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Comparative analysis of external load in small-sided games versus official matches among professional football players

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Abstract

Background and Study Aim Coaches frequently use small-sided games with numerical inequalities. However, it is unclear if these games accurately represent official matches. This study aims to identify the differences in external load between small-sided games and official matches among professional soccer players, incorporating the variance due to positional roles.

Material and Methods The analysis used GPS data collected from 20 professional football players from Turkish Super League club's first team during the 2023-2024 season. The small-sided games (SSGs) were structured as 4vs4+3, including three joker players. Players were divided into five groups based on their field positions: central defenders, fullbacks, midfielders, wingers, and forwards. The GPS metrics recorded included total distance (m), moderate-intensity running distance (16-20 km/h), high-intensity running distance (20-25 km/h), sprint distance (>25 km/h), the number of accelerations and decelerations, and high metabolic power distance, both in absolute and relative terms. Furthermore, the SSGs were compared based on the number of days prior to official matches when they were conducted.

Results The findings revealed that the highest values for all external load variables were recorded 4 to 5 days before official matches ($p<0.001$). However, the per-minute acceleration rate (2.5003±1.09288) and deceleration rate (2.4971±1.10671) in the SSGs were significantly higher than those observed in official matches ($p<0.001$).

Conclusions Coaches and conditioning trainers aiming to simulate match conditions in training should consider using 4vs4+3 SSGs with joker players more tactically. This approach is especially effective for enhancing possession, creating numerical superiority, and focusing on performance metrics such as acceleration and deceleration.

Keywords: small-sided games, position, GPS, performance, monitoring

Introduction

Despite the widespread use of small-sided games in football training, it remains unclear if these exercises accurately replicate the demands of official matches. This uncertainty poses a challenge for coaches aiming to optimize training effectiveness and ensure players are adequately prepared for match conditions.

Football is one of the most popular sports in the world [1], yet the optimal training demands have not been clearly specified [2]. The inclusion of various training demands challenges coaches in physical, physiological, technical, and tactical aspects of player development. However, with the advancement of training methods in modern football, coaches, conditioning coaches, and sports scientists are extending the duration of ball-in-play training to meet all these demands during practice sessions [3]. Game-based training methods, rooted in the nature of football, enable the development of players in physical, physiological, technical, and tactical terms. Among these methods, small-sided games are particularly popular [4, 5].

In football, small-sided games (SSGs) are typically conducted with fewer players compared to 11-a-side matches, on a reduced pitch size, and with adaptable rules according to the coaches' objectives [6]. The ability of coaches to manipulate SSGs for physiological, technical, physical [7], and tactical purposes [8] has significantly contributed to the popularity of this training method [9]. Additionally, its applicability across all age categories and player levels (amateur-professional) further broadens the use of these games [7, 10]. In official football matches, players often face unpredictable scenarios, necessitating preparedness for all situations [11]. SSGs can be applied under conditions similar to match scenarios [12], requiring coaches to make necessary adaptations. However, SSGs contain numerous variables, such as pitch size, player count, and rules, which need to be closely monitored to track training performance and achieve optimal

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results.

With the improvement of technology, valid and reliable analyses of training methods and matches have become widespread [12]. Among the many methods used in football, Global Positioning Systems (GPS) are the most common. The integration of GPS in the sports industry has led to numerous studies validating and verifying this system's ability to measure external loads in athletes. Research confirms that this system is a valid method for measuring and quantifying sports activities. In a study by Castellano et al., the sprint times of athletes over distances of 15 and 30 meters were measured using video analysis, a photoelectric system, and GPS. This study aimed to test the validity and reliability of the system, emphasizing its accuracy and dependability regarding distance [13]. Similarly, Jennings et al. conducted a study involving 20 athletes performing linear movements at various speeds and completing a training circuit, with performance data collected via GPS. The researchers noted that accuracy might decrease with increased speed, but the accuracy of distance measurements improves with longer distances [14]. Likewise, Varley et al. emphasized that using GPS to track and detect performance changes in team sport athletes could provide sufficient precision. The results obtained also suggest that coaches can better evaluate the effects of applied training methods on players in conjunction with official matches [15].

Despite the continuous increase in scientific research on SSGs in the last decade, this training method has been frequently used by coaches since the 1970s [7]. However, much of the literature focuses on studies where the number of players in SSGs is equal [7, 11]. Given the nature of football, which is typically played over a relatively large area, and considering the positions of players, athletes often encounter scenarios in official matches where they are numerically unequal. This situation can catch players physically, physiologically, technically, and tactically unprepared. Coaches need to prepare players for such challenging scenarios within their training sessions. The adaptable formats of SSGs allow for the repetition of situations involving numerical inequality under match conditions [10]. Studying numerically unequal SSGs within a scientific framework is considered important for coaches, athletes, and sports scientists. When reviewing the literature, only a few studies focus on the effects of numerical inequality [7, 11, 16, 17]. These studies show that using additional players in SSGs to create numerical inequality can be more effective in small-sided games and is a good method for maintaining and improving aerobic fitness [17]. However, a study by Sousa et al. on younger age groups suggests that a 3vs3 format (numerically equal) results in more intense physical activity and higher energy expenditure [7]. The variation in results among these studies highlights the need for further research on SSGs involving numerical inequality. Additionally, the general focus on younger age groups makes it challenging to generalize the findings to elite athletes.

