The influence of number of floater players on internal and external load in small-sided games

La influencia del número de jugadores comodines en la carga interna y externa en juegos reducidos

Authors

Pakorn Chootsungnoen [1]
Pornchai Leenoi [1]
Chadaphan Suwannate [1]

[1] Kasem Bundit University (Thailand)

Corresponding author:
Pakorn Chootsungnoen
pakorn.cho@kbu.ac.th

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Abstract

Introduction: Small-sided games (SSGs) have become increasingly popular in soccer training, with the manipulation of floater players emerging as a key variable in training design.
Objective: This study aimed to investigate how different numbers of floater players (no floater, one floater, two floaters) influence physiological responses and locomotor activities during soccer SSGs.
Methodology: Twenty male professional soccer players (age: 21.4 ± 1.82 years) participated in three SSG formats (4v4, 4v4+1, 4v4+2) on a 40×30m pitch. Each format consisted of 4×4-minute bouts with 4-minute rest intervals. Internal load (heart rate) and external load (total distance, high-intensity runs, sprints, accelerations, and decelerations) were monitored using the Polar Pro system.
Results: The 4v4 format elicited higher heart rate responses (HR max: 182.15 ± 8.27 bpm) compared to formats with floaters, though not statistically significant. The 4v4+1 format produced significantly higher values in high-intensity running (236.30 ± 55.00m), sprint distance (10.15 ± 9.51m), accelerations (27.95 ± 5.82), and decelerations (36.00 ± 7.40) compared to other formats.
Discussion: Adding floaters influenced both physiological and physical demands, with one floater optimizing high-intensity actions while two floaters reduced overall movement demands.
Conclusions: The number of floaters significantly impacts training intensity and movement patterns in SSGs, providing coaches with evidence-based guidelines for manipulating training stimuli according to specific objectives.

Keywords

Soccer training; small-sided games; training load; heart rate; locomotor activities.

Resumen

Introducción: Los juegos reducidos (SSG, por sus siglas en inglés) se han vuelto cada vez más populares en el entrenamiento de fútbol, y la manipulación de jugadores flotantes se ha convertido en una variable clave en el diseño del entrenamiento.
Objetivo: Este estudio tuvo como objetivo investigar cómo diferentes cantidades de jugadores flotantes (ningún jugador flotante, un jugador flotante, dos jugadores flotantes) influyen en las respuestas fisiológicas y las actividades locomotoras durante los SSG de fútbol.
Metodología: Veinte jugadores profesionales de fútbol masculino (edad: 21,4 ± 1,82 años) participaron en tres formatos de SSG (4v4, 4v4+1, 4v4+2) en un campo de 40×30 m. Cada formato consistió en combates de 4×4 minutos con intervalos de descanso de 4 minutos. La carga interna (frecuencia cardíaca) y la carga externa (distancia total, carreras de alta intensidad, sprints, aceleraciones y desaceleraciones) se monitorearon utilizando el sistema Polar Pro.
Resultados: El formato 4v4 generó respuestas de frecuencia cardíaca más altas (FC máx: 182,15 ± 8,27 lpm) en comparación con los formatos con flotadores, aunque no de manera estadísticamente significativa. El formato 4v4+1 produjo valores significativamente más altos en carrera de alta intensidad (236,30 ± 55,00 m), distancia de sprint (10,15 ± 9,51 m), aceleraciones (27,95 ± 5,82) y desaceleraciones (36,00 ± 7,40) en comparación con otros formatos.
Discusión: Agregar flotadores influyó tanto en las demandas fisiológicas como físicas, con un flotador optimizando las acciones de alta intensidad mientras que dos flotadores redujeron las demandas generales de movimiento.
Conclusiones: La cantidad de flotadores impacta significativamente en la intensidad del entrenamiento y los patrones de movimiento en los SSG, lo que proporciona a los entrenadores pautas basadas en evidencia para manipular los estímulos de entrenamiento de acuerdo con objetivos específicos.

Palabras clave

Entrenamiento de fútbol; juegos reducidos; carga de entrenamiento; frecuencia cardíaca; actividades locomotoras.

Introduction

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 and physical performance quality has become a central concern for practitioners. Small-sided games (SSGs) have become increasingly popular in soccer training methodologies due to their ability to simultaneously develop technical skills, tactical awareness, and physical fitness while replicating actual match situations (Fernández-Espínola et al., 2020; Clemente et al., 2021). These training formats offer considerable flexibility in manipulating various components such as player numbers, pitch dimensions, rules, and playing duration (Iacono et al., 2021; Riboli et al., 2020), with each modification differently affecting both internal and external training loads (Clemente et al., 2023).

