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Defining the Effects of Floaters' Number on Internal Load, External Load and Technical Skills in Small-Sided Soccer Games

Pakorn Chootsungnoen[1ABCD], Pornchai Leenoi[1BCDE] and Chadaphan Suwannate[1CDE]

[1]Kasem Bundit University

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Corresponding Author: Pakorn Chootsungnoen, e-mail: pakorn.cho@kbu.ac.th
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Abstract

Objectives. This study aimed to examine the effects of different floater configurations in small-sided games (SSGs) on physiological responses, external load metrics, and technical performance among professional soccer players.

Materials and methods. Twenty male players from the Thailand League 3 (age: 21.4 ± 1.82 years) participated in three SSG formats: standard (4v4), one floater (4v4+1), and two floaters (4v4+2). Each format consisted of 4 × 4-minute bouts with 4-minute rest intervals on a 32 × 25-meter pitch. Heart rate responses, locomotor activities, and technical actions were analyzed.

Results. Significant reductions in maximal heart rate and mean heart rate were observed (181.55 vs 169.55 and 168.15 vs 156.15 beats·min-1) in the 4v4+2 format compared to 4v4. High-intensity running decreased (238.60 vs 91.35 m), while technical performance improved, as evidenced by increased total passes and successful passes (81.25 vs 142.50 and 68.00 vs 123.00) in the 4v4+2 format. The 4v4+1 format provided intermediate responses in both physiological and technical parameters.

Conclusions. These findings suggest that floater-modified SSGs effectively reduce physiological demands while enhancing technical performance, offering coaches practical tools for manipulating training intensity and technical development in soccer training programs.

Keywords: small-sided games, heart rate, locomotor activities, technical skills, floater player.

Introduction

The evolution of soccer training methodologies has witnessed a paradigm shift with the emergence of small-sided games (SSGs) as a sophisticated training tool. While traditional training methods often separate physical conditioning from technical skill development, SSGs offer a unique solution by simultaneously addressing multiple performance components. Of particular interest is the innovative use of floaters – additional players who participate for the possession team – which has emerged as a compelling variable in training design, yet remains insufficiently understood in terms of its comprehensive impact on player performance (Clemente et al., 2021). Recent meta-analytical findings have revealed intriguing relationships between SSG design variables and performance outcomes. Clemente et al. (2023) discovered substantial effect sizes for pitch size modifications on physiological responses, physical demands, and technical actions. These compelling results suggest that spatial constraints significantly influence training outcomes, raising important questions about how the addition of floaters might modulate these effects. Most soccer training consists of internal loads consisting of heart rate zones and measurements derived from heart rate, including the level of perceived exertion (sRPE). External loads consist of distance in different speed zones, total distance, and acceleration (Sobolewski, 2020).

The manipulation of floater numbers presents a fascinating paradox in training design. Asian-Clemente et al. (2021) revealed that incorporating two floaters led to counterintuitive results: significant reductions in total distance (-12.3 %), high-speed running (-18.7 %), and accelerations (-15.4 %). This unexpected finding challenges conventional wisdom about numerical advantages in soccer and suggests a more complex relationship between player numbers and physical demands than previously assumed. Contemporary professional soccer demands have reached unprecedented

levels, with Gualtieri et al. (2023) documenting that elite players must perform 55-75 high-speed running actions and 15-35 sprints per match. The challenge of replicating these demands in training while maintaining technical quality has become a central concern for practitioners. Remarkably, Riboli et al. (2023) demonstrated that manipulating area per player (75-175 m^2) could explain 56 % of the variance in high-speed running distances ($\eta^2 = 0.56$) and 48 % of sprint distances ($\eta^2 = 0.48$), suggesting a powerful tool for load management. A particularly compelling finding emerges from the work of Nunes et al. (2020), who discovered that numerical superiority created by floaters produced a fascinating cascade of effects: reduced physiological stress (-8.5 % heart rate, -25.3 % blood lactate) coupled with enhanced technical performance (+35.7 % possession duration, +42.3 % successful passes). This intricate relationship between physical relief and technical enhancement offers exciting possibilities for optimizing training design. The quest for optimal training parameters has yielded surprising insights. Riboli et al. (2020) identified a strong correlation between area per player and successful technical actions ($r = 0.78$, $p < 0.001$), suggesting that spatial constraints might be more crucial for skill development than previously recognized. This finding was further nuanced by their subsequent research with youth players (Riboli et al., 2022), revealing age-specific adaptations in spatial requirements.