In conclusion, this study aims to evaluate the external loads from small-sided games (n=19) conducted on various days relative to match day (MD-6, MD-5, MD-4, MD-3, MD-2, MD-1) and official matches (n=19) among elite soccer players in the Turkish Super League during the 2023-2024 season, considering both specific parameters and the players' positional roles. Another goal of the study is to guide coaches in using small-sided games in their training sessions to prepare for the highest demands they will encounter in both matches and training sessions, predicting the training loads of numerically unequal small-sided games on days MD-6 to MD-1.

Materials and Methods

Participants

The participants consisted of players from a professional football club competing in the Turkish Super League 2023-2024 season. The study includes 20 professional football players (age: 27.6±5.92 years, body weight: 79.6±8.47 kg, height: 182.1±6.12 cm, body fat percentage: 5.2±1.67%) who are all on the same team. Additionally, 8 of them are also university students.

All participants were regularly training 3-6 days per week (depending on official match frequency) and participating in 1-2 official matches per week. The inclusion criteria for the participants were participation in all SSGs and at least 60% of the total official matches [20]. Goalkeepers and players who were injured and thus unable to participate in the SSGs were excluded from the study [21, 22]. All participants were thoroughly informed about the research verbally and in writing before the study. Volunteer consent forms, containing detailed descriptions of the study and potential risks, were signed by all participants. The study was performed in accordance with the latest version of Declaration of Helsinki and approved by the ethics committee of Istanbul Esenyurt University (E-12483425-299-38143).

Research Design

This research was designed as a descriptive comparative study that is observational and non-experimental [18, 19]. The participants were selected using a random sampling method aimed at representing the population adequately. External load data from professional football players were collected using the GPS system during 19 matches and various training sessions involving 4vs.4+3 small-sided games (SSGs) implemented over the 2023-2024 season of the Turkish Super League. The data collection process for the SSGs commenced along with the first week of the season and was expressed in relation to the subsequent official match day (MD- (days until the match)). SSGs and official matches were compared using both absolute values and relative values adjusted for exercise and match durations (m/min-1).

The 20 professional football players included in the study were grouped according to their on-field positions: 4 central defenders (CD), 4 fullbacks (FB), 4 midfielders (MD), 4 wide-midfielders (WMD), and 4 forwards (FWD) [23, 24]. The abbreviations used for field positions were consistent with those generally found in international literature. In this study, the data for SSGs were further analyzed according to the number of days before or after a match (MD -/+) as proposed by Martin-Garcia et al. [25]. Accordingly, throughout the measurement period (38 weeks), SSGs were conducted 1 day (MD-1), 2 days (MD-2), 3 days (MD-3), 4 days (MD-4), 5 days (MD-5), and 6 days (MD-6) before matches

Official Matches and Small-Sided Games

Official matches took place both during weekends and weekdays, typically 1-2 times per week within the research. Data collection for official matches was carried out on natural grass fields compliant with FIFA standards and approved by the Turkish Football Federation (TFF), between the hours of 4:00 PM and 9:00 PM. Official match activities were evaluated based on data collected over two halves of 45 minutes each from 19 full 11-a-side matches. To minimize the impact of the physical and technical level of opponents, one match against each team in the Super League was included in the study. Additionally, the tactical lineup of the team remained the same throughout the season. The team systematically fielded 1 goalkeeper, 2 central defenders, 2 fullbacks, 2 central midfielders, 2 wide-midfielders, and 2 forwards players in a 1-4-4-2 formation. The same warm-up protocol was applied to the athletes before each match, including moderate-intensity running, dynamic stretching exercises, mobility and balance exercises, and acceleration and deceleration drills.

In the training sessions, data collection for the SSGs was conducted on natural grass under similar weather conditions and temperatures to those of the official matches, from 4:00 PM to 8:00 PM. Starting from the week when official matches began, standard warm-up exercises were immediately followed by 4vs4+3 SSGs in all training sessions. In all games, balanced teams of four players each were formed based on the players' technical-tactical levels, competitive experience [8], field positions [26], and coaches' subjective evaluations [27]. To create numerical superiority, three joker players, always assuming an offensive role, were included in each game [28]. The primary purpose of the game, which did not involve goalkeepers or goals, was to allow players to move freely with the aim of maintaining possession as long as possible [29]. The games were conducted on a natural grass field measuring 35x30 meters, providing 955 m-2 per player, and consisted of 3 sets, each lasting 4 minutes, with 2 minutes of passive rest between sets. Passive rest periods were not included in the study. To increase the intensity and continuity of the game, extra balls were placed around the field so that play could restart quickly if the ball went out of play [17, 30]. This arrangement and the right to free ball touches helped maximize effective playing time. Coaches focused solely on verbal encouragement to maintain a high work rate and did not provide technical-tactical advice during the games [18, 31].

