

Article

Impact of Scoring Format and Bout-Ending Mechanism on External Load and Neuromuscular Performance in Youth Soccer Small-Sided Games

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Abstract: Background: Small-sided games (SSG) are widely used in soccer training to replicate match demands; however, limited evidence exists on how different bout-ending mechanisms and scoring formats interact to modulate external load and fatigue responses, particularly in youth players. The aims were to examine the impact of scoring format and bout-ending mechanism on external load and neuromuscular fatigue during soccer SSG. Methods: Eight male youth players completed four 4 vs 4 SSG formats across four sessions: (1) fixed-time with regular goals and goalkeepers (SSG_{FT-GK}), (2) fixed-goal with regular goals and goalkeepers (SSG_{FG-GK}), (3) fixed-time with mini-goals (SSG_{FT-MG}), and (4) fixed-goal with mini-goals (SSG_{FG-MG}). Each session involved four bouts of 4-minutes or 3 goals with 2-minutes recovery. External load variables were measured using GPS (10 Hz), while neuromuscular fatigue was assessed via 10-m and 30-m sprints performed immediately before and after each SSG. Results: Significant effects were found for total distance, jogging distance, peak speed, accelerations, decelerations, and player load ($p = 0.001\text{--}0.044$, $\eta p^2 = 0.358\text{--}0.849$, large). The SSG_{FG-GK} condition elicited the highest locomotor and mechanical demands, including greater distance covered, higher peak speed, and elevated player load compared to other formats. No significant pre-post changes were observed in sprint times ($p \geq 0.459$, $\eta p^2 \leq 0.096$), indicating no acute neuromuscular fatigue. Conclusion: These findings suggest fixed-goal formats with regular goals and goalkeepers can substantially increase external load in youth 4 vs 4 SSG without impairing sprint performance, providing coaches an effective tool to modulate training stimuli.

Keywords: Young soccer; Training load; Locomotor demands; Football

1. Introduction

Small-sided games (SSG) are widely used in soccer training for replicating match-specific contexts while enhancing physical,

technical, and tactical performance (Bujalance-Moreno et al., 2018; Clemente et al., 2024). Alongside their practical benefits, such as efficient use of training time and



increased player physical fitness (Rodríguez-Fernández et al., 2017), coaches frequently manipulate task constraints to elicit desired training responses (Clemente et al., 2021).

Manipulating SSG constraints, such as field size (de Dios-Álvarez et al., 2024), player numbers (Castellano et al., 2015), or sets duration (Sanchez-Sanchez et al., 2018), allows coaches to modulate training loads. Specifically, previous research in soccer has shown that shorter and more intermittent SSG formats elicit higher external and internal loads (Casamichana et al., 2013; Köklü et al., 2017; Sanchez-Sanchez et al., 2018), whereas longer sets increase the perception of effort (Clemente et al., 2019). In addition to set's duration, player pacing patterns are also influenced by their knowledge of the exercise duration (Gabbett et al., 2015). Ferraz et al. (2018) reported that awareness of a shorter duration tends to increase exercise intensity, while longer exercise durations may attenuate the differences between full knowledge and lack of knowledge of the task length. However, despite these valuable insights into how duration and knowledge shape player responses, little is known about how different bout-ending mechanisms, such as fixed-time formats (e.g., 4-minutes) and goal-dependent formats (e.g., reaching 3 goals), influence training load in soccer SSG. In line with this gap, only a few studies have specifically addressed how the scoring method influences external load in soccer players (Clemente et al., 2014). Specifically, the use of mini-goals resulted in higher play intensity compared with regular goals in 4-a-side formats, whereas this effect was not observed in 6-a-side games (González-Rodenas et al., 2015). In contrast,

Casamichana et al. (Casamichana et al., 2011) reported higher internal response in 4-a-side SSG format with regular goals compared to mini-goals. However, such effects appear to be attenuated as the number of players increases, as shown in 7 vs 7 formats where no significant differences were found between scoring methods (Castellano et al., 2013). More recently, a systematic review by Maia Junior et al. (2023), indicated that one-goal SSG resulted in greater total distance covered and higher match volume (i.e., ball recovery and maintenance) compared to two-goal SSG, while sprint frequency remained similar across formats. These findings suggest that scoring constraints may selectively modulate acute external load responses, with different goal configurations eliciting distinct locomotor and technical-tactical demands. Taken together, these studies highlight that the influence of scoring rules is not universal but rather contingent upon interacting variables such as player numbers, tactical context, and the specific physical or technical outcomes targeted by coaches (Halouani et al., 2014).

In addition to monitoring training load, quantifying fatigue-related responses induced by specific SSG formats can provide valuable insights into the physiological stress imposed on players and the practical utility of each drill (Castillo et al., 2021). However, assessing SSG-related fatigue remains a complex process, as it requires the integration of motion analysis during play with standardized physical performance tests administered before and after the game (Hodgson et al., 2014). Among these, linear sprint tests and vertical jump assessments are regarded as the most reliable tools to detect accumulated neuromuscular fatigue during

SSG (Johnston *et al.*, 2014). Extending these evaluations to longer sprint distances (e.g., 30-m) is particularly relevant in soccer, since young players typically reach their maximal sprint velocity around this distance (Al Haddad *et al.*, 2015). Such knowledge may assist coaches in tailoring recovery strategies and drill selection, ensuring that the training stimulus balances technical-tactical objectives with the management of residual fatigue.

Therefore, the primary aim of this study was to examine the effects of modifying bout-ending mechanism (fixed-time vs fixed-goal) and scoring format (regular goals with goalkeepers vs mini-goals without goalkeepers) on the external load in youth soccer SSG. A secondary aim was to determine whether these SSG formats elicit acute neuromuscular fatigue, as reflected by changes in sprint performance. Based on previous evidence (González-Rodenas *et al.*, 2015), it was hypothesized that i) fixed-goal formats would impose greater external load than fixed-time formats, and (ii) regular goals with goalkeepers would elicit greater external load than mini-goals without goalkeepers. Furthermore, these effects were expected to be observed in both locomotor (e.g., running distances, high-speed efforts) and mechanical (e.g., accelerations, decelerations, Player Load) dimensions of external load. In addition, it was hypothesized that the formats eliciting greater external load would induce greater acute neuromuscular fatigue, reflected by impaired 10-m and 30-m sprint performance after the SSG.