Perhaps most intriguingly, de Dios-Álvarez et al. (2024) recently uncovered remarkably strong relationships between playing area and various performance metrics in elite youth soccer: total distance ($r = 0.85$), high-speed running ($r = 0.79$), and sprint distance ($r = 0.72$). These robust correlations suggest a level of predictability in training responses that could revolutionize SSG design. The temporal demands of modern soccer add another layer of complexity to this puzzle. Oliva-Lozano et al. (2021) identified that the most demanding passages of play exhibit 15-25 % higher physical outputs than match averages, lasting 3-5 minutes. This finding raises crucial questions about how floater numbers might be manipulated to replicate or moderate these intense periods effectively. Despite these advances, a significant gap exists in our understanding of how floater numbers simultaneously influence internal load, external load, and technical performance. While individual relationships have been explored, the interaction effects remain largely unknown. This knowledge gap is particularly relevant given Dolci et al.'s (2020) documentation of increasing match demands, with elite players now covering 10-12 km and performing 150-250 high-intensity actions per match. This review aims to unravel the complex relationships between floater numbers and various performance parameters in soccer SSGs. By synthesizing current evidence and identifying methodological gaps, we seek to advance understanding of this crucial training variable. The findings hold significant implications for training optimization in modern soccer, potentially revolutionizing how we approach SSG design and implementation.

Based on these considerations, this research aims to investigate how small-sided games incorporating either one or two floaters influence physiological responses (heart rate), locomotor activities, and technical skill execution when implemented in soccer training. Specifically, this study examines whether different floater configurations (one versus two floaters) result in significantly different proportions of cardiovascular response, movement patterns, and technical skill utilization among soccer players. The findings from this investigation will provide evidence-based guidelines for coaches to effectively implement small-sided games in training programs, optimizing both physical conditioning and technical skill development in soccer players.

Materials and Methods

Study Participants

The participants consisted of 20 male professional soccer players in Thailand League 3 (Age: 21.4 ± 1.82 years, Height: 175 ± 5.41 cm, Weight: 64.7 ± 3.87 kg, BMI: 21.1 ± 1.40, Body fat percentage: 9.54 ± 3.30, VO_2max: 57.7 ± 4.43 $mL \cdot kg^{-1} \cdot min^{-1}$). All participants underwent the Yo-Yo Intermittent Recovery Test Level 1 (YYIR1) to determine their maximal oxygen consumption. The VO_2max was calculated using the formula: VO_2max ($mL \cdot kg^{-1} \cdot min^{-1}$) = IR1 distance (m) × 0.0084 + 36.4 (Kabdwal et al., 2023). Participants were then randomly assigned to groups with no significant differences in mean VO_2max values between groups. The inclusion criteria required participants to be free from any muscular or joint injuries and maintain regular training sessions for at least 5 days per week and 1 match per week. Exclusion criteria included a player having injuries that prevented participation in the experimental procedures, and non-compliance with research protocols. All participants were informed about the research procedures, potential benefits, and risks. Written informed consent was obtained from all participants. This study was approved by the Human Research Ethics Committee of Kasem Bundit University, Bangkok, Thailand, in accordance with the Declaration of Helsinki (approval number: KBU-HREC 034/67).

Study Organization

The small-sided games training with a small pitch format refers to a possession-focused training method conducted on a 32 × 25-meter pitch (1 player per 100 square meters) (Michailidis., 2024). Players were divided into two teams of 4 players each. The training consisted of 4 × 4-minute periods with 4-minute rest intervals between rounds (Riboli et al., 2023; Eniseler et al., 2017) A total of 4 sets were completed with free-play conditions and coach encouragement (Sarmento et al.,2018) In the format with a neutral player, this player could only participate with the team in possession of the ball or in attacking play and was not allowed to challenge for the ball when possession was lost, as shown in Figure 1.

