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Influence of different 1v1 small-sided game conditions in internal and external load of U-15 and U-12 soccer players

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Abstract

Introduction. Soccer is a complex team sport, in which moments of 1v1 during the game may decide the outcome. Despite this evidence, studies on this particularity are scarce, particularly involving young players. Aim of Study. The purpose of this study was to evaluate variations of internal and external loads in U-15 and U-12 soccer players associated to different small-sided game (SSG) conditions, in the 1v1 context. Material and Methods. Eight male soccer players participated in the study, integrating two groups, U-15 (n = 4) and U-12 (n = 4), monitored in different SSG models (2 minutes duration / 3 minutes interval rest, different pitch size SSG1 = 5 × 10 m; SSG2 = 10 × 15 m; SSG3 = 15 × 20 m). Soccer players carried GPS devices (WIMU PROTM, RealTrack System, Almería, Spain) operating at a sampling frequency of 10 Hz. The Mann–Whitney U test was used to compare groups in each SSG and the Kruskal–FWallis test was applied to compare the different SSGs. The significance level was adopted at $p < 0.05$. Results. Differences between the groups were observed mostly in HR_{mean} and $HR_{95\text{-}max}$. The distance covered (different between the groups, SSG1 197.7 ± ± 14.0 vs 162.3 ± 9.0 and SSG3 261.4 ± 10.6 vs 217.1 ± 27.4, respectively, for U-15 and U-12) and maximal velocity always increased with the increase of the pitch size. Explosive distance and accelerations were also different between the groups in SSG1 and SSG2, respectively. Differences throughout the SSGs were mainly recorded in terms of external load. Conclusions. This research suggests that the implemented 1v1 SSG model is relevant from the internal and external load perspective. Nevertheless, the internal and external loads in U-15 and U-12 soccer players present differences and specificities, which should be considered in exercise prescription and individualized evaluation of young soccer players.

KEYWORDS: soccer, internal load, young players, external load, small-sided game.

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Introduction

Soccer is a team sport of great technical-tactical complexity, in which individual actions can determine the result at a given moment in the game. It is physically a highly demanding sport, that requires an efficient collective organization and simultaneously a specific development of each player based on the individual and group perspective [3]. It is also a team sport, which is associated with complexity in collective and individual actions by the players, which individual characteristics potentially determining the success/ outcome of the game [13].
During a match, players typically cover a distance of 10-13 km, performing 150-250 intense actions (e.g. accelerations/decelerations, changes of direction) interspersed with short recovery periods [4]. Moreover, soccer players perform between 1000 and 1400 movements of 2 to 4 seconds in duration [30]. The

physical conditioning for soccer players is of utmost importance. Soccer is nowadays more intense and physically demanding compared to the beginning of the 21st century and players need to cover about 30% greater distances above the high-intensity threshold [5]. Nowadays in team sports small-sided game (SSG) tasks have become a useful resource in player training at all ages and competitive levels [12], namely because the training process in team sports must provide stimuli to a wide range of physical, tactical and technical components [1]. Consequently, SSGs are often used during training to develop both the physical and technical performance of soccer players [16, 18].

Considering the effects of SSGs in terms of technical actions, it has been consistently found that an increase in the number of technical actions individually performed by players occurs in smaller formats of the game [10]. Moreover, SSGs may offer additional advantages, improving essential neuro-muscular and cognitive skills such as reaction time, decision-making and change-of-direction speed [31], all of which are determinants of success in the soccer game.

These drills facilitate the development of technical-tactical aspects together with relevant physical capacities such as specific endurance, strength-power qualities and agility in a realistic match-related context [26]. Therefore, SSGs are developed under special rules, which basically involve the participation of a reduced number of players interacting in a smaller space compared to the competition format [24].

The implications of different task conditions and their concurrency contribute to changes in acute responses in terms of both internal and external loads [29]. Interestingly, altering playing conditions (e.g. game rules or objectives) and game formats (e.g. the number of players per team and/or pitch size) may change physical (external load) and physiological (internal load) demands imposed on players [8].

At the same time, the intensity of SSGs can widely vary, being higher on larger pitches and with a smaller number of players [16], although the optimal design remains to be determined, particularly in young soccer players near the pubertal phase. Typically, small-to-medium formats (2 vs 2 to 6 vs 6) promote heart rates (HR) between 85 and 90% of the HR_{max} and blood lactate concentrations [La^-] between 4 and 8 $mmol/L^{-1}$ [10]. Moreover, distances covered may vary between 80 and 100 m/min^{-1} at running distances between 6 and 10 m/min^{-1} [11].