2. Materials and Methods

Subjects— Eight male youth soccer players (mean $\pm$ standard deviation [SD]; age: 15.57 ± 0.53 years; height: 175 ± 6.14 cm; body mass: 72 ± 3.2 kg; years of experience at the club: 4.5 ± 2.78 years) from the same team participated in the study during the 2022–2023 season. All players were part of a structured training program that included three weekly training sessions (~90 minutes each), in addition to competing in one official match every weekend. Eligibility criteria for inclusion in the study were as follows: (i) full participation in all intervention conditions; (ii) absence of injury during the three months prior to the study; (iii) completion of all pre- and post-intervention physical assessments; and (iv) successful GPS data recording during each session. Goalkeepers were excluded from data collection. External load and physical performance monitoring were part of the club's regular training assessment procedures, and no additional invasive or clinical intervention was introduced for the purposes of this study. Players and coaching staff were fully informed about the study objectives and procedures, participation was voluntary, and institutional consent was obtained from the club. According to the recommendations regarding ethics approval in sport science research (Winter & Maughan, 2009), formal ethics committee approval was not required. Nevertheless, the study protocol was conducted in accordance with the principles of the Declaration of Helsinki.

Design— This study employed a repeated-measures experimental design to examine the training demands and short-term fatigue responses elicited by different SSG formats in soccer. Prior to the

intervention, male soccer players took part in a two-week familiarization period during which they became accustomed to the equipment (GPS devices), testing procedures (30-m sprint), and the SSG formats that would later be evaluated. The main data collection was carried out over four consecutive weeks during the second part of the competitive season. Each SSG format was implemented in a separate week, always on the same day within the team's weekly microcycle and under consistent pre-session conditions. All SSGs were integrated into the team's standard training schedule and were conducted on the usual training pitch, with players wearing their typical training kit and soccer boots, before any additional high-intensity conditioning content. Although this approach improved ecological validity, prior training and match load were not objectively quantified. Each session began with a structured warm-up replicating the team's usual pre-competition routine. This included 3-minutes of light jogging, 5-minutes of general mobility work, 5-minutes of technical soccer actions (such as passing, ball control, and multidirectional dribbling actions), followed by 3 sprints (two over 10-m and one over 20-m). To assess acute fatigue, sprint performance was measured immediately before and after each SSG format, with players evaluated in the same order across all pre- and post-SSG assessments.

Methodology— The study followed established methodological recommendations for the design and reporting of SSG interventions in team sports. Four different SSG formats were implemented, all involving teams of four outfield players (4 vs 4). In formats using regulation goals, goalkeepers were included,

whereas in formats with mini-goals, play occurred without goalkeepers (Figure 1). All SSG were played on a 30 × 40 m pitch, yielding an individual interaction space (IIS) of 150 m². Each format consisted of four bouts interspersed with 2-minutes recovery periods. In the fixed-time conditions, each bout lasted 4-minutes, whereas in the fixed-goal conditions, each bout ended when 3 goals were scored. Pitch layout and goal arrangements for each format are shown in Figure 1. The four experimental conditions were as follows: (1) 4 vs 4 + 2 goalkeepers, played with regular goals and a fixed time of four minutes per bout (SSG_{FT-GK}); (2) 4 vs 4 + 2 goalkeepers, with bouts ending upon the scoring of three goals (SSG_{FG-GK}); (3) 4 vs 4 without goalkeepers, using two mini-goals on each end and a fixed time of four minutes per bout (SSG_{FT-MG}); (4) 4 vs 4 without goalkeepers, using two mini-goals on each end with play ending after three total goals were scored (SSG_{FG-MG}). No specific tactical instructions were given regarding offensive or defensive organization (e.g., man-marking, zonal coverage), allowing players to self-organize according to their understanding of the game. Teams were pre-assigned by the coaching staff to ensure balance across players' technical-tactical level, physical condition, and playing position (Castillo et al., 2021). The same teams competed against each other across all four formats to minimize variability. Verbal encouragement was provided continuously throughout the sessions to maintain a high level of motivation, and additional balls were promptly introduced to prevent unnecessary stoppages and ensure the continuity of play (Rodríguez-Fernández et al., 2024).

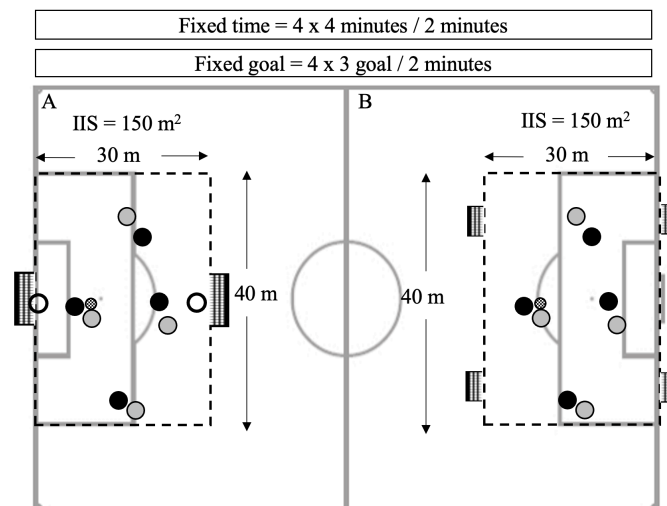


Figure 1. Graphical representation of the four small-sided game formats analyzed. A: 4 vs 4 with regulation goals (IIS = 150 m²); B: 4 vs 4 with small goals (IIS = 150 m²). Both formats were performed either using a fixed duration (4 bouts of 4-minutes) or a fixed goal limit (4 bouts ending after 3 goals). IIS = individual interaction space.