Before beginning the small-sided games training, participants completed a 15-minute warm-up protocol consisting of 5 minutes of jogging, 8 minutes of dynamic stretching exercises, and 3 repetitions of 10-meter maximum sprint runs for muscle activation (Eniseler et al., 2017).

Heart rate measurements were taken during resting conditions before each training session. A sample group of 20 participants was monitored, and training was suspended if heart rates exceeded normal parameters. Heart rate measurements were recorded during each small-sided game session. Heart rate monitoring was conducted using

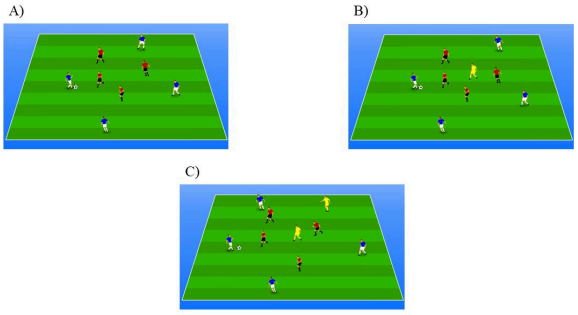

Fig. 1. Three SSG methods: (A) Ball possession without floater players; (B) Ball possession with 1 floater players; and (C) Ball possession with 1 floater

Polar Team Pro system (Polar Electro, Kempele, Finland) to determine internal and external loads for each player (McFadden et al., 2020). Individual participants' mean heart rates were categorized according to playing time proportion (%) using predetermined intensity zones: Zone 3: 70-79% HRmax, Zone 4: 80-89% HRmax, Zone 5: 90-100% HRmax. Maximum and average heart rate responses were recorded for each individual (Nagy et al., 2020). Locomotor activities during each small-sided game, the following parameters were measured: Total distance (TD), High-intensity runs (15-23.9 km/h), Sprint (>24 km/h) (Riboli et al., 2020). All training results were recorded during each session. The small-sided games were conducted between 4:00 - 6:00 PM. A minimum recovery period of 72 hours was implemented between training sessions before beginning a new SSG format (Silva et al., 2018; Goulart et al., 2022). During all small-sided games (SSG), video recordings were captured using a Veo Sport Camera (Veo Technologies ApS, Danmark) positioned at a height of 5 meters above the center of the soccer field to ensure complete coverage of the playing area. To track the skills used by soccer players during small-sided games, the recorded videos were analyzed using Dartfish Live computer software (Dartfish, Fribourg, Switzerland) (Hintermann et al., 2021). The analyzed skills included: Total passes, Successful passes, Dribbling, and Interceptions (Riboli et al., 2023).

Statistical Analysis

Descriptive statistics were calculated for all experimental data as mean and standard deviation (SD). Normality of the distribution for all data was confirmed by Shapiro-Wilks test ($p > .05$). Differences between the performance outcome (Heart rate, Locomotor activities and Technical skills) were compared using one-way ANOVA was used to determine differences between Heart rate, Locomotor activities and Technical skills, with Bonferroni Post Hoc tests used to identify specific differences. Statistical significance was tested at $p < 0.05$. by SPSS Statistics Version 26 (IBM, Armonk, NY, USA).

Results

The finding of Internal and external loads values of the soccer players participating in the study after SSG with 4v4, 4v4+1, 4v4+2 are listed in Table 1.

