duration of compensatory training interventions, as well as exploring their impact on other key performance indicators, such as injury prevention and recovery, would provide valuable insights for tailoring training programs for non-starter players.

The findings of this study suggest practical implications for coaches and practitioners working with non-starting soccer players. Incorporating compensatory training strategies - such as a 2v2 format once a week, either on match day or the following day - may help maintain or improve both aerobic capacity and repeated sprint performance, even during periods of limited match involvement. By using game-based training methods that closely replicate the intense conditions of matches - with high-intensity intervals and brief recovery periods - coaches can effectively target key physiological adaptations while minimizing the risk of detraining. This approach requires continuous monitoring of training load and adjustments based on each player's individual needs and readiness. In particular, compensatory training may be especially beneficial for non-starters, who often experience declines in performance measures like the YYIRT and RSAmean due to reduced playing time. Coaches can integrate short, focused SSG sessions into training schedules to maintain players' cardiovascular fitness and anaerobic power, ensuring they remain match-ready when called upon. However, it is important to clarify that incorporating CS and maintaining performance does not necessarily mean improved performance in matches; this distinction must be clearly stated.

Conclusion

In conclusion, this study highlights the effectiveness of compensatory training strategies, particularly the 2v2 format, in maintaining both aerobic and anaerobic capacities in non-starter soccer players. The findings suggest that CS interventions can mitigate the significant declines observed in players with limited match exposure, ensuring they remain physically prepared for match demands. Specifically, the use of SSGs was shown to improve performance on YYIRT and RSAmean, exhibiting the potential of these training formats to enhance fitness levels in the absence of regular playing time. Additionally, the study stresses the importance of compensatory training in maintaining overall cardiovascular fitness and anaerobic power, with implications for optimizing training programs for non-starter players. While further research is needed to examine the long-term effects - potentially across multiple teams over an entire season - and to identify optimal training parameters, these results provide a valuable starting point for developing practical, game-based strategies to enhance player development and team performance. However, such an application must be contextualized within different training methodologies and settings, aiming to align with the specific needs and capabilities of each team's practices.

Acknowledgements

The authors declare that there are no conflicts of interest. The experiments comply with the current laws of the country where they were performed. The data that support the findings of this study are available on request from the corresponding author.

References

Anderson, L., Orme, P., Di Michele, R., Close, G. G. L., Milson, J., Morgans, R., Drust, B. and Morton, J. (2016) Quantification of seasonal-long physical load in soccer players with different starting status from the English Premier League: Implications for maintaining squad physical fitness. *International Journal of Sports Physiology and Performance* **11**, 1038-1046. https://doi.org/10.1123/ijspp.2015-0672

Bekris, E., Mylonis, L., Gioldasis, A. and Gissis, I. K. N. (2016) Aerobic and anaerobic capacity of professional soccer players in annual macrocycle. *Journal of Physical Education and Sport* **16**, 527.

Brandes, M., Heitmann, A. and Müller, L. (2012) Physical responses of different small-sided game formats in elite youth soccer players. *Journal of Strength and Conditioning Research* **26**, 1353-1360. https://doi.org/10.1519/JSC.0b013e318231ab99

Buchheit, M. and Laursen, P. B. (2013) High-intensity interval training, solutions to the programming puzzle: Part II: Anaerobic energy, neuromuscular load, and practical applications. *Sports Medicine* **43**, 927-954. https://doi.org/10.1007/s40279-013-0029-x

Castillo-Rodríguez, A., González-Téllez, J. L., Figueiredo, A., Chinchilla-Minguet, J. L. and Onetti-Onetti, W. (2023) Starters and non-starters soccer players in competition: Is physical performance increased by the substitutions? *BMC Sports Science, Medicine and Rehabilitation* **15**, 33. https://doi.org/10.1186/s13102-023-00641-3

Clemente, F., Pillitteri, G., Palucci Vieira, L. H., Rabbani, A., Zmijewski, P. and Beato, M. (2024) Balancing the load: A narrative review with methodological implications of compensatory training strategies for non-starting soccer players. *Biology of Sport* **41**, 173-185. https://doi.org/10.5114/biolsport.2024.139071

Çobaj, J., Mara, F. and Golemi, V. (2024) The importance of VO2 max in young soccer players. *Arena - Journal of Physical Activities* **12**, 175-182. https://doi.org/10.62591/ajpa.2023.12.13

Díaz-Serradilla, E., Castillo, D., Rodríguez-Marroyo, J. A., Raya González, J., Villa Vicente, J. G. and Rodríguez-Fernández, A. (2023) Effect of different nonstarter compensatory strategies on training load in female soccer players: A pilot study. *Sports Health* **15**, 1-7. https://doi.org/10.1177/19417381231176556