Physical demands during the various SSG formats and official matches were monitored using integrated microsensor technology (WIMU PRO; RealTrack Systems, Almería, Spain). Each unit featured a GPS receiver with a 10 Hz sampling frequency and a triaxial accelerometer operating at 100 Hz. In order to avoid the inter-unit variability error, all players used the same GPS unit during training sessions and matches. Players wore the devices in a tight-fitting vest provided by the manufacturer, positioned on the upper back, during all monitored sessions. In accordance with manufacturer guidelines, each device was activated at least 15-minutes prior to the start of each training session in an open area to ensure accurate data collection (Malone et al., 2017; Vickery et al., 2014).

After each session, data were downloaded and processed using the system-specific software (WIMU SPRO; RealTrack Systems, Almería, Spain).

The following external load variables were extracted: total distance covered, and distance covered within predefined speed zones, walking (0–4 km·h⁻¹), jogging (4.1–8 km·h⁻¹), running (8.1–13 km·h⁻¹), moderate-intensity (13.1–18 km·h⁻¹), high intensity (18.1–25 km·h⁻¹), and sprint (>25 km·h⁻¹) distance (Díaz-Soto et al., 2023). In addition, the number of efforts at moderate-intensity (13.1–18 km·h⁻¹), high intensity (18.1–25 km·h⁻¹), and sprint (>25 km·h⁻¹) intensity were determined. Acceleration and deceleration efforts were categorized according to the following thresholds: low intensity (0–2.9 m·s⁻² and 0–2.9 m·s⁻², respectively) and high intensity (>3 m·s⁻² and >3 m·s⁻², respectively) (Díaz-Soto et al., 2023). In addition, peak speed was recorded for each session. To quantify overall mechanical load, the player load metric (arbitrary units, AU) was included, calculated from the tri-axial movement data according to a proprietary algorithm

provided by the manufacturer (Guitart et al., 2022).

Neuromuscular fatigue induced by each SSG format was assessed through two sprint performance tests: the 10-m sprint and the 30-m sprint. Players performed two maximal 30-m sprint trials immediately before and after each SSG condition. Sprints began 0.5-m behind the first timing gate (Microgate Polifemo, Bolzano, Italy), which marked the start line. Split times were recorded at 10-m and 30-m using additional timing gates, enabling separate analysis of acceleration (i.e., 10-m sprint) and maximal sprint velocity (i.e., 30-m sprint). Players were instructed to sprint at maximal effort throughout the entire distance. Sprint trials were performed on natural grass, and players used their usual soccer boots. Trials were separated by 45-seconds of passive standing recovery. The best sprint times over 10-m and 30-m were retained for further analysis. Post-SSG sprint assessments were conducted in the same order as the pre-test, within one to two minutes after completing the final SSG bout, ensuring consistent timing across conditions. This sprint-based protocol was selected as a practical and ecologically valid indicator of acute fatigue in team sports (Castillo et al., 2021), given its sensitivity to detect changes in neuromuscular performance under realistic field conditions (Alba-Jiménez et al., 2022; Garrett et al., 2023).

Statistical Analysis— All results are presented as mean $\pm$ standard deviation (SD). Data collected via GPS devices were first processed using WIMU SPRO software (RealTrack Systems, Almería, Spain), exported to Microsoft Excel, and subsequently imported into IBM SPSS Statistics (version 25.0; IBM Corp., Chicago,

IL, USA) for statistical analysis. The assumption of normality was verified using the Kolmogorov–Smirnov test. Given that the analyzed variables followed a normal distribution, parametric procedures were applied. To detect significant differences in external load variables across the four SSG formats, a one-way repeated-measures analysis of variance (ANOVA) was conducted, followed by Bonferroni-adjusted post hoc tests for multiple comparisons. To assess changes in sprint performance before and after each SSG format, a two-way repeated-measures ANOVA (time [pre vs post] $\times$ format) was performed with Bonferroni correction for post hoc pairwise comparisons. Effect sizes (ES) for the main and interaction effects in all ANOVA models were calculated using partial eta squared (η_p^2) and interpreted as follows: small (<0.06), moderate (0.06–0.13), and large (>0.14), in accordance with established guidelines (Cohen, 2013). To assess the magnitude of observed differences in pairwise comparisons for training load and physical performance variables, Cohen's d for dependent samples (with 95% confidence intervals [CI]) were calculated to quantify the effect size (Lakens, 2013). ES magnitudes were classified as *trivial* (<0.20), *small* (0.20–0.49), *moderate* (0.50–0.79), or *large* (≥ 0.80) based on previous recommendations (Cohen, 2013). Statistical significance was set at $p < 0.05$.

3. Results

Although mean duration differed slightly between formats, all participants completed the exact same duration within each condition (e.g., 16.4-minutes in SSG_{FT-GK}, 16.1-minutes in SSG_{FG-GK}, 16.3-minutes in SSG_{FT-MG} and 16.6-minutes in SSG_{FG-MG}). Therefore, no inter-individual variability was present within each condition for total

should be considered when interpreting volume-related comparisons.

The mean $\pm$ SD for all training load variables, along with the corresponding outcomes from the one-way repeated-measures ANOVA across all 4 bouts combined for each SSG format, are presented in Table 1. Statistically significant main effects were observed for total distance, walking distance, and jogging distance ($p = 0.001$ – 0.029 , $\eta_p^2 = 0.385$ – 0.602 , *large*), as well as for peak speed reached ($p = 0.044$, $\eta_p^2 = 0.358$ *large*). Similarly, significant differences were observed in low intensity accelerations and decelerations ($p < 0.001$ – 0.003 , $\eta_p^2 = 0.543$ – 0.849 , *large*), high intensity acceleration distance ($p = 0.035$, $\eta_p^2 = 0.364$, *large*), and Player Load ($p < 0.001$, $\eta_p^2 = 0.732$, *large*) indicating a large magnitude of effect. Outcomes from pairwise comparisons for external load variables between the four SSG

duration, making a repeated-measures ANOVA non-informative for this variable. Given the small range of total exposure time across formats, differences in absolute external-load variables are unlikely to be explained solely by playing duration. However, because distance-related outcomes were expressed as absolute values rather than time-normalized variables, this issue

