



Comparative Analysis of Training Load and Technical Demands in various Small-Sided Games During Soccer Preseason

Jakov Marasović*, Ante Rađa‡, Frane Žuvela‡, Luka Čikotić†, Marko Erceg‡

Faculty of Kinesiology, University of Split, Split, Croatia

*Denotes student investigator, ‡Denotes established investigator

Abstract

International Journal of Exercise Science 18(8): 1286-1297, 2025.

<https://doi.org/10.70252/QCAG3602> Small-sided games (SSG) are often used as a multifunctional form of specific training that allows development of various key components during soccer training. The main goal of this research was to determine the differences in internal and external load of different small-sided games (SSG) during preseason. The secondary goal was to analyze specific technical demands during these SSG. Twelve players of the First Croatian Junior League (U19) participated in this research in the fourth week of the preparatory period for the competitive season 2019/2020. Testing was conducted on two separate days with a day of rest in-between. Internal (IL) and external load (EL) variables and some technical demands were observed in the research. Significant differences in IL and EL were found between different types of SSG. Overall, IL (primarily HRmax ($F=4.24$, $p<0.05$, $\eta^2=0.44$) and 90-100%HRmax ($F=5.18$, $p<0.01$, $\eta^2=0.37$) and EL (primarily TD ($F=3.50$, $p<0.05$, $\eta^2=0.28$) and WR ($F=6.26$, $p<0.01$, $\eta^2=0.41$) increased during 5vs.5 with GK (goalkeeper) series. On the other hand, greater EL (WR ($F=11.43$, $p<0.001$, $\eta^2=0.51$), 2.1-3.0 m/s ($F=7.03$, $p<0.001$, $\eta^2=0.39$) was observed in regular 6vs.6 while some IL parameters (%HRmax ($F=6.07$, $p<0.01$, $\eta^2=0.36$) and HRmax ($F=8.60$, $p<0.001$, $\eta^2=0.44$) were higher in two 6vs.6 GK series. In terms of technical demands, incidences of the PASS, RECEIVE and TURN variables were on average higher in 5vs.5 and 6vs.6 compared to 5vs.5GK and 6vs.6GK. To conclude, different SSG generated different IL and EL outcomes, especially with the addition of goalkeeper. Also, SSG could be used as a useful training tool for pre-season training in order to improve functional abilities while adding specific match-like situations for players.

Keywords: Training, SSG, technical requirements, match situations, preseason

Introduction

Small-sided games (SSG) represent a multifunctional, specific training content that enables the simultaneous development of many key components of the football game in a shorter period of time.^{1,2} SSG enable the simultaneous development of fitness abilities while using the technical and tactical elements of the football game, which makes them extremely popular among soccer and fitness coaches.³ Key technical elements of a football match such as kicks, passes, repeated sprints, dribbling, and sliding tackles are also essential components of small-sided games (SSG).^{4,5,6} Specific-situational fitness training is the most important and dominant form of

training, especially when developing the endurance of football players, it is not surprising that SSG are used more often in the football training.⁷

Many coaches today use games and are often unsure of how these games affect conditioning. Games can be played on a larger or smaller space, with different numbers of players, different rules of the game, with or without a goalkeeper (GK).^{8,9} When implementing this training format, it is essential that the coach clearly understands both the objectives of the training and the methods for determining the appropriate training load. Also, coaches should understand how different game formats affect performance, as these effects can change significantly depending on adjustments to space, rules, or the number of players.¹⁰

For planning and programming, it is extremely important to know the differences in physiological requirements between a football match and games on a shortened space.¹¹ One of the studies that compared the physiological demands between a soccer match and games on a shortened space was conducted by Owen et al⁸ They found that games on a smaller space (SSG, 4vs.4) cause a statistically significant difference in game speed compared to games on a medium (MSG, 5vs.5 to 8vs.8) and large space (LSG, 9vs.9 to 11vs.11). The heart rate during support games varies between 85-95% of the maximum heart rate,^{12,13} which can lead to a significant improvement in aerobic capacity and, consequently, performance in the match.^{14,15} Hoff et al,¹² Kelly and Drust¹³ found that games in a shortened space (SSG) caused a significantly higher heart rate compared to small-sided games in a larger space (LSG). Research showed that the number of high-intensity activities increases when the number of players decreases during the game¹⁶. Hill-Haas et al¹⁷ showed that there is a greater number of actions and touches with the ball in games with a smaller number of players. Monitoring internal and external workload parameters during the preseason is of considerable importance to coaches. In the context of sports training, workload is conceptualized as an input variable. When applied under specific stress conditions, this variable is systematically manipulated to induce targeted physiological and performance adaptations¹⁸. SSG are a commonly used method to develop various parts of a soccer game as well as the abilities of the players.