Data on the internal and external loads during different SSGs formats (Table.1) showed that HR max, %HR max, HR mean, %HRmean, Zone3, Zone4, Zone5, Total distance, High-intensity runs SSGs 4v4 were higher ($p < 0.05$) than for SSGs

Table 1. Internal and external loads during different SSGs formats

Internal and external loads variables	Small-Sided Game Formats (n=20)		
	4v4	4v4+1	4v4+2
HR max (beats·min^{-1})	181.55 ± 8.75	175.65 ± 11.36	169.55 ± 8.85*
HR max (%)	90.70 ± 4.11	88.15 ± 5.65	85.00 ± 4.47*
HR mean (beats·min^{-1})	168.15 ± 10.09	165.95 ± 7.16	156.15 ± 11.73*
HR mean (%)	84.25 ± 5.13	83.25 ± 3.56	78.40 ± 5.72*
Zone 3	22.75 ± 13.10	15.80 ± 6.09	11.27 ± 5.43*
Zone 4	39.62 ± 11.77	47.20 ± 13.6	49.00 ± 8.70*
Zone 5	15.98 ± 12.12	15.16 ± 17.29	7.16 ± 10.23*
Total distance (m)	2596.25 ± 117.33	2584.60 ± 177.04	2475.25 ± 121.98*
High-intensity runs (m)	238.60 ± 82.72	158.80 ± 44.20 #	91.35 ± 35.91*
Sprint (m)	4.90 ± 4.21	4.90 ± 6.66	3.60 ± 8.79

* Significant difference ($p < 0.05$) between 4v4 and 4v4+2 , # Significant difference ($p < 0.05$) between 4v4 and 4v4+1

Table. 2. Technical skills performance during different ssgs formats

Technical Skills Variables	Small-Sided Game Formats (n = 20)		
	4v4	4v4+1	4v4+2
Total passes	81.25 ± 15.39	105.75 ± 7.32#	142.50 ± 18.66*
Successful passes	68.00 ± 12.78	92.50 ± 6.85	123.00 ± 18.12*
Dribbling	11.25 ± 5.73	6.25 ± 2.50	6.00 ± 3.16
Interceptions	10.25 ± 3.40	12.00 ± 1.82	14.25 ± 2.50

* Significant difference ($p < 0.05$) between 4v4 and 4v4+2 , # Significant difference ($p < 0.05$) between 4v4+1 and 4v4+2