formats are presented in Table 2. Specifically, SSG_{FT-GK} elicited greater total distance, peak speed, high-speed (18 – 25 km·h⁻¹) running and counts, low-intensity accelerations and decelerations, and Player Load than SSG_{FG-GK} ($p < 0.001$ – 0.050). Similarly, SSG_{FT-MG} also showed higher values than SSG_{FG-GK} for total distance, low-intensity accelerations and decelerations, and Player Load ($p = 0.000$ – 0.044). Few differences were observed between SSG_{FT-GK} and SSG_{FT-MG}, or between SSG_{FT-MG} and SSG_{FG-MG}, indicating comparable external load responses between formats with similar end-bout mechanisms or goal configuration. No interaction effect for 10-m sprint time ($F = 0.745$; $p = 0.459$; $\eta_p^2 = 0.096$) and 30-m sprint time ($F = 0.138$; $p = 0.869$; $\eta_p^2 = 0.019$) were obtained (Figure 2A and 2B).

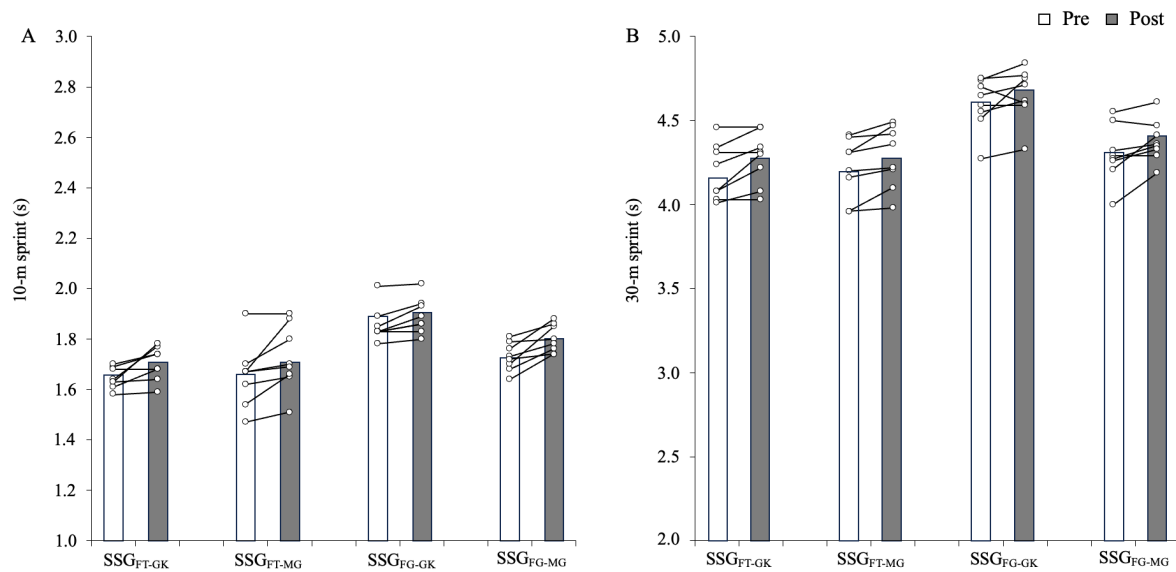


Figure 2. Testing outcomes in the (A) 10-m sprint and (B) 30-m sprint pre and post each small-sided game format.

Note: SSG_{FT-GK}: 4 vs 4 + 2 goalkeepers, played with regular goals and a fixed time of 4-minutes per bout; SSG_{FG-GK}: 4 vs 4 + 2 goalkeepers, with bouts ending upon the scoring of 3 goals; SSG_{FT-MG}: 4 vs 4 without goalkeepers, using two mini-goals on each end and a fixed time of 4 minutes per bout; SSG_{FG-MG}: 4 vs 4 without goalkeepers, using two mini-goals on each end with play ending after 3 total goals were scored * Significant differences with Pre. $p < 0.05$

Table 1. Mean $\pm$ standard deviation for external and internal load variables for different small-sided game (SSG) formats modified according to goals (regular goals and mini goals) and end-bout mechanisms (fixed time and fixed point).