During preseason coaches implement various types of SSG, for example with or without GK, often putting emphasis on different technical-tactical aspect of the game in the same training. Subsequently, different type of games that changed during training session produce different metabolic and technical demands. Monitoring external and internal load during small-sided games is an important part of the training process in soccer. This allows coaches to assess how the athlete's body responds to exertion (internal load – e.g., heart rate) and how much physical work has been performed (external load – e.g., distance covered).

Thus, the main goal of this research was to determine the differences in internal and external load in different types of SSG during preseason training. The secondary goal was to analyze the incidence of specific technical demands during these SSG.

Methods

Participants

Twelve elite male soccer players (18.44 years) of the First Croatian Junior League (U19) participated in this research in the fourth week of the preparatory period for the competitive season 2019/2020. Players were on average 183.96 cm tall and weighed 74.77 kg with an average 11.08 years of training experience. Participants were highly trained / national level athletes and could be classified as tier 3.¹⁹ The Faculty of Kinesiology Split and its ethics committee approved the study design (approval number: 2181-205-02-05-24-009), which was conducted according to the ethical standards of the 1964 Helsinki Declaration and its subsequent amendments. Inclusion criteria to participate in the study were: i) participation in at least 85% of the training sessions, ii) regularly participating in the previous competitive seasons, iii) having a valid sport medical certification, and iv) being healthy (no pain or injury) and being clear of any drug consumption. All players had Croatian Football Federation identity card signed and were fully healthy and medically examined by a local sport specialist doctor. Participants refrained from drinking caffeine-containing beverages for 24 hours and did not eat for 2 hours prior to the testing in order to reduce any possible interference with the experiment. Each participant completed all trials in the same time period of the testing day and under the same climate conditions (4–7 p.m., $25.6 \pm 0.8^\circ\text{C}$ temperature, and $36.3 \pm 2.5\%$ relative humidity). Participants were asked to avoid any stressful activity during testing or between training sessions. This research was carried out fully in accordance with the ethical standards of the *International Journal of Exercise Science*.²⁰ A power analysis was conducted using G*Power (version 3.1.9.7; Universitat Kiel, Germany) to ensure an adequate sample size for detecting significant differences between repeated measures of SSG. Previous studies obtained large effect sizes in some parameters of IL^{1,21,22} and EL^{22,23,24} while assessing differences between different SSG. Assuming a large effect size ($f = 0.40$), based on Cohen's benchmarks and supported by findings in similar studies, for $\alpha = 0.05$, and statistical power of $1 - \beta = 0.80$, analysis determined a minimum sample size of 10 participants. This study included 12 players which surpasses the threshold needed, providing an acceptable power to detect large differences during SSG.

Table 1. Anthropometric characteristics of participants

Variables	M(SD)	Min	Max
HEIGHT (cm)	183.96 (5.32)	176.00	197.00
MASS (kg)	74.77 (4.70)	68.20	86.60
BODY FAT (%)	6.52 (1.23)	4.48	8.87

M(SD) - arithmetic mean, standard deviation, Min- minimal result, Max - maximal result

Protocol

Anthropometric characteristics were measured with a portable stadiometer (SECA, Leicester, UK; for height) and an electronic scale (HD-351, Tanita, Arlington Heights, USA; for body mass). Testing protocol included a warm-up of 20 minutes (with 70 - 95% of theoretical maximal heart rate [$220 - \text{age in yrs}$] as target value). Warm-up included sequences of jogging with and without the ball, change of directions and dynamic stretching with a strong focus on leg and abdominal muscles. Testing took place on the artificial grass during dry and warm weather. Participants were wearing their own soccer shoes and the balls used were Adidas Telstar (Adidas, Germany; 69.0 ± 0.2 cm in circumference and 440 ± 0.2 g in mass). Running performance of the players were collected using GPS technology (SPT GPS, Australia). Polar H7 heart sensors were used as well

as Polar Team App to measure the internal load of the players. Testing was conducted over the course of two days. On the first day, the players were tested on two small side-games and each of them was measured in two series (5vs.5, 5vs.5 with GK). After the day of regeneration, testing continued again, but with two series of 6vs.6 and 6vs.6GK.

Table 2. Description of small-sided games according to Rampanini et al²⁵

	5vs.5	5vs.5GK	6vs.6	6vs.6GK
Number of series	2	2	2	2
Dimensions of the pitch	25*35 m	25*35 m	30*40m	30*40 m
Duration of one series	4 min	4 min	3 min	3 min
Rest between series	4 min	4 min	3 min	3 min
Rest between games	8 min		6 min	

Variables.

Internal load: %HRmax - percentage of maximum heart rate, HRmax-maximum heart rate (using Yo-Yo intermittent recovery test level 1 (Krustrup et al ²⁶)), POLAR zones - time spent (s) in a certain running zone determined according to the maximum heart rate. External load: TD - total distance (m), HIR - high intensity running (speed of 4.5 m/s or higher), WR - work rate m/min (average number of meters in minute), GPS zones - distance covered (m) at certain running speed. Zones for IL and EL were previously set by manufacturer (Table 3).