Data Collection Tools

In this study, external load measurements were performed using GPS technology (Vector® Catapult Sports, Melbourne, Australia) to analyze performance data from training sessions involving SSGs and official matches. Each GPS device (10 Hz) also included a three-axis accelerometer, gyroscope, and magnetometer sampling at 100 Hz. Research indicates that GPS systems provide valid and reliable measurements during linear, multidirectional, and football-specific activities at constant and instantaneous speeds [15, 32]. To minimize measurement errors, the same players wore the GPS devices throughout the season [33]. The devices were placed in the upper back area of specially made training vests by the manufacturer [24]. According to the manufacturer's instructions, each device was activated at least 15 minutes before SSGs and official matches [29, 34]. Immediately after training and official matches, the data were transferred to a computer environment and cloud system for evaluation and analysis using Catapult Open Field software.

Using the GPS system, external load parameters obtained from matches and drills have been comparatively analyzed, including total distance (TD), sprint distance >25 km/h (SD), high-intensity running distance 20-25 km/h (HIRD), moderate-intensity running distance 16-20 km/h (MIRD), number of accelerations (ACC), number of decelerations (DEC), high metabolic power distance (HMPD), and peak metabolic power (PeakMP) values.

Statistical Analysis

In this study, data were presented as mean and standard deviation. The distribution of the data was determined using the Kolmogorov-Smirnov test. According to the results of the Kolmogorov-Smirnov test, it was seen that the dependent variables exhibited a normal distribution. Skewness and kurtosis coefficients were also considered for the normality distribution. The one-way ANOVA test was utilized to determine whether the dependent variables differed significantly in terms of days remaining until the official match (MD) and player positions. Following the one-way ANOVA, where significant differences were found, comparisons between MDs and positions were conducted using the Bonferroni correction method. Only groups between which statistically significant differences were found are specified in the results for comparisons between MDs and player positions. For comparing the dependent variables between the games played (official matches vs. SSGs), the paired samples t-test was used. The level of significance was set at p<0.05. The analyses were conducted using SPSS (25.0) and Jamovi (2.4.14) software packages..

Results

The results indicate differences in external load parameters in small-sided games (SSGs), classified by match days, both in relative and absolute terms. Differences in player performance, grouped by their positions, were also identified. Additionally, there are observed differences between the performance results of players in 4vs4+3 SSGs and those in official matches (OMs), both in relative and absolute terms.

Upon examining Table 1, it has been observed that the total distance per minute on match day-related days (MD) varies significantly across the days (p<0.001). The relevant differences were identified

Table 1. Comparison of relative performance parameters according to match days (MD -6, -5, -4, -3, -2, -1)

Variables	Mean±SD	MDB	Mean Square	F	P	Pairwise Comparisons	Pairwise Comparisons p-value
MIRD (m/min^{-1})	.0740±.18830	MD-1	3.661	8.112	.000		
	.1003±.27179	MD-2				1-5	.006
	.1139±.33074	MD-3				2-4	.032
	.4990±.74715	MD-4				2-5	.000
	.6948±1.20805	MD-5				3-5	.000
	.0590±.09746	MD-6					
HIRD (m/min^{-1})	.0000±.0000	MD-1	.807	8.027	.000		
	.0000±.0000	MD-2				1-5	.005
	.0000±.0000	MD-3				2-5	.000
	.0414±.10812	MD-4				3-5	.000
	.2962±.67399	MD-5				4-5	.001
	.0000±.0000	MD-6					
SD (m/min^{-1})	.0000±.0000	MD-1	.002	1.202	.309	-	-
	.0000±.0000	MD-2					
	.0000±.0000	MD-3					
	.0000±.0000	MD-4					
	.0128±.07735	MD-5					
	.0000±.0000	MD-6					
HMPD (m/min^{-1})	4.8465±1.89741	MD-1	109.898	12.399	.000	1-5	.004
	6.0926±2.86923	MD-2				2-3	.000
	3.8077±2.86789	MD-3				2-5	.026
	6.2840±2.65597	MD-4				3-4	.000
	7.7051±3.76651	MD-5				3-5	.000
	4.6990±1.75955	MD-6					
TD (m/min^{-1})	60.5670±6.72975	MD-1	822.155	8.718	.000		
	62.6841±8.97888	MD-2				2-3	.000
	55.6935±8.53838	MD-3				3-5	.000
	59.1074±13.01314	MD-4				4-5	.000
	66.2198±10.47642	MD-5					
	58.1580±6.05232	MD-6					

Table 1. (Continued)