Training load variable	SSG format				ANOVA outcomes		
	<i>SSG_{FT-GK}</i>	<i>SSG_{FT-MG}</i>	<i>SSG_{FG-GK}</i>	<i>SSG_{FG-MG}</i>	<i>F</i>	<i>p</i>	η_p^2
Locomotor							
Total distance (m)	1253.2 $\pm$ 123.9	1353.4 $\pm$ 213.8	1668.0 $\pm$ 153.9	1462.3 $\pm$ 295.4	7.506	0.001	0.517
0-4 km·h ⁻¹ (m)	226.6 $\pm$ 29.6	270.0 $\pm$ 51.4	334.4 $\pm$ 54.3	297.0 $\pm$ 44.3	10.608	0.002	0.602
4.1-8 km·h ⁻¹ (m)	500.7 $\pm$ 47.9	462.8 $\pm$ 91.5	622.9 $\pm$ 88.9	526.2 $\pm$ 118.9	4.386	0.029	0.385
8-13 km·h ⁻¹ (m)	342.5 $\pm$ 99.4	358.2 $\pm$ 114.3	441.9 $\pm$ 93.0	379.4 $\pm$ 127.4	2.838	0.078	0.288
13.1-18 km·h ⁻¹ (m)	134.6 $\pm$ 31.0	183.2 $\pm$ 86.2	179.8 $\pm$ 45.2	183.4 $\pm$ 62.0	1.380	0.281	0.165
18.1-25 km·h ⁻¹ (m)	18.6 $\pm$ 11.1	43.5 $\pm$ 22.1	48.3 $\pm$ 26.2	40.5 $\pm$ 31.7	2.644	0.106	0.274
>25 km·h ⁻¹ (m)	0.0 $\pm$ 0.0	0.2 $\pm$ 0.5	0.0 $\pm$ 0.0	0.8 $\pm$ 1.5	2.111	0.184	0.232
13-18 km·h ⁻¹ (counts)	13.9 $\pm$ 4.3	16.6 $\pm$ 8.5	16.6 $\pm$ 4.4	15.7 $\pm$ 5.3	0.392	0.724	0.053
18.1-25 km·h ⁻¹ (counts)	1.6 $\pm$ 1.1	3.6 $\pm$ 2.3	3.2 $\pm$ 1.7	3.1 $\pm$ 2.2	2.318	0.135	0.249
>25 km·h ⁻¹ (counts)	0.0 $\pm$ 0.0	0.1 $\pm$ 0.3	0.0 $\pm$ 0.0	0.2 $\pm$ 0.5	1.711	0.224	0.196
Peak Speed (km·h ⁻¹)	20.1 $\pm$ 0.2	22.4 $\pm$ 0.7	22.9 $\pm$ 0.6	21.7 $\pm$ 1.1	3.900	0.044	0.358
Mechanical							
ACC 0–2.9 m·s ⁻² (counts)	393.2 $\pm$ 21.0	416.1 $\pm$ 22.6	542.5 $\pm$ 29.4	507.9 $\pm$ 57.1	39.294	0.000	0.849
ACC 0–2.9 m·s ⁻² (m)	552.9 $\pm$ 57.9	590.4 $\pm$ 104.2	746.4 $\pm$ 67.7	652.7 $\pm$ 133.5	8.304	0.001	0.543
ACC >3 m·s ⁻² (counts)	10.38 $\pm$ 4.5	10.25 $\pm$ 4.3	14.6 $\pm$ 2.7	11.2 $\pm$ 1.7	3.522	0.057	0.335
ACC >3 m·s ⁻² (m)	44.7 $\pm$ 21.5	60.4 $\pm$ 30.8	78.4 $\pm$ 16.6	58.1 $\pm$ 13.3	4.000	0.035	0.364
DEC 0– -2.9 m·s ⁻² (counts)	387.1 $\pm$ 20.9	416.7 $\pm$ 30.5	539.5 $\pm$ 27.4	502.7 $\pm$ 62.5	38.451	0.000	0.846
DEC 0– -2.9 m·s ⁻² (m)	497.2 $\pm$ 68.1	533.9 $\pm$ 74.9	668.1 $\pm$ 60.9	590.4 $\pm$ 101.4	9.423	0.003	0.574
DEC >-3 m·s ⁻² (counts)	15.5 $\pm$ 3.8	11.9 $\pm$ 3.7	16.9 $\pm$ 3.3	13.2 $\pm$ 3.9	3.014	0.066	0.301
DEC >-3 m·s ⁻² (m)	64.4 $\pm$ 18.7	62.4 $\pm$ 1.5	72.3 $\pm$ 15.8	63.9 $\pm$ 15.8	0.334	0.694	0.047
Player Load (A.U.)	16.3 $\pm$ 2.5	17.5 $\pm$ 3.8	24.3 $\pm$ 3.6	18.8 $\pm$ 4.3	19.200	0.000	0.732

Abbreviations: ANOVA, analysis of variance; *SSG_{FT-GK}*: 4 vs 4 + 2 goalkeepers, played with regular goals and a fixed time of 4 minutes per bout; *SSG_{FG-GK}*: 4 vs 4 + 2 goalkeepers, with bouts ending upon the scoring of 3 goals; *SSG_{FT-MG}*: 4 vs 4 without goalkeepers, using two mini-goals on each end and a fixed time of 4 minutes per bout; *SSG_{FG-MG}*: 4 vs 4 without goalkeepers, using two mini-goals on each end with play ending after 3 total goals were scored; ACC = accelerations; DEC: Decelerations; A.U.: arbitrary units. Bolded *p*-value denotes significant effect (*p* < 0.05)

Table 2. Outcomes from pairwise comparisons for external load variables between the four small-sided game (SSG) formats.