Technical parameters.

The technical parameters, taken from Owen, Twist and Ford²⁷ present estimated average technical load for players as total number of all actions were recorded and divided by the number of players.

PASS - Player in possession sends the ball to a teammate. RECEIVE - Player gains or attempts to gain control of the ball in order to retain possession. TURN - Player in possession, with ball at feet, changes direction in order to play in other areas of the pitch. DRIBBLE - Player in possession, with ball at feet, runs with ball, beats or attempts to beat an opponent. HEADER - Player contacts the ball using their head. TACKLE - An action intending to dispossess an opponent who is in possession of the ball. BLOCK - Ball strikes a player, preventing an opponent's pass from reaching its intended destination. INTERCEPTION - Player contacts the ball, preventing an opponent's pass from reaching its intended destination.

Statistical Analysis

Descriptive statistics are presented as means (M), standard deviations (SD), minimum (Min), and maximum (Max). Data normality was evaluated using the Shapiro-Wilk test, and Mauchly's test was employed to assess sphericity. Differences between 5vs.5 and 5vs.5GK series, and differences between 6vs.6 and 6vs.6GK series of SSG were determined by using repeated

measures analysis of variance (ANOVA). Partial eta squared (η^2) was computed to estimate effect size in ANOVA with the following thresholds: 0.01 (small effect), 0.06 (medium effect) and 0.14 (large effect) as described by Cohen.²⁸ Bonferroni post-hoc test was used for pairwise comparisons. Additionally, Cohen's d effect size (d) was calculated to assess effect size with following thresholds for interpretation: <0.25 (trivial), 0.25 to 0.50 (small), 0.50 to 1.0 (moderate), and >1.0 (large) according to Rhea.²⁹ The data were analyzed using the Statistica ver. 13.0 (Dell Inc., Round Rock, TX USA) statistical package.

Results

Internal load parameters for 5vs.5 series are presented in table 4. No reading was obtained in Zone 1 (50-59% HRmax), probably due to intensity of games.

Table 4. Differences in internal load parameters between 5vs.5 and 5vs.5GK

Zone	INTERNAL LOAD	5vs.5(1)	5vs.5(2)	5vs.5GK(1)	5vs.5GK(2)	η^2
	%HRmax	91.10 ^c	92.20	93.70	93.30	0.32
	HRmax	183.70 ^{cd}	186.00	188.90	188.40	0.32
2	60 to 69% HRmax (s)	8.90 ^d	3.40	5.00	1.90	0.32
3	70 to 79% HRmax (s)	22.40	18.90	18.00	20.60	0.06
4	80 to 89% HRmax (s)	84.37 ^d	58.02	56.89	51.68	0.28
5	90 to 100% HRmax (s)	64.10 ^{bcd}	100.20	104.80	108.10	0.37

(1), (2) - number of series, GK - game with goalkeeper, 5vs.5, 5vs.5GK - type of SSG, %HRmax - percentage of maximum heart rate, HRmax - maximum heart rate, a - denotes significant differences from 5vs.5(1), b - denotes significant differences from 5vs.5(2), c - denotes significant differences from 5vs.5GK(2), d - denotes significant differences from 5vs.5GK(2), η^2 - partial eta squared

Significant differences were found in %HRmax ($F=4.27$, $p=0.002$, $d=\text{trivial}$) between 5vs.5(1) and 5vs.5GK(1). Significant differences were also found in HRmax ($F=4.24$, $p=0.014$, $d=\text{trivial}$) but between 5vs.5(1) and 5vs.5GK(1) / 5v.5GK(2). In zone 2 ($F=4.19$, $p=0.014$, $d=\text{moderate}$) significant differences were found between 5vs.5(1) and 5vs.5GK(2). In zone 3 ($F=0.57$, $p=0.64$) there were no significant differences between SSG. Zone 4 ($F=3.50$, $p=0.029$, $d=\text{small}$) differed 5vs.5(1) and 5vs.5GK(2) while in zone 5 ($F=5.18$, $p=0.006$, $d=\text{small}$) differences were found between 5vs.5(1) and all other measurements.

For 6vs.6 series values of IL are presented in table 5. As was the case in the 5vs.5 series no readings were gathered in 50-59% HRmax zone. Percentage of maximum Heart rate ($F=6.07$, $p=0.002$, $d=\text{trivial}$) and HRmax ($F=8.60$, $p<0.001$, $d=\text{trivial}$) differed between types of SSG. Differences between SSG were found in the zone 2 ($F=7.81$, $p<0.001$, $d=\text{small}$) between 6vs.6(1) and 6vs.6GK(2) (12.42 vs. 3.58s), 6vs.6GK(1) and GK(2) (9.58 vs. 3.58s). In zone 3 ($F=6.00$, $p=0.002$, $d=\text{small}$) differences were found between 6vs.6(1) and 6vs.6(2), 6vs.6(2) and 6vs.6GK(1). In zone 4 ($F=0.46$, $p=0.71$) and zone 5 ($F=0.50$, $p=0.690$) differences were not found between SSG (Table 5).