Variables	Mean±SD	MDB	Mean Square	F	P	Pairwise Comparisons	Pairwise Comparisons p-value
ACC (m/min^{-1})	2.3965±.77579	MD-1	7.101	6.530	.000	2-3	.000
	2.7458±1.21059	MD-2				3-5	.000
	1.9928±.86417	MD-3					
	2.4326±1.02217	MD-4					
	2.9192±1.12619	MD-5					
	2.1250±.71683	MD-6					
DEC (m/min^{-1})	2.3965±.87054	MD-1	6.747	5.999	.000	2-3	.001
	2.7200±1.26902	MD-2				3-5	.000
	2.0100±.86042	MD-3					
	2.4479±1.05736	MD-4					
	2.9177±1.08885	MD-5					
	2.0590±.59964	MD-6					
Peak MP	63.8500±17.19631	MD-1	4842.587	11.669	.000	1-3	.007
	59.6538±14.56809	MD-2				2-3	.001
	45.5775±29.12076	MD-3				2-4	.033
	71.7143±18.44476	MD-4				3-4	.000
	67.4262±16.81910	MD-5				3-5	.000
	61.1000±15.97533	MD-6					

SD - Standard Deviation; MDB - match day before; MIRD - moderate-intensity running distance (16-20 km/h); HIRD - high-intensity running distance (20-25 km/h); SD - Sprint Distance (>25 km/h); HMPD - high metabolic power distance; TD - total distance; ACC - accelerations; DEC - decelerations; Peak MP - peak metabolic power

between MD-2 and MD-5, and between MD-3 and MD-4 days. No statistically significant differences were observed between other days (p>0.05). It has been determined that the total distance values of the players on match day-related days differ significantly (p<0.001). There are statistically significant differences between MD-1 and both MD-2 and MD-4 days; between MD-2 and MD-3, MD-4, and MD-5 days; and between MD-4 and MD-3, MD-5, and MD-6 days (p<0.001).

Table 2 presents data comparing the effects of different training protocols on athletes based on match days. Significant differences were found in MIRD between MD-1 and MD-4, MD-2 and MD-4, MD-2 and MD-5, MD-3 and MD-4, MD-3 and MD-5, and MD-4 and MD-6 (p<0.05). Similarly, for the HIRD parameter, significant differences were observed between MD-1 and MD-5, MD-2 and MD-5, MD-3 and MD-5, and MD-4 and MD-5 (p<0.05). No significant differences were found in the SD parameter. These data indicate that training conducted one day and four days before a match significantly affects athletes' MIRD and HIRD.

Significant differences were also detected in TD and HMPD parameters across various days (p<0.05). Similarly, significant differences were observed in ACC and DEC parameters on different days. These findings demonstrate that training conducted on different days significantly impacts athletes' TD and HMPD performances.

Table 3 presents a comparison of performance parameters from 19 small-sided games based on the positions of the players. When examining the MIRD data, no significant differences were found in pairwise comparisons (p>0.05). A similar situation was observed for HIRD; although the highest value was recorded for the FB position (0.1100 m/min) and the lowest for the WMD position (0.351 m/min), no significant differences were noted.

Significant differences were found in HMPD among the positions, particularly between CD and MD and WMD, and between FB and MD and WMD (p<0.05). Similarly, significant differences were detected in TD, ACC, and DEC values across different positions. Notably, significant differences were observed particularly between CDs and MDs and WMDs, and FBs and MDs and WMDs in terms of ACC and DEC parameters, similar to the HMPD parameter.

These table results demonstrate significant differences in performance parameters among players in different positions. Particularly, the

Table 2. Comparison of absolute performance parameters according to match days (MD -6, -5, -4, -3, -2, -1)

Variables	Mean±SD	MDB	Mean Square	F	P	Pairwise Comparisons	Pairwise Comparisons p-value
MIRD (m)	1.1000±2.82657	MD-1	1621.826	9.447	.000	1-4	.001
	1.0128±2.51486	MD-2				2-4	.000
	1.9577±5.86865	MD-3				2-5	.002
	15.2857±25.73627	MD-4				3-4	.000
	9.6066±16.91279	MD-5				3-5	.014
	.7000±1.15950	MD-6				4-6	.026
HIRD (m)	.0000±.0000	MD-1	157.403	7.366	.000		
	.0000±.0000	MD-2				1-5	.009
	.0000±.0000	MD-3				2-5	.000
	1.4048±3.67629	MD-4				3-5	.000
	4.1475±9.43722	MD-5				4-5	.050
	.0000±.0000	MD-6					
SD (m)	.0000±.0000	MD-1	.311	1.208	.000	-	-
	.0000±.0000	MD-2					
	.0000±.0000	MD-3					
	.0000±.0000	MD-4					
	.1803±1.08794	MD-5					
	.0000±.0000	MD-6					
HMPD (m)			41364.275	20.582	.000	1-4	.000
	70.6500±28.65636	MD-1				2-4	.000
	67.6154±33.02035	MD-2				2-5	.001
	50.4225±36.02763	MD-3				3-4	.000
	129.1905±67.93370	MD-4				3-5	.000
	99.8197±53.39273	MD-5				4-5	.018
	56.4000±21.10924	MD-6				4-6	.000
TD (m)			1421276.170	27.401	.000	1-2	.014
	880.0500±92.84252	MD-1				1-4	.000
	688.5897±133.87748	MD-2				2-3	.047
	799.9014±218.13856	MD-3				2-4	.000
	1184.0476±432.48087	MD-4				2-5	.002
	842.1639±169.56436	MD-5				3-4	.000
	697.9000±72.63677	MD-6				4-5	.000
						4-6	.000
ACC	34.8000±11.23247	MD-1	2409.097	13.077	.000	1-4	.029
	30.5769±14.50796	MD-2				2-4	.000
	27.0704±9.01637	MD-3				3-4	.000
	46.3333±17.69479	MD-4				3-5	.000
	37.2459±14.96015	MD-5				4-5	.014
	25.5000±8.59263	MD-6				4-6	.000