Training load variable	Pairwise comparison (<i>p</i> -value, ES, magnitude)					
	SSG _{FT-GK} vs SSG _{FT-MG}	SSG _{FT-GK} vs SSG _{FG-GK}	SSG _{FT-GK} vs SSG _{FG-MG}	SSG _{FT-MG} vs SSG _{FG-GK}	SSG _{FT-MG} vs SSG _{FG-MG}	SSG _{FG-GK} vs SSG _{FG-MG}
Locomotor						
Total distance (m)	<i>p</i> = 0.315, -0.573, moderate	<i>p</i> = 0.001, -2.969, large	<i>p</i> = 0.491, -0.923, large	<i>p</i> = 0.035, -1.689, large	<i>p</i> = 1.00, -0.422, small	<i>p</i> = 0.719, 0.873, large
0–4 km·h ⁻¹ (m)	<i>p</i> = 0.147, -1.035, large	<i>p</i> = 0.015, -2.465, large	<i>p</i> = 0.024, -1.869, large	<i>p</i> = 0.294, -1.218, large	<i>p</i> = 0.570, -0.563, moderate	<i>p</i> = 0.485, 0.755, moderate
4–8 km·h ⁻¹ (m)	<i>p</i> = 0.836, 0.519, moderate	<i>p</i> = 0.124, -1.711, large	<i>p</i> = 0.100, -0.281, small	<i>p</i> = 0.088, -1.775, large	<i>p</i> = 0.100, -0.598, moderate	<i>p</i> = 0.601, 0.921, large
8–13 km·h ⁻¹ (m)	<i>p</i> = 0.100, -0.147, trivial	<i>p</i> = 0.164, -1.033, large	<i>p</i> = 0.100, -0.323, small	<i>p</i> = 0.277, -0.803, large	<i>p</i> = 0.100, -0.175, trivial	<i>p</i> = 0.100, 0.560, moderate
13–18 km·h ⁻¹ (m)	<i>p</i> = 0.671, -0.750, moderate	<i>p</i> = 0.586, -1.166, large	<i>p</i> = 0.731, -0.996, large	<i>p</i> = 0.100, 0.049, small	<i>p</i> = 0.100, -0.003, trivial	<i>p</i> = 0.100, -0.066, trivial
18–25 km·h ⁻¹ (m)	<i>p</i> = 0.118, -1.424, large	<i>p</i> = 0.011, -1.476, large	<i>p</i> = 0.663, -0.922, large	<i>p</i> = 0.100, -0.198, trivial	<i>p</i> = 0.100, 0.110, trivial	<i>p</i> = 0.100, 0.268, small
> 25 km·h ⁻¹ (m)	<i>p</i> = 0.100, -0.566, moderate	–, –	<i>p</i> = 0.100, -0.754, moderate	<i>p</i> = 0.100, 0.566, moderate	<i>p</i> = 0.100, -0.537, moderate	<i>p</i> = 0.100, -0.754, moderate
13-18 km·h ⁻¹ (counts)	<i>p</i> = 0.100, -0.401, small	<i>p</i> = 0.100, -0.621, moderate	<i>p</i> = 0.100, -0.373, small	<i>p</i> = 0.100, 0.000, trivial	<i>p</i> = 0.100, 0.127, trivial	<i>p</i> = 0.100, 0.185, trivial
18-25 km·h ⁻¹ (counts)	<i>p</i> = 0.223, -1.109, large	<i>p</i> = 0.037, -1.117, large	<i>p</i> = 0.526, -0.862, large	<i>p</i> = 0.100, 0.198, trivial	<i>p</i> = 0.100, 0.222, small	<i>p</i> = 0.100, 0.051, moderate
> 25 km·h ⁻¹ (counts)	<i>p</i> = 0.100, -0.471, small	–, –	<i>p</i> = 0.100, -0.566, moderate	<i>p</i> = 0.100, 0.471, small	<i>p</i> = 0.100, -0.243, small	<i>p</i> = 0.100, -0.566, moderate
Peak speed (km·h ⁻¹)	<i>p</i> = 0.138, -4.468, large	<i>p</i> = 0.005, -6.261, large	<i>p</i> = 0.100, -2.024, large	<i>p</i> = 0.100, -0.767, moderate	<i>p</i> = 0.100, 0.759, moderate	<i>p</i> = 0.100, 1.354, large
Mechanical						
ACC 0–2.9 m·s ⁻² (counts)	<i>p</i> = 0.118, -1.050, large	<i>p</i> = 0.000, -5.844, large	<i>p</i> = 0.002, -2.666, large	<i>p</i> = 0.000, -4.820, large	<i>p</i> = 0.021, -2.114, large	<i>p</i> = 0.846, 0.762, moderate
ACC 0–2.9 m·s ⁻² (m)	<i>p</i> = 0.609, -0.445, small	<i>p</i> = 0.001, -3.072, large	<i>p</i> = 0.414, -0.970, large	<i>p</i> = 0.038, -1.775, large	<i>p</i> = 0.100, -0.520, moderate	<i>p</i> = 0.756, 0.885, large
ACC >3 m·s ⁻² (counts)	<i>p</i> = 0.100, 0.030, trivial	<i>p</i> = 0.234, -1.137, large	<i>p</i> = 0.100, -0.241, small	<i>p</i> = 0.268, -1.212, large	<i>p</i> = 0.100, -0.291, small	<i>p</i> = 0.071, 1.507, large
ACC >3 m·s ⁻² (m)	<i>p</i> = 0.570, -0.591, moderate	<i>p</i> = 0.050, -1.755, large	<i>p</i> = 0.100, -0.750, moderate	<i>p</i> = 0.833, -0.728, moderate	<i>p</i> = 0.100, 0.097, trivial	<i>p</i> = 0.185, 1.350, large
DEC 0 – -2.9 m·s ⁻² (counts)	<i>p</i> = 0.046, -1.132, large	<i>p</i> = 0.000, -6.254, large	<i>p</i> = 0.005, -2.481, large	<i>p</i> = 0.000, -4.236, large	<i>p</i> = 0.026, -1.749, large	<i>p</i> = 0.801, 0.763, moderate
DEC 0 – -2.9 m·s ⁻² (m)	<i>p</i> = 0.973, -0.513, moderate	<i>p</i> = 0.004, -2.645, large	<i>p</i> = 0.079, -1.079, large	<i>p</i> = 0.044, -1.966, large	<i>p</i> = 0.100, -0.634, moderate	<i>p</i> = 0.405, 0.929, large
DEC >-3 m·s ⁻² (counts)	<i>p</i> = 0.239, 0.960, large	<i>p</i> = 0.100, -0.393, small	<i>p</i> = 0.100, 0.597, moderate	<i>p</i> = 0.108, -1.426, large	<i>p</i> = 0.100, -0.342, small	<i>p</i> = 0.563, 1.024, large
DEC > -3 m·s ⁻² (m)	<i>p</i> = 0.100, 0.151, large	<i>p</i> = 0.100, -0.456, small	<i>p</i> = 0.100, 0.029, trivial	<i>p</i> = 0.100, -0.882, large	<i>p</i> = 0.100, -0.134, trivial	<i>p</i> = 0.100, 0.532, moderate
Player Load (A.U.)	<i>p</i> = 0.100, -0.373, small	<i>p</i> = 0.000, -2.581, large	<i>p</i> = 0.222, -0.711, moderate	<i>p</i> = 0.013, -1.837, large	<i>p</i> = 0.100, -0.320, small	<i>p</i> = 0.001, 1.387, large

Abbreviations: ANOVA, analysis of variance; SSG_{FT-GK}: 4 vs 4 + 2 goalkeepers, played with regular goals and a fixed time of 4 minutes per bout; SSG_{FG-GK}: 4 vs 4 + 2 goalkeepers, with bouts ending upon the scoring of 3 goals; SSG_{FT-MG}: 4 vs 4 without goalkeepers, using two mini-goals on each end and a fixed time of 4 minutes per bout; SSG_{FG-MG}: 4 vs 4 without goalkeepers, using two mini-goals on each end with play ending after 3 total goals were scored; ACC = accelerations; DEC: Decelerations; A.U.: arbitrary units. Bolded *p*-value denotes significant effect (*p* < 0.05).