In 7 out of 8 variables of EL (presented in Table 6), there was a large effect between 5vs.5 series ($\eta^2 = 0.26 - 0.41$). Notably, differences were found in TD ($F=3.50$, $p=0.028$, $d=\text{moderate}$) between 5vs.5(1) and 5vs.5GK(1) / 5vs.5GK(2) (248.60 vs. 302.20 / 301.40m). High intensity running

($F=4.47$, $p=0.011$, $d=\text{large}$) differed between 5vs.5(2) and 5vs.5GK(1). Additionally, WR ($F=6.26$, $p=0.002$, $d=\text{moderate}$) differed between 5vs.5(1) and 5vs.5GK(1) / 5vs.5GK(2) (83.30 vs. 97.00 / 93.80m/min). In zone 1 ($F=8.38$, $p<0.001$, $d=\text{large}$) and zone 2 ($F=3.19$, $p=0.030$, $d=\text{moderate to large}$) significant differences were also found between SSG. In zone 3 ($F=0.22$, $p=0.880$) significant differences were not found. The distance covered in zone 4 ($F=5.18$, $p=0.005$, $d=\text{small to large}$) differed between 5vs.5(2) and 5vs.5GK(1) / 5vs.5GK(2) (10 vs. 26.10 / 23.40m) while in zone 5 ($F=5.18$, $p=0.020$, $d=\text{large}$) differences were found between 5vs.5(2) and 5vs.5GK(1).

Table 5. Differences in internal load parameters between 6vs.6 and 6vs.6GK

Zone	INTERNAL LOAD	6vs.6(1)	6vs.6(2)	6vs.6GK(1)	6vs.6GK(2)	η^2
	%HRmax	92.17 ^{bcd}	94.00	94.25	94.83	0.36
	HRmax	185.00 ^{cd}	186.92	188.50	189.58	0.44
2	60 to 69% HRmax (s)	12.42 ^d	7.83	9.58 ^d	3.58	0.42
3	70 to 79% HRmax (s)	15.92 ^b	22.83 ^c	13.17	18.42	0.35
4	80 to 89% HRmax (s)	85.33	71.25	73.92	67.50	0.04
5	90 to 100% HRmax (s)	125.25	139.25	138.08	145.50	0.04

(1), (2) - number of series, GK - game with goalkeeper, 6vs.6, 6vs.6GK - type of SSG, %HRmax - percentage of maximum heart rate, HRmax - maximum heart rate, a - denotes significant differences from 6vs.6(1), b - denotes significant differences from 6vs.6(2), c - denotes significant differences from 6vs.6GK(2), d - denotes significant differences from 6vs.6GK(2), η^2 - partial eta squared

Table 6. Differences in external load parameters between 5vs.5 and 5vs.5GK

Zone	EXTERNAL LOAD	5vs.5(1)	5vs.5(2)	5vs.5GK(1)	5vs.5GK(2)	η^2
	TD (m)	248.60 ^{cd}	295.70	302.20	301.40	0.28
	HIR (m)	8.70	3.10 ^c	18.40	14.70	0.33
	WR (m/min)	83.30 ^{cd}	89.10	97.00	93.80	0.41
1	≤ 2.0 m/s (m)	119.00 ^{bd}	157.40 ^c	133.00	144.50	0.48
2	2.1-3.0 m/s (m)	60.00 ^{bc}	77.40	76.90	75.60	0.26
3	3.1-4.0 m/s (m)	49.40	50.20	55.50	52.10	0.02
4	4.1-5.0 m/s (m)	17.00	10 ^{cd}	26.10	23.40	0.37
5	>5.0 m/s (m)	3.10	0.90 ^c	8.90	5.20	0.28

(1), (2) - number of series, GK - game with goalkeeper, 5vs.5, 5vs.5GK - type of SSG, TD - total distance (m), HIR - high intensity running (speed of 4.5 m/s or higher), WR - work rate m/min (average number of meters in minute), a - denotes significant differences from 5vs.5(1), b - denotes significant differences from 5vs.5(2), c - denotes significant differences from 5vs.5GK(2), d - denotes significant differences from 5vs.5GK(2), η^2 - partial eta squared

It can be seen in Table 7 that TD ($F=3.42$, $p=0.028$, $d=\text{moderate}$) differed between 6vs.6(2) and 6vs.6GK(2) (381.92 vs. 329.08m). In the HIR ($F=4.09$, $p=0.014$, $d=\text{moderate}$), significant differences were found between 6vs.6(2) and 6vs.6GK(2). Differences were found between 6vs.6GK(2) and all other series in the variable WR ($F=11.43$, $p<0.001$, $d=\text{moderate}$). Distance covered in zone 1 ($F=10.35$, $p<0.001$, $d=\text{large}$) and zone 2 ($F=7.03$, $p<0.001$, $d=\text{moderate to large}$) also differentiated between SSG. On the other hand, there were no significant differences in zone 3 ($F=2.54$, $p=0.064$) and zone 4 ($F=1.42$, $p=0.25$). In zone 5 ($F=4.42$, $p=0.010$, $d=\text{moderate}$) differences were found between 6vs.6(2) and 6vs.6GK(2).