Recently, it was stressed that in a soccer academy not only players with greater physical performances should be promoted, but also those with lesser physical performances, particularly when exhibiting greater abilities and skills to play soccer [23], which in our opinion leads to the need for individual evaluation of the training process.

Typically, studies concerning SSGs are predominantly related to small-to-medium formats and do not consider the one that possibly is more predominant in a soccer game and may be a determinant in the outcome of the game, the 1v1 soccer actions. The literature on this subject is scarce and there is no previous research that compares age-group differences between different SSG conditions.

Aim of Study

To evaluate variations of internal and external loads in under 15 and under 12 (U-15 and U-12) soccer players, associated to different SSG conditions in the 1v1 context.

Material and Methods

Eight male soccer players participated in the study, integrating two distinct groups, U-15 (n = 4) and U-12 (n = 4), both including three SSG formats composed of 2-minute play and 3-minute rest in the 1v1 context, with changes in the pitch size between SSGs. The participating players belonged to a training club, catalogued by the Portuguese Football Federation, awarded three stars in the club certification model implemented in Portugal, assuming a zero to top three stars scale by the Portuguese Football Federation evaluation for clubs with only youth teams training and competing, not the senior level.

The club comprises teams from different age-groups competing in the final stages of national championships, together with the best teams in Portugal. In recent years the club may also boast the regular presence of athletes in national youth teams (which compete for international titles at club and national team levels with the best soccer teams in Europe), as well as transfers of athletes to some of the most prestigious Portuguese clubs.

All the players participating in this study usually train four times a week plus one match every weekend. The U-15 training sessions lasted 90 minutes and those for U-12 – 60 minutes. The official games of U-15 consisted in an 11 a-side game with two periods of 35 minutes and the U-12 ones were 7 a-side games with 30 minutes in each of the two periods. This study followed the guidelines indicated in the Helsinki declaration and international ethical standards for sport and exercise science research [17]. Before starting the investigation, the object of the study was explained to the club officials and coaches, authorizations were guaranteed. Parents and players were also informed and their written consent was obtained. Table 1 presents the soccer players' characteristics.

Table 1. Characteristics of soccer players

	U-15 (n = 4)	U-12 (n = 4)
Age (years)	14.71 ± 0.48	11.69 ± 0.52
Height (cm)	1.71 ± 0.04	1.56 ± 0.07
Total body mass (kg)	58.0 ± 7.20	43.98 ± 4.61
Body fat (%)	12.74 ± 0.81	11.95 ± 0.52
Experience (years)	6.5 ± 0.6	9.5 ± 0.5

The study was conducted in the middle of the 2018/2019 competitive season. The tasks were performed on a synthetic grass floor under very good conditions. The training session started with a 20-minute standardized warm-up, consisting of 5 minutes of slow jogging, and strolling locomotion followed by 7 minutes of specific soccer drills, and finishing with 3 minutes of progressive sprints and accelerations. Agility and speed drills were also conducted and a 5-minute ball possession game within a space of 20 × 20 m was also performed.
The participants were free from injury and medical conditions and had not been involved in any type of other physical exercises within 2 days prior to the study. Twenty-four hours prior to the experimental session the players and parents were instructed to maintain their usual habits, which included 8 hours of sleep the night before the data collection session and to maintain the nutritional routine, since it was previously stated that factors such as dehydration may contribute to the development of fatigue in soccer [4].
The SSGs took place with the goal objective on a 1v1 player basis, with mini training goals (2 m width signalized with training cones). Throughout the SSGs colleagues and coaches were around the pitch with soccer balls in their hands to quickly replace the ball each time it left the pitch, ensuring playing time to be completed and identical in all the games. The research team had digital stopwatches to monitor the real time of play in each SSG. During the recovery time periods of the SSGs the players could drink fluids.
Soccer players carried GPS devices (WIMU PRO™, RealTrack System, Almería, Spain) operating at a sampling frequency of 10 Hz. The technology used to collect the GPS data had been previously validated and was shown to be reliable for monitoring soccer players [6]. Participants wore fitted body vests and the GPS device was inserted in a purpose-built harness prior to SSGs.
Before being placed on the players, the GPS devices were calibrated and synchronized following the manufacturer's recommendations [6]. The procedures were as follows: (a) turn on the devices, (b) wait approximately 30 seconds after turning them on, (c) press the button to start recording once the device's operating system is initialized and (d) analyze the data obtained from the devices using the SPRO™ software (RealTrack Systems, Almería, Spain).
The WIMU SPRO calculates the external load indicator used in our study, i.e. player load. Player load is derived from triaxial accelerometers (*x*, *y* and *z*), being used to evaluate neuromuscular load in different athletes.