Table 2. (Continued)

Variables	Mean±SD	MDB	Mean Square	F	P	Pairwise Comparisons	Pairwise Comparisons p-value
DEC	34.8000±12.65161	MD-1	2356.466	12.834	.000	1-4	.034
	30.4872±15.07448	MD-2				2-4	.000
	27.3099±9.10666	MD-3				3-4	.000
	46.1429±16.85747	MD-4				3-5	.001
	37.1967±14.26747	MD-5				4-5	.017
	24.7000±7.19645	MD-6				4-6	.000
Peak MP	63.8500±17.19631	MD-1	4842.587	11.669	.000	1-3	.007
	59.6538±14.56809	MD-2				2-3	.001
	45.5775±29.12076	MD-3				2-4	.033
	71.7143±18.44476	MD-4				3-4	.000
	67.4262±16.81910	MD-5				3-5	.000
	61.1000±15.97533	MD-6					

SD - Standard Deviation; MDB - match day before; MIRD - moderate-intensity running distance (16-20 km/h); HIRD - high-intensity running distance (20-25 km/h); SD - Sprint Distance (>25 km/h); HMPD - high metabolic power distance; TD - total distance; ACC - accelerations; DEC - decelerations; Peak MP - peak metabolic power

Table 3. Comparison of relative performance parameters according to the players' positions

Variables	Mean±SD	MDB	Mean Square	F	P	Pairwise Comparisons	Pairwise Comparisons p-value
MIRD (m/min^{-1})	.2825±.78322	1) CD	.557	1.098	.358	-	-
	.4300±.74271	2) FWD					
	.3881±.79830	3) FB					
	.2306±.58772	4) MD					
	.1721±.65476	5) WMD					
HIRD (m/min^{-1})	.0928±.39642	1) CD	.058	.511	.727	-	-
	.0635±.29586	2) FWD					
	.1100±.45770	3) FB					
	.0467±.21236	4) MD					
	.0351±.25549	5) WMD					
SD (m/min^{-1})	.0000±.00000	1) CD	.001	.903	.463	-	-
	.0000±.00000	2) FWD					
	.0036±.02734	3) FB					
	.0000±.00000	4) MD					
	.0108±.07830	5) WMD					
HMPD (m/min^{-1})	6.8578±3.59198	1) CD	84.084	8.758	.000	1-4	.000
	6.0124±2.63665	2) FWD				1-5	.007
	6.8954±6.8954	3) FB				3-4	.000
	4.3590±2.90665	4) MD				3-5	.007
	4.8949±2.70398	5) WMD					

Table 3. (Continued)

Variables	Mean±SD	MDB	Mean Square	F	P	Pairwise Comparisons	Pairwise Comparisons p-value
TD (m/min-1)	61.6195±11.21207	1) CD	441.103	4.306	.002	3-4	.001
	61.2771±8.32046	2) FWD					
	64.8086±8.44543	3) FB					
	57.7643±11.73304	4) MD					
	59.4081±9.05169	5) WMD					
ACC (m/min-1)	2.7689±1.21131	1) CD	5.975	5.310	.000	1-4	.006
	2.5682±.96471	2) FWD				1-5	.031
	2.8371±.98889	3) FB				3-4	.009
	2.1724±1.08189	4) MD				3-5	.040
	2.2028±.96824	5) WMD					
DEC (m/min-1)	2.7962±1.20961	1) CD	6.066	5.252	.000	1-4	.006
	2.6112±.99453	2) FWD				1-5	.031
	2.7897±1.01622	3) FB				3-4	.009
	2.1563±1.07737	4) MD				3-5	.040
	2.2000±1.00747	5) WMD					
Peak MP	62.5156±22.44075	1) CD	1939.160	4.100	.003	3-4	.004
	64.4706±21.48465	2) FWD					
	65.7458±19.86818	3) FB					
	52.0556±23.81199	4) MD					
	58.1509±20.04072	5) WMD					

SD - Standard Deviation; MIRD - moderate-intensity running distance (16-20 km/h); HIRD - high-intensity running distance (20-25 km/h); SD - Sprint Distance (>25 km/h); HMPD - high metabolic power distance; TD - total distance; ACC - accelerations; DEC - decelerations; Peak MP - peak metabolic power; CD - central defender; FWD - forward; FB - full back; MD - midfielder; WMD - wide-midfielder

significant differences found between midfielders and wingers (MD and WMD) and other positions suggest that players in these positions face less physical demand in 4vs4+3 games.