Table 7. Differences in external load parameters between 6vs.6 and 6vs.6GK

Zone	EXTERNAL LOAD	6vs.6(1)	6vs.6(2)	6vs.6GK(1)	6vs.6GK(2)	η^2
	TD (m)	377.25	381.92 ^d	372.50	329.08	0.24
	HIR (m)	11.92	8.08 ^d	17.50	20.42	0.27
	WR (m/min)	92.17 ^d	89.42 ^d	88.92 ^d	78.42	0.51
1	≤ 2.0 m/s (m)	175 ^b	208.33 ^{cd}	172.42	170.42	0.48
2	2.1-3.0 m/s (m)	100.83 ^d	98.25 ^d	92.83 ^d	71.00	0.39
3	3.1-4.0 m/s (m)	71.92	53.33	70.25	50.42	0.24
4	4.1-5.0 m/s (m)	24.92	19.33	30.42	27.50	0.11
5	>5.0 m/s (m)	4.25	2.42 ^d	6.00	9.50	0.29

(1), (2) - number of series, GK - game with goalkeeper, 6vs.6, 6vs.6GK - type of SSG, TD - total distance (m), HIR - high intensity running (speed of 4.5 m/s or higher), WR - work rate m/min (average number of meters in minute), a - denotes significant differences from 6vs.6(1), b - denotes significant differences from 6vs.6(2), c - denotes significant differences from 6vs.6GK(1), d - denotes significant differences from 6vs.6GK(2), η^2 - partial eta squared

Table 8. Average individual technical demands during SSG

	5vs.5	5vs.5GK	6vs.6	6vs.6GK
PASS	6.6	4.5	6.95	3.92
RECEIVE	3	2.55	4.04	2.25
TURN	2.15	1.9	3.08	1.96
DRIBBLE	0.25	0.45	0.38	0.42
HEADER	0.05	0.15	0.08	0.25
TACKLE	0.75	0.9	0.88	1.08
BLOCK	0.1	0.2	0.08	0.29
INTERCEPTION	0.75	0.75	0.79	0.54

Table 8 presents average technical requirements during 5vs.5 and 6vs.6 SSG. During 5vs.5 games without GK, higher average values were recorded for PASS (6.6), RECEIVE (3) and TURN (2.15), while some parameters like DRIBBLE and TACKLE were more used with GK. Furthermore, in 6vs.6 games, higher average values were found for the variables PASS, RECEIVE, TURN and INTERCEPTION compared to 6vs.6 with GK. On average, majority of actions during these SSG involve passing, receiving and turning sides with the ball. It is also evident, that actions like heading and blocking are less frequent, but have increase during games with GK.

Discussion

Significant increase in both IL and EL were identified in 5vs.5 formats with goalkeepers (5vs.5GK) compared to regular 5vs.5 SSG. Likewise, in the 6vs.6 format, IL increased in games with goalkeeper (6vs.6GK), however some parameters of EL like TD and WR decreased in SSG with GK. Additionally, during previously mentioned SSG technical actions such as passing, receiving, and turning the side with the ball were highest recorded technical incidences.

Players in 5vs.5GK(1) format had significantly higher %HRmax compared to 5vs.5(1) (93.7 vs. 91.1%). Furthermore, in the HRmax parameter, differences ($p < 0.05$) were found between 5vs.5(1) and 5vs.5GK(1) / 5vs.5GK(2) (183.70 vs. 188.90 / 188.40). The obtained results suggest that games with a GK cause a greater physiological response and in such SSG a greater intensity