$$PL_n = \sqrt{\frac{(x_n - x_{n-1})^2 + (y_n - y_{n-1})^2 + (z_n - z_{n-1})^2}{100}}$$

$$Accumulated\ PL = \sum_{n=0}^{m} PL_n \times 0{,}01$$

Players were randomly assigned in the SSGs. During all the games the coach was giving some feedback to the players to encourage them. All the SSGs were conducted in a 1v1 context with 2 minutes of play and 3 minutes of rest (density: work × rest = 1 : 1.5). The pause between the performed SSGs was passive, while the objective during the playing time was always to defend the small goals marked with cones (2 m) in one side and to score

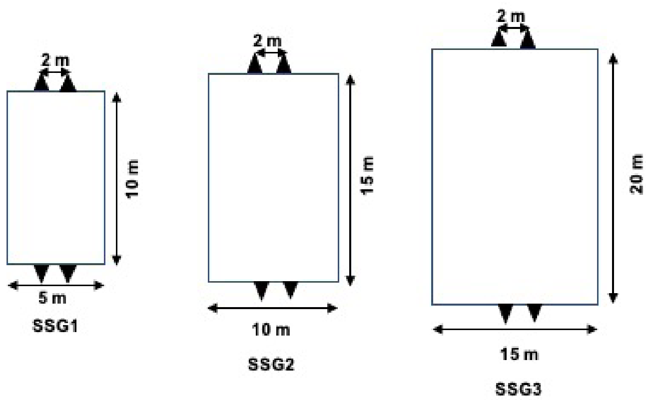

Figure 1. Schematic representation of the experimental protocol

goals in the opposite side. SSG1 presented a 5 × 10 m of pitch dimension (width × length) with an area per player of 25 / 16.66 m^2, SSG2 was characterized by pitch dimensions of 10 × 15 m (width × length) with an area per player of 75 / 50 m^2 and SSG3 was 15 × 20 m pitch dimensions (width × length) with an area per player of 150 / 100 m^2. Figure 1 presents schematically the SSG models used in this study.

The studied variables were distance (total meters covered); explosive distance (distance travelled at more than 12 km/h); player load (effort metric that accumulates tackles, jumps and other non-running activities, enabling visualization of the total amount of movement accumulated during a session); number of accelerations and decelerations; number of impacts (measures G force, to which the body is subject in the different actions of the game) and jumps; maximum velocity and mean velocity.

The normality of the distributions was assessed with the Shapiro–Wilk test. Parametric and nonparametric statistics were selected accordingly. Standard statistical methods were applied to calculate means and standard deviations. The Mann–Whitney U test was used to compare groups in each SSG and the Kruskal–Wallis test was applied to compare SSGs. The significance level was adopted at $p < 0.05$. The data analysis was carried out using the Statistical Package for Social Sciences (SPSS 25.0, SPSS Inc., Chicago, IL, USA).

Results

Under the different SSG conditions for the U-15 and U-12 soccer players differences were mostly observed in HR_{mean} and $HR_{95\text{-}max}$ compared to lower HR zones. Table 2 present the internal load values recorded for the players.

As expected, lower percentages of HR zones (50-60% and 60-70%) were not very evident during the SSGs. In turn, significant differences between the age-groups were recorded in SSG1 in % $HR_{60\text{-}70}$ and in % $HR_{70\text{-}80}$ in SSG2. HR_{mean} was also significantly different between the age-groups in SSG2 and SSG3 and $HR_{>95}$ in all the performed SSGs.

The tendency throughout all the performed SSGs was for the U-15 to show lower values of the HR zone when compared to the U-12, except for $HR_{95\text{-}max}$ and HR_{mean}. Only in HR_{max} significant differences were found between SSG1 and SSG3 ($p < 0.05$).