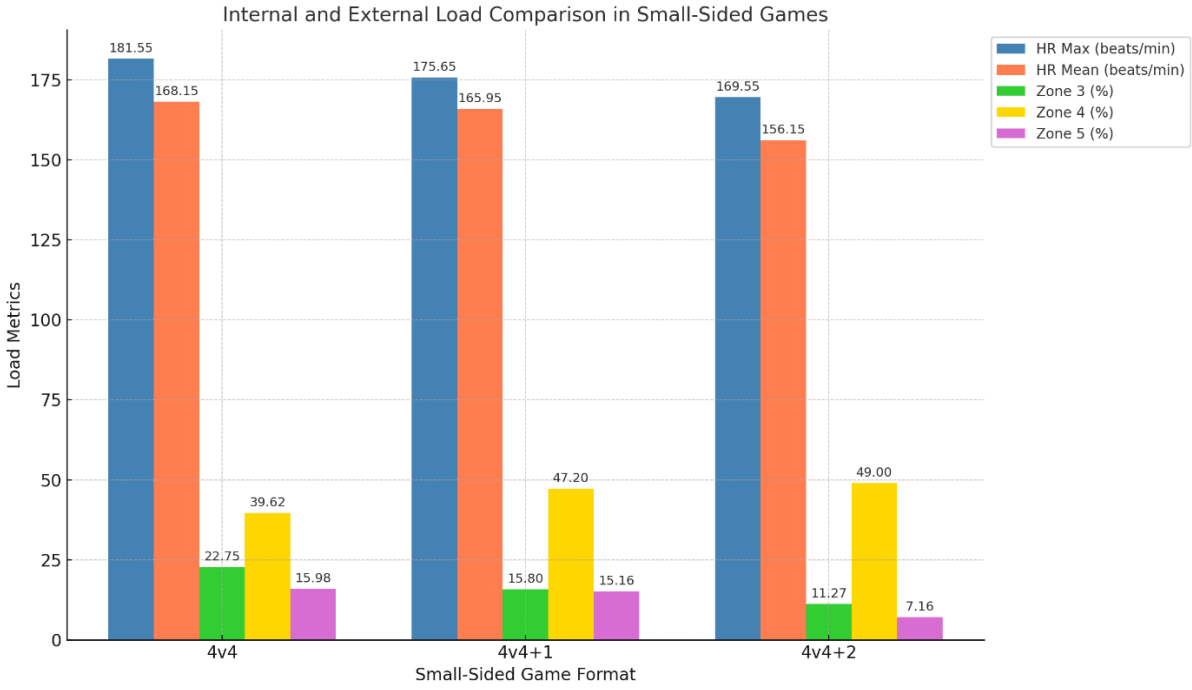

Fig. 2. Internal and external load comparison in small-sided games

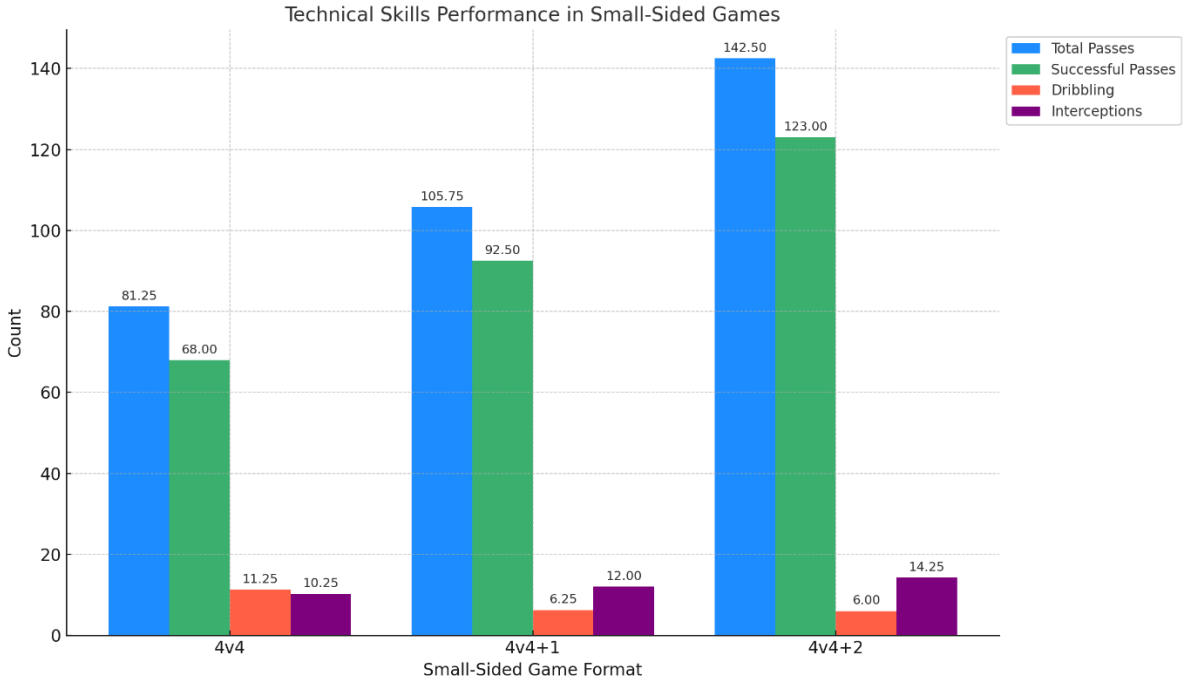

Fig. 3. Technical skills performance in small-sided games

4v4+2 (HR max: 181.55 ± 8.75 vs 169.55 ± 8.85 beats·min^{-1}, %HR max: 90.7 ± 4.11 vs 85.0 ± 4.47 %, HR mean: 168.15 ± 10.09 vs 156.15 ± 11.73 beats·min^{-1}, %HR mean: 84.25 ± 5.13 vs 78.40 ± 5.72 %, Zone 3: 22.75 ± 13.10 vs 11.27 ± 5.43 %, Zone 4: 39.62 ± 11.77 vs 49.0 ± 8.70 %, Zone 5: 15.98 ± 12.12 vs 7.16 ± 10.23 %, Total distance: 2596.25 ± 117.33 vs 2475.25 ± 121.98 m, High-intensity runs: 238.60 ± 82.72 vs 91.35 ± 35.91 m., respectively). And high-intensity runs SSGs 4v4 were higher ($p < 0.05$) than for SSGs 4v4+2 (High-intensity runs: 238.60 ± 82.72 vs 158.80 ± 44.20 m); however, there was no discernable difference between sprints in the small-sided games all the groups.