could be expected. It could be hypothesized that GK changed the physiological and tactical behavior of the players.³⁰ Additionally, during 6vs.6 formats, players on average had statistically greater intensity with GK (94.25 and 94.83 %HRmax) than regular 6vs.6 (92.17 and 94.00 %HRmax). Possible reason for these results could be that in games with a GK, the players are more motivated, because they had a greater incentive to prevent or score a goal. This type of game requires additional energy, which agrees with the results of Dellal et al.,³¹ who obtained a 10.7% increase in cardiac parameters in games with GK. However, Sassi, Reilly, and Impellizzeri³² obtained significantly lower values of %HRmax during games with a GK compared to games without a GK (88.8 vs. 91.00%) which agrees with Hulka, Weisser and Belka²⁴ and Castellano, Casamichana and Dellal.¹ Also, Mallo and Navarro³⁰ obtained lower HRmax values in games with a GK than in games without a GK (166 vs. 173). Regarding internal load, zones 4 and 5 (80-100%HRmax) are particularly interesting to soccer coaches as majority of time in matches, players play around anaerobic threshold.^{6,33} For time spent (s) in the 80 to 89% HRmax zone, significantly higher values were observed in the first series without a GK for 5vs.5. On the other hand, the time spent (s) in the most intense zone (90-100% HRmax) was significantly lower in the first series for 5vs.5 compared to series 2,3 and 4. These results could be the effect of an accumulated fatigue or even adaptation to certain tactical requirements and coaches' feedback between the series. No significant differences were found between 6vs.6 series in time spent for 80-89% and 90-100% HRmax zones. However, there is an increase in time spent in Zone 5 across series and decrease in time spent in zone 4 which is similar to 5vs.5 SSG.

The analysis of EL parameters revealed mostly similar patterns as those observed with internal load. The parameters are generally significantly higher in situations involving a GK, and there is an increase in the IL and EL with an increasing number of series. One of the most widely used measures of EL is the measure of total distance covered. The shortest TD was covered in 5vs.5(1) compared to other sets of SSG with GK. There was a greater overall distance covered in games with a GK, which is probably a consequence of specific tactical demands like a greater defensive and offensive engagement of players while trying to score or stop opponents in doing so.^{1,24} Interestingly, in 6vs.6 games, a greater TD and WR was recorded in games without a GK (Table 5). The results are different from those obtained in 5vs.5 SSG where, as mentioned, higher values of EL parameters were recorded in games with a GK. It could be explained by the effects of accumulated fatigue that built up in the series played without a GK, which negatively impacted the distance cover and work rate, especially in 6vs.6GK(2). However, during 6vs.6 SSG, series (1) and (2) included 3.2 and 2.1% of HIR, compared to 4.7 and 6.2% in series (3) and (4) with GK.

The significantly higher HIR values observed in games with a goalkeeper did not align with the findings of Mallo and Navarro,³⁰ who reported that the inclusion of goalkeepers reduced the tempo of the game, as players performed less high-intensity running ($p<0.05$). Significant differences were also noted in distances covered at certain running speeds. During 6vs.6 series without GK, the players had the greatest total distances in the first two zones, i.e., at speeds ($<3.1\text{m/s}$), and in these zones they covered a significantly greater distance than in 6vs.6 with GK. However, in zone 5 ($>5.0\text{ m/s}$) significantly greater distances can be seen in 6vs.6 with GK compared to 6vs.6.

In addition to knowing the physical demands of different types of SSG, it is important to know the technical demands in order to see which technical characteristics make up the largest share of actions that players undertake within the game. In the terms of technical demands, the values of the PASS, RECEIVE and TURN variables were on average higher in 5vs.5 and 6vs.6 compared to the same SSG with a GK. The results of the dribbles, headers, tackles, and blocks were on average higher in the SSG with a GK (5vs.5GK, 6vs.6GK). Research by Owen, Twist and Ford²⁷ observed the same variables as this research and found significant differences between different SSG (2vs.2, 3vs.3, 4vs.4 and 5vs.5) while Tessitore et al³⁴ reported a decline in technical actions per minute during longer 6-a-side games. On the other hand, Kelly and Dust¹³ concluded that by reducing the size of the field (5vs.5GK), differences are obtained in the variables: shots and tackles. These results coincide with the claims of Hodgston et al³⁵ and Vilar et al.³⁶ Moreover, Sanicandro and Cofano³ have established that increasing the number of players (3vs.3, 4vs.4, 5vs.5) will increase the number of TACKLES.

Understanding the physical demands within certain SSG is crucial for several reasons, especially in the context of training optimization, injury prevention and achieving better performance. Training can be more efficient if it is adapted to the specifics of the game in a limited space. During different types of SSG, players could develop abilities such as quick decision-making, precision in movements, as well as adaptation to rapidly changing technical-tactical circumstances. Training in these conditions helps athletes to face these challenges and be more efficient during matches.

There were few possible limitations of the study. The absence of randomization in participant selection could have produced results that are also influenced by other factors unrelated to research. A longer data collection period could provide more reliable insights into the training process and allow a better assessment of training effects. Although the study speculates on the potential impact of motivation on player performance during SSG with or without GK, motivation was not directly measured. This study focused primarily on a limited set of technical parameters, without exploring other potentially relevant factors (e.g., tactical decisions, psychological aspects, or physical conditioning) that may have influenced the observed outcomes. Lastly, warm-up protocol used in the research was designed by club's top-level strength and conditioning coaches but it is not previously scientifically evaluated.