Another interesting fact was to observe that the $HR_{95\text{-}max}$ and HR_{mean} stabilized or even decreased between SSG1 and SSG2, to increase in SSG3, which reveals that the duration of the different SSGs and the recovery time

Table 2. Internal load values in the two groups during three performed SSGs

		SSG1			SSG2			SSG3		
		M ± *SD*	*CI* (95%)	*p*	*M* ± *SD*	*CI* (95%)	*p*	*M* ± *SD*	*CI* (95%)	*p*
HR_{max} p = 0.050*	U-12	189.50 ± 1.91	186.45-192.55	0.206	193.75 ± 3.30	188.49-199.01	0.283	195.75 ± 3.30	190.49-201.01	0.073
	U-15	196.75 ± 11.14	187.43-296.07		200.00 ± 7.21	193.97-206.03		201.5 ± 5.31	197.05-205.95	
HR_{mean} p = 0.082	U-12	174.50 ± 3.31	169.22-179.77	0.099	176.75 ± 3.59	171.03-182.46	0.018*	181.50 ± 4.65	174.52 ± 188.91	0.028*
	U-15	186.75 ± 11.39	177.22-196.27		188.25 ± 10.51	179.46-197.03		190.75 ± 5.77	185.92-195.57	
$HR_{60\text{-}70}$ (%) p = 0.060	U-12	5.89 ± 5.00	–2.06-13.85	0.002**	0 ± 0	0 ± 0	0.515	4.04 ± 4.71	–3.46-11.54	0.091
	U-15	0 ± 0	0 ± 0		2.58 ± 4.78	–1.41-6.58		0 ± 0	0 ± 0	
$HR_{70\text{-}80}$ (%) p = 0.197	U-12	4.82 ± 2.31	1.14-8.50	0.162	12.68 ± 6.51	2.31-23.04	0.010**	4.80 ± 2.10	1.46-8.15	0.184
	U-15	3.65 ± 6.76	–2-9.31		1.94 ± 2.86	–0.44-4.34		2.45 ± 3.61	–0.56-5.47	
$HR_{80\text{-}90}$ (%) p =0.815	U-12	6.71 ± 1.63	4.11-9.32	0.109	11.45 ± 9.17	–3.59-25.6	0.535	6.16 ± 2.05	2.89-9.42	0.204
	U-15	4.64 ± 2.88	2.23-4.79		6.19 ± 4.66	2.29-10.09		3.70 ± 2.68	1.45-5.94	
$HR_{90\text{-}95}$ (%) p = 0.188	U-12	8.11 ± 3.66	2.27-13.95	0.109	3.75 ± 1.93	0.66-6.83	0.782	4.98 ± 3.43	–0.47-10.44	0.778
	U-15	3.22 ± 2.02	1.52-4.91		2.83 ± 1.13	1.87-3.78		4.63 ± 2.21	2.79-6.47	
$HR_{>95}$ (%) p = 0.162	U-12	74.45 ± 4.64	67.06-81.83	0.051*	72.56 ± 7.63	60.41-84.70	0.051*	80.00 ± 5.83	70.71-89.28	0.051*
	U-15	88.55 ± 9.84	80.32-96.78		86.44 ± 9.58	78.91-93.96		89.21 ± 5.43	84.69-93.73	

* statistical significance ($p < 0.05$); ** statistical significance ($p < 0.01$)