4. Discussion

This study aimed to examine how manipulating the scoring format and bout-ending mechanism during small-sided games affects the external load and acute neuromuscular fatigue in youth soccer players. While several studies have explored how task constraints in SSG impact external load (Clemente *et al.*, 2025; Rodríguez-Fernández *et al.*, 2024; Toivonen *et al.*, 2025), the combined effects of bout-ending mechanism (i.e., fixed-time vs fixed-goal) and scoring format (i.e., regular goals with goalkeepers vs mini-goals without goalkeepers) remain largely unexplored. The main findings partially support our initial hypothesis, revealed that the fixed-goals mechanism elicited the highest external load, when combined with the regular goal format with goalkeeper (SSG_{FG-GK}). This condition resulted in greater total distance covered, increased distance and number of high-speed efforts (18–25 km·h⁻¹), higher peak running speed, and more frequent low-intensity decelerations (0 to -2.9 m·s⁻²). Additionally, Player Load was significantly greater in SSG_{FG-GK} than in both SSG_{FT-GK} and SSG_{FT-MG}. These results suggest that while playing to time or to goals may not influence locomotor and mechanical demands in mini-goal formats, it does have a substantial impact in formats using regular goals with goalkeepers. Despite these load differences, none of the formats induced pre-post changes in 10-m or 30-m sprint performance, suggesting that no acute neuromuscular fatigue was elicited under any condition.

Despite the widespread use of SSG and extensive research on how goal type affects player demands in male soccer (Clemente *et al.*, 2014; Halouani *et al.*, 2014), little is known about how bout-ending mechanisms influence external loads in youth populations. To the best of our knowledge, this is the first study to assess the interaction between scoring format and bout-ending constraints on the physical demands experienced specifically by young soccer players. In practical settings, coaches often implement rules that condition the duration of SSG, such as playing until a certain number of goals are scored rather than setting a fixed time limit (Delgado-Bordonau & Mendez-Villanueva, 2012). Although these rules may reduce precise control of training load, they introduce valuable variability and enhance ecological validity by replicating the spontaneous and unpredictable rhythm of match play. Despite their widespread use in soccer training, bout-ending constraints—particularly formats in which task duration depends on achieving a goal—have received limited attention in the literature. To our knowledge, only the study by Sanchez-Sanchez *et al.* (2018) have addressed this aspect by comparing the physical demands of SSG under fixed-time versus fixed-goal conditions.

Building on this line of research, our results indicate that SSG formats performed under a fixed-goal regime, in which task duration varies according to when goals are scored, elicited greater external demands than fixed-time conditions. These results emphasize the role of bout duration as a

critical constraint influencing players' physical responses during training. Unlike fixed-time formats, which standardize bout and recovery durations, fixed-goal formats introduce variability and competitive urgency that more closely resemble match conditions (Clemente et al., 2019). The inherent unpredictability of these formats can prompt players to adopt more intense and risk-oriented behaviors, simulating match scenarios in which teams are under pressure to score (Sanchez-Sanchez et al., 2018). Research shows that pacing behavior varies based on prior knowledge of task duration, with unknown or shorter durations often leading to more aggressive intensity patterns, characterized by heightened initial efforts and reduced pacing strategies (Ferraz et al., 2020). This increased urgency likely explains the elevated external load observed, as players prioritize immediate goal attainment over pacing strategies typically seen in time-constrained tasks. These findings suggest that outcome-based SSG formats can serve as valuable tools for modulating training load, provided they are strategically integrated within the microcycle to balance variability with recovery and performance goals.

The choice of scoring methods in SSG, such as using mini-goals or regular goals with goalkeepers, represents a key design element that can shape players' tactical behavior and physical responses during training (Clemente et al., 2014). Early research by Casamichana et al. (2011) and Diaz García et al. (2023) reported that mini-goals elicited higher internal loads (heart rate and rating of perceived exertion) than formats with regular goals and goalkeepers

in 4 vs 4 and 8 vs 8 games respectively. Similarly, González-Rodenas et al. (2015) observed greater play intensity in 4 vs 4 mini-goals compared to regular goals, although no differences were found in 6 vs 6 games. More recently, a systematic review suggested that using a single mini-goal in SSG may impose greater physical demands than employing two mini-goals (Mauro Malheiro Maia Junior et al., 2023). In our study, differences between large and small goals were limited to low-intensity decelerations (in fixed-time conditions) and player load (in fixed-goal conditions). Such discrepancies may be explained by other task constraints modulating locomotor responses, including team size and spatial configuration (Clemente et al., 2023; Mauro Malheiro Maia Junior et al., 2023). The higher deceleration rate in SSG_{FT-MG} may reflect the increased technical and tactical demands required to generate scoring opportunities, as mini-goals are smaller and more widely dispersed, encouraging more ball handling, dribbling, and coordinated team actions, as well as greater directional variability due to their dual scoring orientation (Travassos et al., 2014). In contrast, regular goals with goalkeepers promote a more centralized and structured style of play, characterized by compact defensive blocks and reduced attacking options, emphasizing precision over unpredictability (Almeida et al., 2016). Despite these contrasting tactical and technical demands, high-intensity actions did not differ significantly between formats, possibly because the intermittent nature of SSG and the reactive demands of mini-goal play limit sustained high-speed actions. Overall, our findings indicate that while the scoring method may not substantially affect

total external load in 4 vs 4 SSG, it can shape specific movement patterns, such as low-intensity decelerations, which may be relevant when designing training tasks.