To conclude, a significant increase in most parameters of internal and external load were identified in formats with goalkeepers (5vs.5GK and 6vs.6GK) compared to formats without goalkeepers (5vs.5 and 6vs.6). On the other side, out of 8 assessed variables of technical demands, 3 variables with the highest incidence: passing, receiving, and turning sides with the ball were observed in SSG without a goalkeeper. Obtained results give additional understanding how different SSG formats affect players' workload, contributing to the development of more effective and tailored training programs.

Acknowledgements

Authors' wish is to thank all the players and staff from NK Dugopolje, Dugopolje, Croatia for participating in the research. Their time and effort are very much appreciated.

References

1. Castellano J, Casamichana D, Dellal A. Influence of game format and number of players on heart rate responses and physical demands in small-sided soccer games. *J Strength Cond Res.* 2013;27(5):1295-1303. <https://doi.org/10.1519/JSC.0b013e318267a5d1>
2. Little T, Williams AG. Measures of exercise intensity during soccer training drills with professional soccer players. *J Strength Cond Res.* 2007;21(2):367-371. <https://doi.org/10.1519/00124278-200705000-00013>
3. Sannicandro I, Cofano G. Small-sided games: Analysis of the internal load and technical skills in young soccer players. *Int J Sci Res.* 2017;6(3):735-739.
4. Coutinho D, Gonçalves B, Santos S, Travassos B, Wong DP, Sampaio J. Effects of the pitch configuration design on players' physical performance and movement behaviour during soccer small-sided games. *Res Sports Med.* 2019;27(3):298-313. <https://doi.org/10.1080/15438627.2018.1544133>
5. Sanchez-Sanchez J, Ramirez-Campillo R, Carretero M, Martín V, Hernández D, Nakamura FY. Soccer small-sided games activities vary according to the interval regime and their order of presentation within the session. *J Hum Kinet.* 2018; 62(1):167-175. <https://doi.org/10.1515/hukin-2017-0168>
6. Sarmento H, Marcelino R, Anguera MT, Campaniço J, Matos N, and Leitão JC. Match 448 analysis in football: a systematic review. *J Sports Sci.* 2014;32:1831-1843. <https://doi.org/10.1080/02640414.2014.898852>
7. Halouani J, Chtourou, H, Dellal A, Chaouachi A, Chamari K. Soccer small-sided games in young players: Rule modification to induce higher physiological responses. *Biol Sport.* 2017;34(2):163-168. <https://doi.org/10.5114/biolSport.2017.64590>
8. Owen AL, Wong DP, Paul D, Dellal A. Physical and technical comparisons between various-sided games within professional soccer. *Int J Sports Med.* 2014;35(04):286-292. <https://doi.org/10.1055/s-0033-1351333>
9. Sarmento H, Clemente FM, Harper, LD, Costa ITD, Owen A, Figueiredo AJ. Small sided games in soccer-a systematic review. *Int J Perform Anal Sport.* 2018;18(5):693-749. <https://doi.org/10.1080/24748668.2018.1517288>
10. Sgrò F, Bracco S, Pignato S, Lipoma M. Small-sided games and technical skills in soccer training: Systematic review and implications for sport and physical education practitioners. *J Sports Sci.* 2018;6(1):9-19. <https://doi.org/10.17265/2332-7839/2018.01.002>
11. Lacome M, Simpson BM, Cholley Y, Lambert P, Buchheit M. Small-sided games in elite soccer: does one size fit all? *Int J Sports Physiol Perform.* 2018;13(5):568-576. <https://doi.org/10.1123/ijspp.2017-0214>
12. Hoff J, Wisloff U, Engen LC, Kemi OJ, Helgerud J. Football specific aerobic endurance training. *Br J Sports Med.* 2002;36(3):218-221. <https://doi.org/10.1136/bjsm.36.3.218>
13. Kelly, DM, Drust B. The effect of pitch dimensions on heart rate responses and technical demands of small-sided soccer games in elite players. *J Sci Med Sport.* 2009;12:475-479. <https://doi.org/10.1016/j.jsams.2008.01.010>
14. Helgerud J, Engen LC, Wisloff U, Hoff, J. Aerobic endurance training improves soccer performance. *Med Sci Sports Exerc.* 2011;33(11):1925-1931. <https://doi.org/10.1097/00005768-200111000-00019>
15. Impellizzeri FM, Marorca SM, Castagna C, Reilly T, Sassi A, Iaia FM, Rampinini E. Physiological and performance effects of generic versus specific aerobic training in soccer players. *Int J Sports Med.* 2006;27:483-492. <https://doi.org/10.1055/s-2005-865839>
16. Jones S, Drust B. Physiological and technical demands of 4 v 4 and 8 v 8 games in elite youth soccer players. *Kinesiology.* 2007;39(2):150-156.