Table 3. External load values in the two groups during three performed SSGs

		SSG1			SSG2			SSG3		
		M ± *SD*	*CI* (95%)	*p*	*M* ± *SD*	*CI* (95%)	*p*	*M* ± *SD*	*CI* (95%)	*p*
Distance (m) p = 0.000**	U-12	162.31 ± 9.02	147.95-176.68	0.004**	195.00 ± 28.12	150.45-239.95	0.352	217.14 ± 27.41	173.57-260.71	0.018*
	U-15	197.75 ± 13.96	186.02-209.37		206.89 ± 11.87	196.97-216.81		261.43 ± 10.64	252.56-270.29	
Explosive distance (m) p = 0.029*	U-12	37.06 ± 2.76	32.65-41.47	0.018*	46.44 ± 5.07	38.32-54.47	0.533	53.07 ± 6.48	42.75-63.39	0.099
	U-15	48.91 ± 11.64	39.18-58.65		50.88 ± 11.76	41.04-60.71		63.62 ± 12.40	53.25-73.99	
Accelera-tions p = 0.018*	U-12	59.09 ± 4.65	59.09-73.91	0.558	58.67 ± 9.38	43.07-72.93	0.046*	59.86 ± 7.74	46.67-71.33	0.436
	U-15	66.57 ± 7.30	60.39-72.61		69.43 ± 5.07	64.76-73.24		61.75 ± 5.92	56.80-66.70	
Decelera-tions p = 0.040*	U-12	66.52 ± 4.21	59.81-73.19	0.558	58.25 ± 9.64	42.97-73.53	0.099	59.76 ± 7.74	46.74-71.26	0.455
	U-15	66.75 ± 6.81	61.01-72.49		69.17 ± 5.82	64.15-73.85		62.25 ± 5.77	57.42-67.08	
Max sprint p = 0.007**	U-12	15.23 ± 0.41	14.57-15.88	0.099	19.44 ± 0.65	18.44-20.47	0.204	19.82 ± 0.37	19.23-20.41	0.202
	U-15	18.23 ± 2.63	16.03-20.43		17.59 ± 2.14	15.81-19.38		21.01 ± 1.49	19.76-22.26	
Mean sprint p = 0.000**	U-12	5.06 ± 0.21	4.71-5.41	0.099	6.06 ± 0.68	4.97-7.15	0.352	6.46 ± 0.69	5.36-7.56	0.109
	U-15	5.56 ± 0.55	5.09-6.02		5.72 ± 0.18	5.57-5.87		7.07 ± 0.36	6.76-7.37	
Impacts p = 0.041*	U-12	101.75 ± 23.44	64.45-139.05	0.525	96.75 ± 8.65	82.98-110.52	0.206	120.25 ± 8.53	106.66-133.84	0.529
	U-15	111.77 ± 26.49	88.85-133.15		117.56 ± 27.81	94.26-140.74		138.5 ± 32.43	111.39-165.61	
Jumps p = 0.758	U-12	0.75 ± 0.95	–0.77-2.27	1.000	1.02 ± 1.15	–0.84-2.84	0.758	–	–	0.051*
	U-15	0.75 ± 0.88	0.01-1.49		0.75 ± 0.88	0.01-1.49		1.50 ± 1.19	0.50-2.50	
Player load$_{vol}$ p = 0.100	U-12	4.09 ± 0.23	3.70-4.47	0.042*	4.27 ± 0.29	3.80-4.74	0.109	4.68 ± 0.29	4.21-5.15	0.099
	U-15	4.52 ± 0.41	4.17-4.87		4.76 ± 0.46	4.31-5.08		5.14 ± 0.59	4.65-5.63	
Player load$_{int}$ p = 0.082	U-12	1.93 ± 0.09	1.78-2.07	0.024*	2.03 ± 0.11	1.84-2.22	0.206	2.24 ± 0.14	2.01-2.48	1.000
	U-15	2.13 ± 0.17	1.98-2.27		2.14 ± 0.23	1.94-2.34		2.38 ± 0.22	2.12-2.48	

* statistical significance (p < 0.05); ** statistical significance (p < 0.01)

periods (the implemented protocol) provided a favorable physiological adaptation with a decline in HR, and then an increase in SSG3, where the dimensions of the pitch size were greater (15 × 20 m) compared to SSG2 (10 × 15 m).

External load values of the soccer players are presented in Table 3.

It was noticed that the distance covered by the players always increased with the increase of pitch size. In SSG1, when analyzing the variables of distance covered, explosive distance, player load volume and player load intensity significant differences were observed between U-15 and U-12 soccer players. In contrast, in SSG2 significant differences between the age-groups were only observed in accelerations, while in SSG3 it was in distance covered and jumps.

In all the SSGs the U-15 players covered more distance and presented more accelerations, declarations and explosive distance compared to the U-12. In all these variables, as well as maximal velocity, average velocity and impacts, significant differences were observed when all the games were compared.

Average and maximal velocity also rose in line with the increase in pitch size, with the exception in the U-15 regarding the transition between SSG1 and SSG2 in the average velocity. As far as decelerations are concerned, no trend was evident throughout the SSGs, but the number of actions was always higher in U-15 when compared to U-12 soccer players. In accelerations no clear trend was also observable, with the number of actions being very balanced between the groups, except for SSG2, where significant differences were observed (69.0 ± 5.1 and 58.0 ± 9.3 for U-15 and U-12, respectively).