Data on the technical skills during different SSGs formats (Table.2) showed that total passes and successful passes SSGs 4v4+2 were higher ($p < 0.05$) than for SSGs 4v4 (total passes: 142.50 ± 18.66 vs 81.25 ± 15.39 pass, successful passes: 123.00 ± 18.12 vs 68.00 ± 12.78 pass) and total passes SSGs 4v4+1 were higher ($p < 0.05$) than for SSGs 4v4

(total passes: 105.75 ± 7.32 vs 81.25 ± 15.39 pass); however, there was no discernable difference between dribbling and interceptions in the small-sided games all the groups.

Discussion

This study investigated the effects of different floater configurations in small-sided games (SSGs) on internal load, external load, and technical performance among professional soccer players. The findings reveal significant differences across various performance parameters when comparing different SSG formats (4v4, 4v4+1, and 4v4+2), which warrant detailed discussion.

The results demonstrated significant reductions in cardiovascular demands when additional floaters were introduced, particularly in the 4v4+2 format compared to the standard 4v4 setup. The decrease in HRmax (181.55 ± 8.75 vs 169.55 ± 8.85 beats·min^{-1}) and HRmean (168.15 ± 10.09 vs 156.15 ± 11.73 beats·min^{-1}) represents approximately a 6.6 % and 7.1 % reduction respectively. This physiological response pattern aligns with recent research by Gantois et al. (2023), who found that manipulating SSG configurations significantly affects heart rate responses and perceived exertion. The magnitude of these changes is particularly noteworthy when compared to Rabano-Muñoz et al. (2023) findings, which reported similar reductions (5-8 %) in internal load metrics among young elite players during defensive SSGs with numerical imbalances. The distribution of time spent in different heart rate zones revealed a systematic shift towards lower intensity zones with the addition of floaters. Zone 3 (70-79 % HRmax) showed a marked decrease from 22.75 ± 13.10% in 4v4 to 11.27 ± 5.43 % in 4v4+2, while Zone 4 (80-89 % HRmax) increased from 39.62 ± 11.77 % to 49.0 ± 8.70 %. This redistribution suggests a more controlled physiological response, supporting Guard et al. (2022) conclusions about the effectiveness of numerical imbalance in modeling training intensity while maintaining tactical engagement. Meanwhile, Ueda et al. (2023) conducted a study comparing 3v3 and 6v6 minigames and found that smaller formats create an environment in which players display more aggressive behavior. with more movement towards the opponent's goal and more frequent duel. This can be explained by reduced opportunities to play together. and the need to develop individual skills to deal with different game situations. This study highlights that managing numerical ratios between teams in small-sided games influences decision-making and strategic aspects. An increased number of opponents leads to lower heart rates, reduced uncertainty, and reduced flexibility, resulting in different internal loads, which is consistent with the results of this study.

The analysis of external load metrics revealed substantial differences between SSG formats, particularly in high-intensity activities. The 4v4+2 format resulted in a 4.7 % reduction in total distance covered (2596.25 ± 117.33 m vs 2475.25 ± 121.98 m) compared to the 4v4 format. More dramatically, high-intensity runs decreased by 61.7 % (238.60 ± 82.72 m vs 91.35 ± 35.91 m), indicating a fundamental shift in movement patterns. These findings expand upon Asian-Clemente et al. (2021) research on high-speed training adequacy in SSGs, demonstrating that while floater-modified formats may reduce high-intensity actions, they maintain sufficient overall physical engagement for training purposes. Trombiero et al. (2023) research on numerical superiority provides context for these changes, suggesting that the reduced physical demands stem from improved tactical positioning and ball circulation. This is further supported by our sprint distance data, which showed no significant differences between formats (4.9 ± 4.21 m vs 3.6 ± 8.79 m), indicating that while sustained high-intensity running decreased, the opportunity for explosive actions remained consistent.