Player load is a comprehensive indicator of the mechanical and physiological demands imposed on players, integrating the intensity and volume of accelerations, decelerations, impacts, and changes of direction during play (Oliva-Lozano et al., 2023). In our study, player load was significantly greater in SSG_{FG-GK} than in SSG_{FG-MG}. This may be attributed to regular-goal formats with goalkeepers fostering more dynamic and tactically complex scenarios, characterized by frequent transitions (e.g., rapid goalkeeper restarts) and varied movement patterns, which demand sustained mechanical effort and thus elevate player load (Clemente et al., 2014; Mortatti et al., 2019). Although scoring in these formats occurs through clearly defined targets, their structure increases external load compared to mini-goal games (Katis & Kellis, 2009). This finding contrasts with earlier studies reporting higher physical intensity in mini-goal SSG (Casamichana et al., 2011). Although Castellano et al. (2013) observed no significant differences in external load between mini-goal and regular-goal formats in 7 vs 7 SSG, suggesting that the influence of goal type on physical load is context-dependent, whereas Sanchez-Sanchez et al. (2021) found that, in 4 vs 4 formats, mini-goals elicited greater distances at higher speeds than regular goals with goalkeepers. Mini-goal formats often encourage a more structured attacking style, with longer possessions and compact defensive blocks

near the goal, potentially reducing collective movement and high-intensity actions, which may explain the lower player load in our results (González-Rodenas et al., 2015; Hammami et al., 2017; Sanchez-Sanchez et al., 2021). Ultimately, player load is shaped not by goal type alone, but by the interaction of multiple task constraints—including scoring format, pitch dimensions, defensive strategies, and bout duration—whose combined effects can produce divergent outcomes and limit direct comparison between studies (Bujalance-Moreno et al., 2021).

Despite the differences in external load observed across formats, no significant neuromuscular fatigue was detected in the present study, as reflected by stable 10-m and 30-m sprint times before and after the SSG. These findings contrast with previous research reporting impaired sprint performance following small-sided games involving goalkeepers, such as 3 vs 3 and 6 vs 6 formats (Katis & Kellis, 2009) or after modified formats in youth and amateur players (Bujalance-Moreno et al., 2021; Sanchez-Sanchez et al., 2014). Interestingly, Castillo et al. (2021) demonstrated significant decrements in 30-m sprint performance in youth players after SSG with 6-minutes and 4-minutes bouts, even when using similar individual interaction space (100 m²). Notably, the decline in sprint performance occurred regardless of bout duration, suggesting that pitch size and accumulated neuromuscular demands may be critical factors for fatigue. In contrast, the 4 vs 4 formats used in our study, consisting of short bouts interspersed with 2-minutes recovery

periods and performed under both time-fixed and goal-targeted regimes, did not impair subsequent sprint performance. Several factors may explain this absence of detectable sprint-performance decrement. First, neuromuscular fatigue was assessed only through immediate 10-m and 30-m sprint tests. Although these tests provide practical and field-based indicators of acceleration and maximal sprint performance, they may not capture other fatigue-related responses, such as reductions in vertical jump performance, change-of-direction ability, perceptual fatigue, muscle soreness, or delayed neuromuscular impairment. Second, the SSG stimulus may have been insufficient to induce measurable decrements in linear sprint performance, despite producing differences in external load between formats. The relatively short bout duration, the structured recovery periods, and the intermittent nature of play may have allowed partial physiological and neuromuscular recovery between efforts. Third, the fixed pitch size and the 4 vs 4 format may have constrained the occurrence of sustained high-speed actions, thereby limiting the accumulated neuromuscular stress typically associated with post-exercise sprint-performance decrements. Finally, the scoring format and the presence or absence of goalkeepers may have modified tactical behavior and movement patterns, but these changes did not appear to generate enough fatigue to impair subsequent linear sprint performance. Therefore, under the specific conditions examined, bout-ending mechanism and scoring method influenced external load responses during 4 vs 4 small-sided games in youth soccer players, while no format produced detectable acute

impairment in 10-m or 30-m sprint performance. From a practical standpoint, these findings suggest that short-duration 4 vs 4 SSG formats may be used to modulate acute external load without necessarily compromising immediate linear sprint performance. Nevertheless, given the relatively brief exposure in this study, caution is warranted when extrapolating these findings to longer or more intense protocols, larger pitch areas, different recovery structures, repeated exposures, or fatigue outcomes assessed with complementary measures such as countermovement jump, change-of-direction tests, perceptual responses, or delayed post-exercise assessments.

This study has some limitations. The small, single-team sample of male youth players ($n = 8$) may have reduced statistical power and restricts generalizability to other competitive levels, age groups, and female players. The ecological nature of task design introduced confounders, as the scoring formats also differed in goalkeeper involvement, complicating the isolation of goal type effects. In addition, the fixed pitch size and the relatively short exposure duration may have limited the expression of high-speed running and fatigue responses. Furthermore, each small-sided game format was performed only once, which may have increased the influence of day-to-day variability. Moreover, although total exposure time was similar across formats, external-load variables were reported as absolute values rather than time-normalized outcomes, which may have influenced comparisons of volume-related variables such as total distance and distance covered in

speed zones. The lack of counterbalanced session order and contextual control (e.g., prior training or match load, environmental factors) may also have influenced results. Finally, neuromuscular status was only assessed with immediate pre-post sprints (10-m and 30-m), without complementary markers such as countermovement jump or delayed assessments.

5. Practical Applications.

From a practical perspective, the findings provide relevant insights for coaches. Mini-goal formats elicited lower external loads in the present study, whereas regular goals with goalkeepers generated greater locomotor and mechanical demands. Fixed-time formats standardized load distribution, while fixed-goal formats introduced variability and competitive urgency, enhancing ecological validity. Coaches should therefore select SSG designs according to training objectives, balancing tactical realism with structured load management.

6. Conclusions

In summary, under the specific conditions of this study, bout-ending mechanism and scoring method influenced external load responses during 4 vs 4 SSG in male youth soccer players. The fixed-goal format with regular goals and goalkeepers elicited the greatest locomotor and mechanical demands, while none of the formats produced significant acute decrements in 10-m or 30-m sprint performance. Therefore, fixed-goal, goalkeeper-based formats may be a useful option to increase acute external load

without impairing short-term sprint performance in similar training contexts. However, given the small, single-team sample and the acute repeated-measures design, these findings should not be interpreted as evidence of training-induced performance development or generalized to broader populations. Future longitudinal studies should examine whether these acute responses translate into chronic adaptations, while also considering maturation-related changes, regular sport participation, and natural developmental processes in youth players.

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