The utilization of floaters (neutral players) represents a common strategy in SSGs, where these players support the team in possession, creating constant numerical superiority to enhance ball possession skills and goal-scoring opportunities (Praça et al., 2020; Moniz et al., 2020). Previous research has demonstrated that the inclusion of floaters influences players' tactical behavior (Carvalho et al., 2021; Clemente, 2022) and impacts both physiological and physical demands during training sessions (Asian-Clemente et al., 2021; Lozano et al., 2020). 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). While previous research has largely focused on examining the effects of floaters or pitch dimensions independently (Praça et al., 2020; Castillo et al., 2021), there is a notable gap in understanding the interaction between these two components and their combined effect on training load. A deeper comprehension of the relationship between the number of floaters and pitch dimensions would enable coaches to design more effective training programs by appropriately controlling training intensity according to specific objectives (Iacono et al., 2021; Riboli et al., 2022).

This research aims to investigate how small-sided games incorporating either no floater, one or two floaters influence physiological responses (heart rate) and locomotor activities execution when implemented in soccer training. Specifically, this study examines whether different floater configurations (no floater, one floater, two floaters) result in significantly different proportions of internal load and external load 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.

Method

Participants

The participants consisted of 20 male professional soccer players in Thailand League 3 (mean ± SD; 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, VO2max: 57.7 ± 4.43 mL × kg^{-1} × min^{-1}). All participants underwent the Yo-Yo Intermittent Recovery Test Level 1 (YYIR1) to determine their maximal oxygen consumption. The Vo2max was calculated using the formula: VO2max (mL × kg^{-1} × min^{-1}) = IR1 distance (m) × 0.0084 + 36.4 (Karakoc et al., 2012). Participants were then randomly assigned to groups with no significant differences in mean VO2max 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 being a goalkeeper, 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

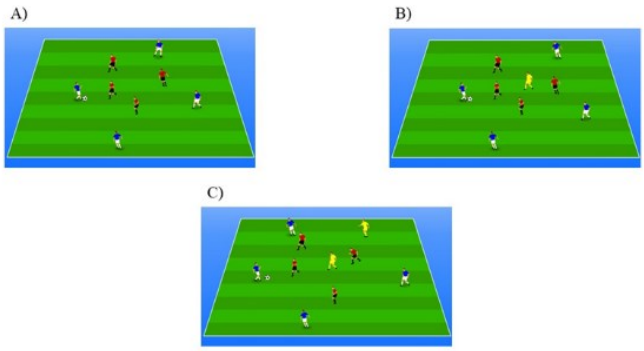
Ethics Committee of Kasem Bundit University, Bangkok, Thailand, in accordance with the Declaration of Helsinki (approval number: KBU-HREC 034/67).

Procedure

The small-sided games training with a small pitch format refers to a possession-focused training method conducted on 40 × 30 meters (1 player per 150 square meters) (Michailidis., 2024). Players were divided into two teams of 4 players each. The training consisted of 4 x 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).

Figure 1. Small-sided games training : A) 4v4, B) 4v4+1, C) 4v4+2



Instrument

The Polar Pro system (Polar Electro, Kempele, Finland) was used to determine internal and external loads for each player. Participants wore identical Polar Team Pro chest straps (Polar Electro, Kempele, Finland) positioned at the center of the chest and secured to the lower sternum using an elastic band. Data was stored in the devices and downloaded using the manufacturer's software (POLAR Team Pro, software version 1.3.1; POLAR, Polar Electro Oy, Kempele, Finland). Heart rate (HR) measurements were used to assess internal load during matches (excluding rest periods). Continuous HR measurements were recorded from all participants at one-second intervals throughout gameplay. Maximum heart rate (HRmax) and absolute mean HR (bpm) were established, with relative mean HR (%HRmax) calculated using the formula: %HRmax = Exercise HR / [220 – age] × 100.

Individual participants' mean heart rates were categorized according to maximum and average heart rate responses were recorded for each individual (Nagy et al., 2020).