Table 4 presents a comparison of absolute performance parameters based on the positions of the players. In terms of MIRD, FB exhibited the highest average value (8.3898±21.25463 m/min), while WMD showed the lowest (2.6038±9.57428 m/min). No significant differences were observed in HIRD and SD parameters (p=0.573 and p=0.464, respectively). However, significant differences in HMPD were found between CD and MD (p=0.002), FB and MD (p<0.001), and FB and WMD (p=0.031).

Significant differences were also detected in ACC and DEC parameters between CD and MD (ACC; p=0.03, DEC; p=0.016) and between FB and MD (ACC; p=0.006, DEC; p=0.008). These findings indicate that midfielders encounter lower physical demands in small-sided games.

Table 5 presents the t-test results for the performance parameters of players in small-sided games (SSGs) and official matches (OM), normalized per minute. This analysis aims to highlight the performance differences between the two types of games. According to Table 5, the MIRD, HIRD, and SD are significantly higher in OMs compared to 4vs4+3 games (p<0.001).

In terms of HMPD and TD parameters, OMs also exhibit higher performance compared to SSGs. HMPD in OMs shows a value of 24.5833±5.22459 per minute, while in SSGs, the value is 5.7568±3.26516. Similarly, the TD values normalized per minute are significantly higher in OMs than in SSGs (t=-51.017, p<0.001). According to the results in Table 5, OMs require significantly more running and metabolic power than 4vs4+3 joker games.

In addition to running and metabolic power demands, ACC and DEC parameters in SSGs show higher values compared to OMs (p<0.001). This indicates that SSGs impose greater sudden ACC and DEC loads on the players.

Upon examining Table 6, a comparison of absolute performance values of players in 4vs4+3 games and OMs is presented. It is observed that in all external load parameters, OMs exhibit

Table 4. Comparison of absolute performance parameters according to the players' positions

Variables	Mean±SD	MDB	Mean Square	F	P	Pairwise Comparisons	Pairwise Comparisons p-value
MIRD (m)	4.2969±11.89061	1) CD	293.420	1.496	.203	-	-
	7.1471±13.06193	2) FWD					
	8.3898±21.25463	3) FB					
	4.5000±11.13932	4) MD					
	2.6038±9.57428	5) WMD					
HIRD (m)	1.3281±5.56079	1) CD	17.398	.729	.573	-	-
	1.0294±4.30986	2) FWD					
	1.8983±6.82211	3) FB					
	.7500±3.12081	4) MD					
	.4906±3.57137	5) WMD					
SD (m)	.0000±.00000	1) CD	.223	.900	.464	-	-
	.0000±.00000	2) FWD					
	.0508±.39057	3) FB					
	.0000±.00000	4) MD					
	.1509±1.09888	5) WMD					
HMPD (m)	92.0000±53.51724	1) CD	15699.698	6.224	.000	1-4	.002
	85.0882±50.81301	2) FWD				3-4	.000
	96.1356±61.25004	3) FB				3-5	.031
	59.7222±41.70426	4) MD					
	67.7925±42.06056	5) WMD					
TD (m)	838.3906±272.96285	1) CD	72443.513	.950	.436	-	-
	854.5000±271.89406	2) FWD					
	887.6780±304.34364	3) FB					
	795.8611±235.62343	4) MD					
	826.4151±300.15813	5) WMD					
ACC	36.5000±16.37943	1) CD	960.977	4.508	.002	1-4	.031
	35.5000±14.24515	2) FWD				3-4	.006
	37.9153±14.60313	3) FB					
	29.0139±12.64186	4) MD					
	30.3208±15.02021	5) WMD					
DEC	36.7031±15.72550	1) CD	983.403	4.655	.001	1-4	.016
	36.1471±15.01541	2) FWD				3-4	.008
	37.4237±14.21656	3) FB					
	28.7639±12.59387	4) MD					
	30.3774±15.51702	5) WMD					
Peak MP	62.5156±22.44075	1) CD	1939.160	4.100	.003	3-4	.004
	64.4706±21.48465	2) FWD					
	65.7458±19.86818	3) FB					
	52.0556±23.81199	4) MD					
	58.1509±20.04072	5) WMD					

SD - Standard Deviation; MIRD - moderate-intensity running distance (16-20 km/h); HIRD - high-intensity running distance (20-25 km/h); SD - Sprint Distance (>25 km/h); HMPD - high metabolic power distance; TD - total distance; ACC - accelerations; DEC - decelerations; Peak MP - peak metabolic power; CD - central defender; FWD - forward; FB - full back; MD - midfielder; WMD - wide-midfielder

Table 5. Comparative t-test results according to relative performance parameters variables in OMs and SSGs