Fransson, D., Nielsen, T. S., Olsson, K., Christensson, T., Bradley, P. S., Fatouros, I. G., Krustrup, P., Nordsborg, N. and Mohr, M. (2018) Skeletal muscle and performance adaptations to high-intensity training in elite male soccer players: Speed endurance runs versus small-sided game training. *European Journal of Applied Physiology* **118**, 111-121. https://doi.org/10.1007/s00421-017-3751-5

Köklü, Y. (2012a) A comparison of physiological responses to various intermittent and continuous small-sided games in young soccer players. *Journal of Human Kinetics* **31**, 89-96.

Köklü, Y. and Alemdaroglu, U. (2016) Comparison of the heart rate and blood lactate responses of different small-sided games in young soccer players. *Sports* **4**, 1-10. https://doi.org/10.3390/sports4040048

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 and Performance* **13**, 568-576. https://doi.org/10.1123/ijspp.2017-0214

Lehance, C., Binet, J., Bury, T. and Croisier, J. L. (2009) Muscular strength, functional performances and injury risk in professional and junior elite soccer players. *Scandinavian Journal of Medicine & Science in Sports* **19**, 243-251. https://doi.org/10.1111/j.1600-0838.2008.00780.x

Malone, S., Owen, A., Newton, M., Mendes, B., Collins, K. D. and Gabbett, T. J. (2017) The acute:chronic workload ratio in relation to injury risk in professional soccer. *Journal of Science and Medicine in Sport* **20**, 561-565. https://doi.org/10.1016/j.jsams.2016.10.014

Meckel, Y., Machnai, O. and Eliakim, A. (2009) Relationship among repeated sprint tests, aerobic fitness, and anaerobic fitness in elite adolescent soccer players. *Journal of Strength and Conditioning Research* **23**, 163-169. https://doi.org/10.1519/JSC.0b013e31818b9651

Rampinini, E., Sassi, A., Morelli, A., Mazzoni, S., Fanchini, M. and Coutts, A. J. (2009) Repeated-sprint ability in professional and amateur soccer players. *Applied Physiology, Nutrition, and Metabolism* **34**, 1048-1054. https://doi.org/10.1139/H09-111

Sporis, G., Jovanovic, M., Omrcen, D. and Matkovic, B. (2011) Can the official soccer game be considered the most important contribution to player's physical fitness level? *Journal of Sports Medicine and Physical Fitness* **51**, 374-380.

Strauss, A., Jacobs, S. and Van den Berg, L. (2012) Anthropometric, fitness and technical skill characteristics of elite male national soccer players: A review science. *African Journal for Physical Health Education, Recreation and Dance* **18**, 365-394.

Teixeira, J. E., Branquinho, L., Ferraz, R., Leal, M., Silva, A. J., Barbosa, T. M., Monteiro, A. and Forte, P. (2022) Weekly training load across a standard microcycle in a sub-elite youth football academy: A comparison between starters and non-starters. *International Journal of Environmental Research and Public Health* **19**, 11611. https://doi.org/10.3390/ijerph191811611

Varjan, M., Hank, M., Kalata, M., Chmura, P., Mala, L. and Zahalka, F. (2023) Weekly training load differences between starting and non-starting soccer players. *Journal of Human Kinetics* **90**, 125-135. https://doi.org/10.5114/jhk/171449

Key points

- Game-based compensatory strategies (CS) using small-sided games significantly improved aerobic (YYIRT) and anaerobic (RSAmean) performance in non-starter soccer players compared to non-compensatory strategies (NCS).
- CS sessions helped maintain physical fitness in non-starters, offering a practical method to reduce performance gaps caused by limited match play.

AUTHOR BIOGRAPHY

	**TongZheng LIU** **Employment** Nanchong Vocational College of Culture and Tourism, Nanchong, China **Degree** MEd **Research interests** Chinese traditional sports,soccer, etc. **E-mail:** liutongzheng2025@126.com
	**Mingbang LI** **Employment** College of physical education and health,Geely University of China **Degree** MEd **Research interests** Sports training, basketball, etc. **E-mail:** limingbang@guc.edu.cn
	**XiaoYan PU** **Employment** Nanchong Vocational College of Culture and Tourism, Nanchong, China **Degree** MEd **Research interests** Chinese traditional sports,soccer, etc. **E-mail:** puxiaoyan2025@126.com

✉ **XiaoYan Pu**
Nanchong Vocational College of Culture and Tourism, Nanchong, 637400, China