Players' movements during SSGs (external load) were recorded using portable Global Positioning System devices (Polar Electro, Kempele, Finland). The Polar Team Pro devices were inserted into straps attached to specially designed chest bands, worn at mid-chest as per manufacturer specifications. All data was downloaded using the Team Pro webpage (teampro.polar.com). 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), Number of accelerations (>2 m/s), Number of decelerations (>2 m/s) (Riboli et al., 2020)

Ten minutes before each match, selected players were equipped with heart rate monitors, vests, and devices. After equipment installation and upon receiving preliminary situation data and individual player information, the exact start time of the small-sided game training was recorded. All small-sided game training sessions were recorded to validate collected data. Equipment was removed after each

game. Each small-sided game training session was analyzed separately, considering the entire game duration excluding recovery periods (Tatakasem et al., 2024).

Data 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 and Locomotor activities) were compared using one-way ANOVA repeated measures was used to determine differences between Internal load and external load with Bonferroni Post Hoc tests used to identify specific differences. Effect sizes were measured using partial eta squared (ηp2), with the following thresholds applied: ηp2=0.01 indicating a small effect, ηp2=0.06 indicating a medium effect, and ηp2=0.14 indicating a significant effect. 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.

Table 1. Internal and external loads during different SSGs formats.

Internal and external loads variables	Small-Sided Game Formats.					
	4v4	4v4+1	4v4+2	F	p	ηp2
HR max (beats/min)	182.15 ± 8.27	180.90 ± 11.10	177.40 ± 9.40	1.15	0.32	0.057
HR max (%)	91.50 ± 4.07	89.25 ± 5.02	88.90 ± 4.62	1.62	0.21	0.079
HR mean (beats/min)	171.80 ± 9.12	167.90 ± 10.85	164.10 ± 8.45	2.92	0.66	0.133
HR mean (%)	86.20 ± 4.51	84.60 ± 5.29	82.30 ± 4.28	3.00	0.06	0.137
Total distance (m.)	2669.85 ± 182.33	2654.90 ± 143.23	2797.50 ± 146.51*@	8.60	0.001*	0.312
High-intensity runs (m.)	211.20 ± 45.58 *	236.30 ± 55.00 @	138.60 ± 86.47	11.31	0.00*	0.373
Sprint (m.)	6.65 ± 5.10	10.15 ± 9.51@	2.10 ± 5.12	5.97	0.006*	0.239
Accelerations (n)	21.00 ± 7.12	27.95 ± 5.82 #	23.90 ± 9.17	4.13	0.02*	0.179
Decelerations (n)	27.80 ± 8.09	36.00 ± 7.40 #@	27.60 ± 14.21	4.10	0.02*	0.178

Significant difference (P <0.05) between 4v4 and 4v4+1
* Significant difference (P <0.05) between 4v4 and 4v4+2
@ Significant difference (P <0.05) between 4v4+1 and 4v4+2

Table 1 shows the mean and standard deviation values of various performance metrics across three small-sided game formats: 4v4, 4v4+1, and 4v4+2. The maximum heart rate values were 182.15 ± 8.27, 180.90 ± 11.10, and 177.40 ± 9.40 beats per minute, respectively. The percentage of maximum heart rate was 91.50 ± 4.07%, 89.25 ± 5.02%, and 88.90 ± 4.62%, respectively. The average heart rate recorded during the sessions was 171.80 ± 9.12, 167.90 ± 10.85, and 164.10 ± 8.45 beats per minute, respectively, while the percentage of average heart rate reached 86.20 ± 4.51%, 84.60 ± 5.29%, and 82.30 ± 4.28%, respectively.

Regarding physical performance metrics, the total distance covered was 2669.85 ± 182.33, 2654.90 ± 143.23, and 2797.50 ± 146.51 meters, respectively. High-intensity running distance measured 211.20 ± 45.58, 236.30 ± 55.00, and 138.60 ± 86.47 meters, respectively, while sprint distance (maximum speed running) was 6.65 ± 5.10, 10.15 ± 9.51, and 2.10 ± 5.12 meters, respectively. The number of accelerations recorded was 21.00 ± 7.12, 27.95 ± 5.82, and 23.90 ± 9.17, respectively, while the number of decelerations was 27.80 ± 8.09, 36.00 ± 7.40, and 27.60 ± 14.21, respectively.

Figure 2. Internal load during different SSGs formats.

Figure 2 presents the mean and standard deviation comparisons of physiological responses across three small-sided game formats. Regarding maximum heart rate, although the 4v4 format showed higher mean values compared to both 4v4+1 and 4v4+2 formats, no statistically significant differences were observed between the formats (F=1.15, p=0.32, ηp2=0.057). Similarly, for average heart rate, the 4v4 format demonstrated higher mean values compared to 4v4+1 and 4v4+2 formats, no statistically significant differences were observed between the formats (F=2.92, p=0.66, ηp2=0.133).