Variables	Game Type	Mean±SD	t	p	Mean Difference
MIRD (m/min^{-1})	SSG	.2884 ± .71302	-50.456	.000	-6.32587
	OM	6.6142 ± 1.90944			
HIRD (m/min^{-1})	SSG	.0702 ± .33624	-49.218	.000	-4.08937
	OM	4.1596 ± 1.30523			
SD (m/min^{-1})	SSG	.0028 ± .03613	-25.738	.000	-1.42231
	OM	1.4251 ± .89381			
HMPD (m/min^{-1})	SSG	5.7568 ± 3.26516	-49.962	.000	-18.82644
	OM	24.5833 ± 5.22459			
TD (m/min^{-1})	SSG	60.8455 ± 10.35669	-51.017	.000	-49.09115
	OM	109.9367 ± 12.06927			
ACC (m/dk^{-1})	SSG	2.5003 ± 1.09288	19.214	.000	1.28498
	OM	1.2153 ± .24936			
DEC (m/dk^{-1})	SSG	2.4971 ± 1.10671	18.166	.000	1.24152
	OM	1.2556 ± .29298			
Peak MP	SSG	59.9361 ± 22.22121	24.509	.000	-61.14398
	OM	121.0802 ± 34.98162			

SD - Standard Deviation; MIRD - moderate-intensity running distance (16-20 km/h); HIRD - high-intensity running distance (20-25 km/h); SD - Sprint Distance (>25 km/h); HMPD - high metabolic power distance; TD - total distance; ACC - accelerations; DEC - decelerations; Peak MP - peak metabolic power; SSG - 4vs4+3; OM - official matches

Table 6. Comparative t-test results according to absolute performance parameters variables in OMs and SSGs

Variables	Game Type	Mean±SD	t	p	Mean Difference
OKSM (m)	DAO	5.2305 ± 14.05252	-51.606	.000	-554.58630
	RM	559.8168 ± 173.411991			
YSKM (m)	DAO	1.1064 ± 4.87743	-49.636	.000	-349.99667
	RM	351.1031 ± 114.03875			
SM (m)	DAO	.0390 ± .50819	-25.984	.000	-119.75489
	RM	119.7939 ± 74.59790			
HMPM (m)	DAO	79.2411 ± 52.05772	-65.179	.000	-2001.4573
	RM	2080.6985 ± 494.50031			
TM (m)	DAO	837.5355 ± 276.10914	-91.553	.000	-8486.3290
	RM	9323.9275 ± 1476.58225			
ACC (m)	DAO	33.6028 ± 14.96015	-40.796	.000	-69.22159
	RM	102.8244 ± 23.37500			
DEC (m)	DAO	33.5709 ± 14.90863	-38.902	.000	-72.52450
	RM	106.0954 ± 26.53492			
Peak MP	DAO	59.9361 ± 22.22121	24.509	.000	61.14398
	RM	121.0802 ± 34.98162			

SD - Standard Deviation; MIRD - moderate-intensity running distance (16-20 km/h); HIRD - high-intensity running distance (20-25 km/h); SD - Sprint Distance (>25 km/h); HMPD - high metabolic power distance; TD - total distance; ACC - accelerations; DEC - decelerations; Peak MP - peak metabolic power; SSG - 4vs4+3; OM - official matches significantly higher values compared to SSGs. However, when the absolute performance values in SSGs are compared as a percentage of those in OMs, the running distances account for a very small portion (MIRD=0.93%, HIRD=0.32%), while the values for ACC, DEC, and MP cover approximately 33%, 32%, and 50% of those in OMs, respectively, when calculated based on absolute values.

Discussion

In this study, the differences between positional roles in 4vs4+3 joker player SSGs conducted on various days by professional soccer players were evaluated and compared with OMs. The principal findings of the research are as follows:

1. The days showing the highest performance in terms of all external load parameters generally occurred 4 and 5 days before a match, particularly in games involving numerical inequality.
2. The rates of ACC and DEC per minute implemented by professional soccer players were found to be significantly higher compared to those in OMs, in contrast to other parameters.
3. Considering player positions, statistically significant differences were identified between MD players and both CD and FB in terms of external load parameters.
4. The comparison between OMs and 4vs4+3 joker player SSGs revealed that SSGs do not meet the external load parameters of OMs.

However, one of the practical outcomes of our study is identifying which SSGs should be utilized on which days before matches and for what specific purposes. In this context, it is crucial for coaches and conditioning trainers to understand the optimal use of these games. They should not be used when physical performance needs to be maximized. Instead, they should be employed more for tactical purposes. This is especially important when considering specific performance values such as possession, ACC, and DEC.