Discussion

To the best of our knowledge, this is the first study to monitor internal and external loads under different SSG conditions, specifically with young soccer players (U-15 and U-12) in a 1v1 context. The main findings of this study were that the performance of three SSGs of 2 minutes in duration and a 3-minute rest (different pitch sizes of 5 × 10 m, 10 × 15 m and 15 × 20 m, respectively) allow U-15 and U-12 soccer players to display a high level and increasing performance throughout all the SSGs. However, the internal and external loads in U-15 and U-12 soccer players presented differences in certain variables of internal and external loads, which needs to be considered in exercise prescription between different player soccer age-groups, and whenever possible, indicate an individualized evaluation of young soccer players.

From the physiological point of view, in terms of the internal load during all the performed SSGs the U-15 players tended to have lower values for % HR zone (from 50 to 95%) when compared to the U-12, except for $HR_{95\text{-}max}$ and HR_{mean}. It should be noted that significant differences in HR throughout all the three SSGs were only recorded in HR_{max}. Nevertheless, values below the $HR_{90\text{-}95}$ were residual, in both age-groups and in all the performed SSGs, confirming that the physiological demand of SSGs in young soccer players is very relevant. This fact is very important for physiological adaptations in soccer training session routines, since attainment of VO_{2max}, despite being individual, is commonly associated to exercise durations of min. 2 minutes. Previously it was indicated that 98% of the total VO_{2max} is attained at four times the time constant of the primary phase of VO_2 kinetics [14], which in athletes is commonly below 30 seconds (evidence in high level athletes indicates it is below 20 seconds), so it is reasonable to speculate that in soccer, 2 minutes of exercise duration provide the possibility to attain VO_{2max}, and consequently, aerobic adaptations. These authors also confirmed that approximately 82% of VO_{2max} did not induce an appreciable rise in $[La^-]$, a fact that in our perspective enables young soccer players to perform during 2 minutes in high level. It was also previously observed no effect of duration from 2 to 6 minutes for technical actions suggesting that these different durations can be used interchangeably in terms of technical proficiency [15].

Regarding this topic, it was indicated that the higher physiological strain typically observed in SSGs on larger pitches is likely to be due to the possibility to make longer offensive and defensive runs [25]. Also in a recent study it was observed in recreational soccer players that HR_{max} and HR_{mean} as well as time spent with HR above 90% of HR_{max} were higher during 5 vs 5 with 80 m^2 compared to 60 m^2 per player [22].

Interestingly, in our study it was observed that the $HR_{95\text{-}max}$ and HR_{mean} stabilized or even decreased between SSG1 and SSG2 (respectively 5 × 10 m and 10 × 15 m), then increasing in SSG3 (15 × 20 m). This reveals that the time duration of the different SSGs and the recovery time periods (all SSGs of 2 minutes with a 3-minute rest interval) allowed, in the first phase, a favorable physiological adaptation with a decline in HR, followed by an increase in SSG3, where the dimensions of the pitch were greater compared to SSG2.

This fact is particularly important, since coaches of young soccer players should ensure that players are given the appropriate stimuli for capacity development, particularly from the physiological point of view in the near pubertal and post pubertal career phases. Recently, this idea was corroborated with a more global perspective [29], indicating that the actual challenge for researchers is to align these new measures with the needs of coaches through a more integrated collaboration between coaches, practitioners and researchers, to produce practical and useful information that improves player's performance and coach activity.

Our results also suggest that, with respect to players' external loads, the distances covered by the players are proportional to the increase of the pitch size both in U-15 and U-12 soccer players. Despite this fact, in SSG2 no significant difference was observed between both soccer player age-groups. Nevertheless, in all the SSGs the U-15 players covered more distance compared to the U-12, the same was observed in explosive distance, whereas only in SSG1 significant differences were observed. This suggests that at smaller pitch dimensions, although the total distance is different between younger and older soccer players (in this specific case U-15 and U-12), the more vigorous actions in soccer differ depending on to the maturation phase of the players.