The technical analysis revealed substantial improvements in passing metrics with the addition of floaters. The 4v4+2 format demonstrated a 75.4 % increase in total passes (142.50 ± 18.66 vs 81.25 ± 15.39) and an 80.9 % increase in successful passes (123.00 ± 18.12 vs 68.00 ± 12.78) compared to the 4v4 format. The success rate of passes also improved from 83.7 % in 4v4 to 86.3% in 4v4+2, indicating enhanced technical efficiency. These improvements align with Clemente and Sarmento's (2020) systematic review findings on SSG effects on technical actions. Notably, while passing metrics improved significantly, dribbling frequency decreased from 11.25 ± 5.73 in 4v4 to 6.00 ± 3.16 in 4v4+2, suggesting a shift towards more collaborative play patterns. This aligns with Ueda et al. (2023) research on creative movements in SSGs, indicating that numerical advantages promote collective tactical solutions over individual actions. The enhanced passing performance observed in our study reflects both technical and cognitive adaptations. The increase in successful passes (80.9 %) coupled with a higher success rate suggests improved decision-making under reduced temporal pressure. Sousa et al. (2021) demonstrated that unbalanced formats affect decision-making processes by creating clear numerical advantages, allowing players more time and options for tactical choices. The relationship between technical execution and tactical positioning is further evidenced by the increase in interceptions (10.25 ± 3.40 to 14.25 ± 2.50) in the 4v4+2 format. This improvement, as supported by Coutinho et al. (2024) research on ball possession directionality, suggests that players in the defensive phase adapted their positioning to compensate for the numerical disadvantage. These findings provide specific guidelines for training design in professional soccer. The observed 6.6% reduction in HRmax and 61.7 % reduction in high-intensity running with 4v4+2 formats suggests these configurations are ideal for technical development sessions or recovery training. This aligns with Nagy et al.'s (2020) findings that different SSG formats can be strategically employed to achieve specific training objectives, with larger-sided games (including floaters) being particularly effective for technical development while maintaining moderate physiological demands. Their research demonstrated that manipulating player numbers is an effective tool for controlling training intensity, with formats similar to our 4v4+2 configuration producing lower physiological responses while maintaining high levels of technical engagement. However, as highlighted by Rabano-Muñoz et al. (2023), coaches should consider complementary high-intensity training to maintain match-specific physical capabilities. The progressive changes observed from 4v4 to 4v4+1 to 4v4+2 formats provide coaches with a systematic approach to manipulating training intensity. The intermediate responses in the 4v4+1 format (e.g., 158.80 ± 44.20 m high-intensity running) offer a

stepped approach to load management while maintaining technical engagement. An increase in the number of teammates produced an increase in the frequency of attacking patterns. By contrast, an increase in the number of opponents produced a decrease in the use of basic actions such as passing or driving by players in possession of the ball, while an increase in the number of teammates produced more defensive actions focused on protecting the goal, with more players balancing, although it did not produce an increase in the number of players pressing or dissuading. (Torrents et al., 2019)

Future research should investigate the long-term training adaptations to different SSG formats with varying floater numbers and examine how these adaptations might differ across playing levels and positions. Additionally, morphometric indicators and the role of soccer players should also be taken into account, particularly in light of recent work by Coutinho et al. (2024) on the impact of spatial constraints on player behavior.

Conclusions

This study demonstrates distinctive performance characteristics between standard small-sided games (4v4) and formats incorporating floaters (4v4+1, 4v4+2), providing valuable insights for training application in professional soccer. In standard 4v4 formats, players exhibited higher physiological responses and increased high-intensity running (238.60 ± 82.72 m), making this format particularly effective for high-intensity interval training and match-specific conditioning. These characteristics align with professional match demands, as documented by Gualtieri et al. (2023), who identified the need for 55-75 high-speed running actions per match.