Upon examining the findings of the study, statistically significant differences have been identified between the SSGs conducted on various days leading up to a match among professional soccer players (Tables 1, 2). Table 1, which assesses external load over the days leading up to a match, shows results similar to previous studies. Sanchez-Sanchez et al. [35] found that external load values obtained from training sessions on MD-2 (TD: 5042±1312; HIRD: 804±349; SD: 278.1±135.97) were higher compared to MD+1 (TD: 3814±616; HIRD: 154±129; SD: 45.76±47.99). In our study, although no statistical differences were identified with MD-2 values, they were generally higher than those on the first day after a match (MD-6). This pattern may be due to some weeks where players participate in two matches, leading to a reduced number of training days within a microcycle. Therefore, it is considered that coaches might have applied the necessary training loads during these days. Coaches generally prefer to reach peak physical and physiological training intensity on the second and third days after a match [36]. It is expected that the training load will decrease as the next match approaches [37]. The findings of this research are supported by the literature. When examining Tables 1 and 2, the days MD-4 and MD-5, generally considered 2-3 days after a previous match and 4-5 days before the next match, are seen as the days with the highest demands in terms of training intensity and scope. However, Owen et al., [38] found that the highest values for TD, HIRD, and SD were recorded on MD-3. Despite both studies involving elite soccer players from teams competing in European leagues, the main reason for this discrepancy between the findings may stem from differences in training methodologies across countries [37].

During a soccer match, there are moments when players are numerically superior or inferior in specific areas of the field where the ball is located [17]. Coaches can use games with numerical imbalances to simulate scenarios that players may encounter on the field. The choice of these games, considering the players' positions, is critically important. Research shows that different football positions experience variations in external loads during matches and training sessions [39]. An examination of Table 3 reveals that positional differences have varied impacts on players within SSGs. It is observed that CD face significantly higher physical loads in 4vs4+3 joker player games compared to MD players. The outcomes from games with numerical inequality do not consistently align with those found in the literature. Hill-Haas et al. [17] found no temporal-movement or physiological differences between teams at a numerical disadvantage or advantage. However, the perceived exertion ratings provided by players indicated a clear distinction between the two scenarios, with the numerically disadvantaged team experiencing a higher intensity of play. In contrast, Malone et al., [40] highlighted that MD players cover more distance than players in other positions. Considering the findings of our study, it is thought that MD players managing to maintain possession more frequently could be a factor in achieving numerical superiority. Consequently, defenders may exhibit higher values in external load parameters when they are numerically disadvantaged in SSGs.

The quantification and evaluation of external load values are widely used within professional football [15], allowing coaches to gain detailed insights into SSGs and OMs [41]. Upon reviewing Tables 5 and 6 in this study, a comparison has been conducted between players in SSGs and OMs based on both per-minute and total values. The findings reveal that players exhibit significantly lower values in OMs than in SSGs concerning MIRD (0.2884±0.71302), HIRD (0.0702±0.33624), and SD (0.0028±0.03613), along with the TD (60.8455±10.35669) and HMPD (5.7568±3.26516). These results are consistent with those found in the literature. For instance, Lacome et al. [3] observed that 4vs4 SSGs resulted in lower TD and HIRD compared to OMs. Similarly, Lozano et al. [29] found that physical parameters in SSGs were lower compared to OMs. These findings align with those obtained by Sanchez-Sanchez et al. [35], where it was concluded that the external load values from training were lower than those from matches. However, differing from these studies, Casamichana et al. [19] obtained different results. In their research comparing seven matches and various SSGs, it was observed that players covered more distance in SSGs (118.3 m/min-1) compared to matches. The differences in results could potentially stem from the nature of the matches being compared official versus friendly matches. Furthermore, in the study by Casamichana et al. [19], the playing area per player in all SSGs was standardized at 210 m^2. In contrast, in our study, the playing area per player was 95.5 m^2, whereas other studies applied 71 m^2 [3] and 75 m^2 [29]. Considering that a smaller playing area may limit players' ability to achieve high speeds, this factor could be a contributing reason for the differences observed between studies.

Conclusions

This research aimed to compare the external loads experienced by professional soccer players in the Turkish Super League during official matches and small-sided games, considering both positions and the days on which the games were conducted. Upon examining the data obtained, it is evident that the demands placed on players by official matches and small-sided games (4vs4+3 joker) differ in terms of external loads. This variation is thought to be due not to the physical and physiological parameters specific to the match, but rather to the suitability of the chosen small-sided games from a technical-tactical perspective. Notably, parameters such as total distance covered, high-intensity running distance, and high metabolic power distance recorded during official matches were found to be significantly higher compared to those in small-sided games. Conversely, acceleration and deceleration count during small-sided games were higher than in official matches. This indicates that small-sided games serve as a crucial training tool for adapting players to various scenarios. Based on these findings, different small-sided games could be preferred to apply planned training loads to players during weeks with one or two official matches. However, it seems more appropriate to include 4vs4+3 games specifically targeted at technical-tactical and physical objectives concerning acceleration and deceleration parameters.

It is recommended that coaches and sports scientists plan official matches and small-sided games in a balanced manner to meet the physical and technical requirements of the players. Particularly, increasing the intensity of small-sided games during the periods before and after matches can adopt an approach that supports players' adaptation to match conditions. Additionally, coaches should consider players' positions when designing small-sided games that involve numerical inequality. Future research comparing official matches with small-sided games could explore the effects of various numerically unequal small-sided games together, providing opportunities to examine their impact on professional soccer players.

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