When analyzing the percentage of maximum heart rate, the 4v4 format exhibited higher mean values compared to both 4v4+1 and 4v4+2 formats no statistically significant differences were observed between the formats (F=1.62, p=0.21, ηp2=0.079). Additionally, the comparison of percentage of maximum heart rate means across the three small-sided game formats revealed higher values in the 4v4 format compared to 4v4+1 and 4v4+2 formats, no statistically significant differences were observed between the formats (F=3.00, p=0.06, ηp2=0.137).

Figure 3. Total distance during different SSGs format

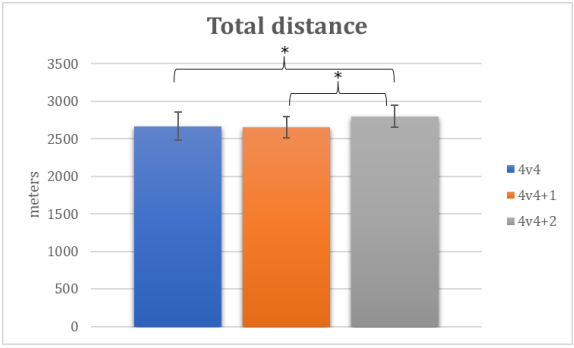


Figure 3 presents the mean and standard deviation comparisons of total distance covered across three small-sided game formats. Statistical analysis revealed that the 4v4+1 format resulted in significantly higher total distance covered compared to both 4v4 and 4v4+2 formats (F=8.60, p=0.001, ηp2=0.312).

Figure 4. High-intensity runs and sprint during different SSGs formats.

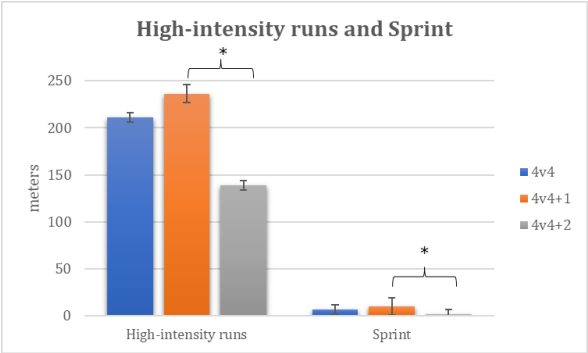


Figure 4 presents the mean and standard deviation comparisons of high-intensity running distances. The analysis demonstrated that the 4v4+1 format elicited significantly higher high-intensity running distances compared to the 4v4+2 format (F=11.31, p=0.000, ηp2=0.373). Similarly, when comparing sprint distances (maximum speed running), the 4v4+1 format showed significantly higher values compared to the 4v4+2 format (F=5.97, p=0.006, ηp2=0.239).

Figure 5. Number of accelerations and decelerations during different SSGs formats.

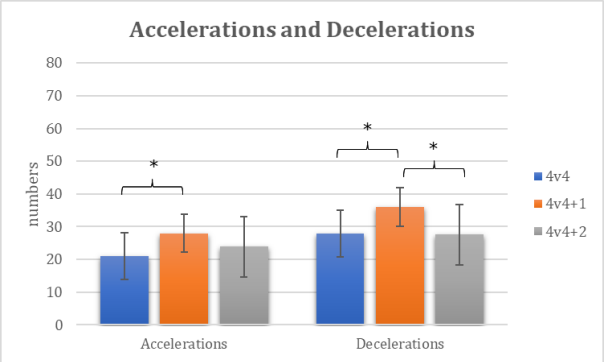


Figure 5 presents the mean and standard deviation comparisons of acceleration counts across three small-sided game formats. Statistical analysis revealed that the 4v4+1 format produced significantly higher numbers of accelerations compared to the 4v4 format ($F=4.13$, $p=0.02$, $\eta p2=0.179$). Regarding deceleration counts, the 4v4+1 format demonstrated significantly higher values compared to both 4v4 and 4v4+2 formats ($F=4.10$, $p=0.02$, $\eta p2=0.178$).

Discussion

This study demonstrates the effects of using floaters on internal and external load in small-sided games, revealing that increasing the number of floaters significantly impacts both internal and external responses.