Conversely, floater-modified formats demonstrated distinct advantages for technical development. The 4v4+2 configuration significantly enhanced passing while reducing physiological stress. This format proves particularly valuable for technical training sessions, recovery days, or tactical development. The intermediate 4v4+1 format offers a balanced approach, maintaining moderate physiological demands while facilitating improved technical execution. This configuration provides coaches with a flexible tool for progressive training adaptation and can be particularly useful during transitional training phases.

In conclusion, floater-modified SSGs represent an effective training tool that simultaneously addresses multiple performance components in soccer training. The evidence supports their strategic implementation while highlighting the importance of systematic training design based on specific developmental objectives.

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Conflict of Interest

The authors declare no conflict of interest.

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Визначення впливу кількості флоатерів на внутрішнє навантаження, зовнішнє навантаження та технічні навички в іграх неповними складами

Пакорн Чуцуное[1ABCD], Порнчай Ліной[1BCDE], Чандфан Суваннате[1CDE]

[1]Університет Касема Бундита

Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 9 с., 2 табл., 2 рис., 35 джерел.

Мета дослідження. Це дослідження мало на меті вивчити вплив різних конфігурацій флоатерів у іграх неповними складами (SSGs) на фізіологічні реакції, показники зовнішнього навантаження та технічну результативність серед професійних футболістів.

Матеріали та методи. Двадцять гравців чоловічої статі з Таїландської 3-ї ліги (вік: 21,4 ± 1,82 року) брали участь у трьох форматах ігор неповними складами: стандартному (4v4), із залученням одного флоатера (4v4+1) та з двома флоатерами (4v4+2). Кожен формат складався з 4 × 4-хвилинних поєдинків з 4-хвилинними інтервалами відпочинку, які проводилися на майданчику розміром 32 × 25 метрів. Проаналізовано реакції серцевого ритму, локомоторну активність та технічні дії.

Результати. У форматі 4v4+2 спостерігалося значне зниження максимальної та середньої частоти серцевих скорочень порівняно з 4v4 (181,55 проти 169,55 та 168,15 проти 156,15 уд·хв$^{-1}$). Показники високоінтенсивного бігу зменшилися (238,60 проти 91,35 м), тоді як рівень технічної результативності покращився, про що свідчить збільшення загальної кількості пасів та успішних передач (81,25 проти 142,50 та 68,00 проти 123,00) у форматі 4v4+2. Формат 4v4+1 показав проміжні результати як за фізіологічними, так і за технічними параметрами.

Висновки. Отримані дані дозволяють припустити, що модифіковані ігри неповними складами із застосуванням позиції флоатерів сприяють ефективному зниженню фізіологічних вимог та водночас підвищують технічну результативність, надаючи тренерам практичні інструменти для маніпулювання інтенсивністю тренувань і технічного розвитку в тренувальних програмах з футболу.

Ключові слова: ігри неповними складами, частота серцевих скорочень, локомоторна активність, технічні навички, гравець-флоатер.

Information about the authors:

Chootsungnoen, Pakorn: pakorn.cho@kbu.ac.th; https://orcid.org/0009-0001-3801-5203; Faculty of Sports Science, Kasem Bundit University, 60 Romklao Road, Minburi Subdistrict, Minburi District, Bangkok, 10510, Thailand.

Leenoi, Pornchai: pornchai.lee@kbu.ac.th; https://orcid.org/0009-0004-0741-1256; Faculty of Sports Science, Kasem Bundit University, 60 Romklao Road, Minburi Subdistrict, Minburi District, Bangkok, 10510, Thailand.

Suwannate, Chadaphan: chadaphan.suw@kbu.ac.th; https://orcid.org/0009-0004-0256-281; Faculty of Sports Science, Kasem Bundit University, 60 Romklao Road, Minburi Subdistrict, Minburi District, Bangkok, 10510, Thailand.

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