17. Hill-Haas SV, Coutts AJ, Rowsell GJ, Dawson, BT. Generic versus small sided games training in soccer. *Int J Sport Med.* 2009;30(9):636- 642. <https://doi.org/10.1055/s-0029-1220730>
18. Impellizzeri FM, Marcora SM, Coutts AJ. Internal and external training load: 15 years on. *Int J Sports Physiol Perform.* 2019;14,270-273. <https://doi.org/10.1123/ijsp.2018-0935>
19. McKay AK, Stellingwerff T, Smith ES, Martin DT, Mujika I, Goosey-Tolfrey VL, et al. Defining training and performance caliber: a participant classification framework. *Int J Sports Physiol Perform.* 2021;17(2):317-31. <https://doi.org/10.1123/ijsp.2021-0451>
20. Navalta JW, Stone WJ, Lyons TS. Ethical issues relating to scientific discovery in exercise science. *Int J Exerc Sci.* 2020;12(1):1-8. <https://doi.org/10.70252/EYCD6235>
21. Wang T, Xue T, and He J. Do different playing formats and aerobic capacity influence variances in psychophysiological demands and technical performance in small-sided games? A study among under-17 male soccer players. *J Sports Sci Med.* 2024;23(3):619. <https://doi.org/10.52082/jssm.2024.619>
22. Castillo D, Rodríguez-Fernández A, Nakamura FY, Sanchez-Sanchez J, Ramirez-Campillo R, Yanci J, ... and Raya-González J. Influence of different small-sided game formats on physical and physiological demands and physical performance in young soccer players. *J Strength Cond Res.* 2021;35(8):2287-2293. <https://doi.org/10.1519/JSC.0000000000003114>
23. Pellegrino GC, Paredes-Hernández V, Sánchez-Sánchez J, García-Unanue J, and Gallardo L. Effect of the fatigue on the physical performance in different small-sided games in elite football players. *J Strength Cond Res.* 2020;34(8):2338-2346. <https://doi.org/10.1519/JSC.0000000000002858>
24. Hulka K, Weisser R, and Belka J. Effect of the pitch size and presence of goalkeepers on the work load of players during small-sided soccer games. *J Hum Kinet.* 2016;51:175. <https://doi.org/10.1515/hukin-2015-0180>
25. Rampinini E, Impellizzeri FM, Castagna C, Abt G, Chamari K, Sassi A, Marcora SM. Factors influencing physiological responses to small-sided soccer games. *J Sports Sci.* 2007;25(6):659-666. <https://doi.org/10.1080/02640410600811858>
26. Krstrup P, Mohr M, Amstrup T, Rysgaard T, Johansen J, Steensberg A, Bangsbo J. The yo-yo intermittent recovery test: physiological response, reliability, and validity. *Med Sci Sports Exerc.* 2003;35(4):697-705. <https://doi.org/10.1249/01.MSS.0000058441.94520.32>
27. Owen A, Twist C, Ford P. Small-sided games: The physiological and technical effect of altering pitch size and player numbers. *Insight.* 2004;7(2):50-53.
28. Cohen, J. Statistical power analysis for the behavioral sciences (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum, 1988.
29. Rhea MR. Determining the magnitude of treatment effects in strength training research through the use of the effect size. *J Strength Cond Res.* 2004;18(4):918-920. <https://doi.org/10.1519/14403.1>
30. Mallo J, Navarro E. Physical load imposed on soccer players during small-sided training games. *J Sports Med Phys Fit.* 2008;48(2):166.
31. Dellal A, Chamari K, Pintus A, Girard O, Cotte T, Keller D. Heart rate responses during small-sided games and short intermittent running training in elite soccer players: a comparative study. *J Strength Cond Res.* 2008;22(5):1449-1457. <https://doi.org/10.1519/JSC.0b013e31817398c6>
32. Sassi R, Reilly T, Impellizzeri F. A comparison of small-side games and interval training in elite professional soccer players. *Science and football V. Oxon: Routledge.* 2005; 352-4.

33. Faude O, Kindermann W, Meyer T. Lactate threshold concepts. *Sports Med.* 2009;39:469-490. <https://doi.org/10.2165/00007256-200939060-00003>
34. Tessitore A, Meeusen R, Piacentini MF, Demarie S, Capranica L. Physiological and technical aspects of "6-a-side" soccer drills. *J Sports Med Phys Fit.* 2006;46(1):36.
35. Hodgson C, Akenhead R, Thomas K. Time-motion analysis of acceleration demands of 4v4 small-sided soccer games played on different pitch sizes. *Hum Mov Sci.* 2014;33:25-32. <https://doi.org/10.1016/j.humov.2013.12.002>
36. Vilar L, Esteves PT, Travassos B, Passos P, Lago-Peñas C, Davids K. Varying numbers of players in small-sided soccer games modifies action opportunities during training. *Int J Sports Sci Coach.* 2014;9(5):1007-1018. <https://doi.org/10.1260/1747-9541.9.5.1007>

Corresponding author: Ante Rađa; anteradja7@gmail.com ante.rada@kifst.eu