Regarding internal load, the research shows that the 4v4 format exhibited higher maximum (182.15 ± 8.27 beats/min) and average heart rates (171.80 ± 9.12 beats/min) compared to formats with floaters, although no statistically significant differences were found. This aligns with Gantois et al. (2023), who found that increasing the number of players in small-sided games from 3v3 to 5v5 resulted in heart rate decreases from 89% to 82%, respectively. Asian-Clemente et al. (2021) demonstrated that adding floaters reduced the training intensity in small-sided games by 8-12%. Furthermore, Praça et al. (2022) found that increasing the area per player in small-sided games from 75 m^2 to 200 m^2 led to a 4-7% decrease in heart rate, which corresponds with this study's findings that adding floaters reduces the area per player and consequently decreases training intensity. Faga et al. (2023) stated that pitch sizes smaller than 75 square meters per person might adversely affect aerobic fitness development, suggesting that optimal aerobic fitness development requires small-sided game dimensions of approximately 76 to 300 square meters per person. This study utilized an area of approximately 120-150 square meters per person, which is suitable for developing footballers' aerobic fitness. Training at or slightly above the anaerobic threshold (85-90% of maximum heart rate) appears effective in developing footballers' aerobic capacity. Additionally, Small-Sided Games (SSGs) have been shown to improve physical condition and physiological parameters (Castillo-Rodríguez et al., 2023).

Regarding external load, the 4v4+1 format showed significantly higher distances in high-speed running (236.30 ± 55.00 meters) and sprint distance (10.15 ± 9.51 meters) compared to the 4v4+2 format. This corresponds with Guard et al. (2022), who found that increasing floaters from one to two resulted in reduced high-intensity running distances due to increased passing options. Castillo et al. (2021) noted that having one floater helps develop diverse attacking situations, requiring players to move quickly to create space. Reducing the number of players on the field increases the available space, resulting in increased high-intensity running in small-sided games (Dalen et al., 2021).

The research also found that the 4v4+1 format had significantly higher numbers of accelerations (27.95 ± 5.82) and decelerations (36.00 ± 7.40) compared to other formats. This aligns with Clemente et al.'s (2023) meta-analysis, which found that having one floater increases acceleration and deceleration movements by approximately 20-25% due to players frequently adjusting their positions to receive and pass the ball with the floater. Farhani et al.'s (2021) shown youth soccer players found that using one floater increased acceleration and deceleration numbers by 30-35% compared to formats without floaters. However, adding a second floater resulted in a 15-20% decrease in movement, which corresponds

with this study's findings. de Dios-Álvarez et al. (2024) shown that small pitch sizes affect locomotor activities acceleration due to limited space, requiring more movement to receive passes from teammates compared to larger pitches. Larger pitches result in greater total distance covered, high-intensity running, and maximum speed running due to wider spaces for supporting teammates. In this study, adding one floater affected high-intensity running, acceleration, and deceleration movements, as the 5v4 play format required footballers to press and move to receive passes from teammates in a larger pitch area compared to 4v4+2. However, when floaters are positioned outside the pitch, the playing area for players increases, consistent with Clemente's (2022) shown number of floater position influence in 4v4+2 SSGs, which found that floater positioning affects running distance and locomotor activities, with outline floaters covering more distance than in-field floaters.

By adding more than 1 Floater Player, it results in more defensive players having more defensive styles. And adding more teammates this increases attack patterns in possession of the ball, such as passing the ball and receiving the ball. On the contrary, reducing the number of players reduces the use of basic actions, such as passing and receiving, by the players in possession of the ball, because the playing area is larger, so they have to locomotor activities more (Torrents et al. 2016). Therefore, the increase in Floater Players in the playing area is a natural adaptation resulting from the limited space. Players need to perform more individual tactics under pressure, because the distance between teammates is shorter to maintain ball possession, so they locomotor activities less with high intensity.

Conclusions

This study demonstrates that manipulating floating player numbers significantly affects both internal and external loads in soccer SSGs. The findings provide evidence-based guidelines for coaches to design training sessions that effectively target specific physiological and performance objectives. The 4v4 format proves optimal for high-intensity conditioning, while the 4v4+1 format on better serves heart rate and locomotor activities development purposes. These insights contribute to the growing body of knowledge regarding SSG optimization in soccer training methodology.

The results emphasize the importance of carefully considering spatial and numerical constraints when designing SSG-based training sessions. Coaches can use these findings to create more effective training programs that appropriately balance physiological stimulus with technical and tactical development opportunities. Future research should continue to explore the long-term effects of these training modifications and their application across different player populations.

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Authors' and translators' details:

Pakorn Chootsungnoen	pakorn.cho@kbu.ac.th	Author
Pornchai Leenoi	pornchai.lee@kbu.ac.th	Author& Translator
Chadaphan Suwannate	chadaphan.suw@kbu.ac.th	Author