We should highlight here that in our perspective the individual characteristics of the players in this pre-pubertal (U-12) and post pubertal (U-15) phase contribute to the difference in the SSG dynamics, in parallel with factors such as the years of experience, the total weekly time of training practice as well as the duration and dimensions of the official weekly games, all of which should be considered with caution in the prescription of training tasks by soccer coaches.

Several studies, the majority with 3v3 or more players, have been conducted to examine a wide variety of different training variables for SSGs, such as player numbers [9] and pitch size [7]. These specific tasks are commonly used as a training drill by coaches to develop the physical fitness [26] or technical and tactical abilities of soccer players [21]. Fanchini et al. [15] tested the 3v3 format in three regimens and found that long sets (3 × 6 minutes / 2 minutes rest) contributed to a drop in HR responses compared to medium (3 × 4 minutes / 2 minutes rest) and short (3 × 2 minutes / 2 minutes rest) sets, although no significant differences were observed for perceived effort or technical actions. Köklü et al. [19], when comparing internal and external load variations in young players between training regimens, observed that shorter sets elicited a lower maximal HR, a shorter distance covered at low running speed and contributed to an increase in the distances covered at both medium and high running speeds.

Our results showed that the average and maximal velocity tend to rise independently of the regimens (work × rest = = 1 : 1.5, 2 minutes work and 3 minutes rest, respectively) in the three performed SSGs tasks, indicating that the main factor influencing the sprint is the pitch size, which lead the young soccer players (both U-15 and U-12) to always show more maximal velocity between SSG1 and SSG3 [except for the U-15 in the transition between SSG1 (5 × × 10 m) and SSG2 (10 × 15 m) in the average velocity, with a slightly decrease]. This fact seems to be associated with the limitation of SSGs in producing high-speed activities when played on smaller pitch areas (such as 5 × 10 m or 10 × 15 m compared to 15 × 20 m), where the players do not have enough space to reach their maximal sprinting speed for a relevant period of time.

Likewise, as previously indicated, the distance and explosive distance rose from SSG2 to SSG3 in both age-groups of soccer players, but the accelerations and decelerations from SSG2 to SSG3 decreased in the U-15 soccer players, but not in their U-12 colleagues, where the number of actions remained stable. Considering that in U-15 between SSG1 and SSG2 both accelerations and decelerations rose, but this trend was not evident in U-12 (a decrease from SSG1 and SSG2) the increase in distance from SSG2 to SSG3 in both groups may have been related metabolically to the aerobic pathway, since it is clear that glycolytic reserves are limited, and the increase in accelerations and decelerations between SSG1 and SSG2 only in U-15 is probably related to the muscular development in the U-15 maturation phase compared to the U-12. The significant difference observed in accelerations between U-15 and U-12 in SSG2 supports this evidence and lead us to consider that changes in external load in soccer are more relevant and associated to the tasks compared to the monitoring of HR. When differences between SSGs were analyzed in terms of external load, no differences were observed only in jumps and player load (both volume and intensity). Contrary to internal load, in which a significant difference between SSGs was found in HR_{max}, the significant differences throughout all SSGs in distance covered, accelerations, declarations, explosive distance, maximal velocity, average velocity and impacts, revealed that the dynamic related to external load during the three performed SSGs is greater compared to internal load.

Moreover, Rábano-Muñoz et al. [23] recently studied the SSGs with different soccer player age-groups (senior, U-19 and U-17), concluding that this forms of games in the training routine could be an adequate stimulus for aerobic training of these age-groups because the reported values were close to the 80-85% of HR_{max}. Previous evidence also indicates that young soccer players experience negative outcomes relating to physical performance [2] and hormonal profile [20] during periods of higher density training [28], which require careful balancing of workloads in the younger individual. SSGs can facilitate this balance by providing a multidimensional approach to addressing the diverse demands of soccer play [27].

This study had some limitations. The sample was not large, thus the inferences should be taken cautiously. Moreover, in the future it will be useful to analyze alongside with internal and external load also the tactical behavior of players combining such variables with technical performance in order to understand the outcomes. Nevertheless, the results of this study are pertinent for improving training practices that integrate SSGs in U-15 and U-12 soccer players, aiming at the young soccer player development. Further studies may include maturation assessment of players, as well as the maximal velocity of each player to determine the percentage exhibited in each SSG format. It could also be interesting to determine repeated sprint ability of the players aiming at a comparison with the physical performance displayed in each SSG format.

Conclusions

The findings of this study suggest that SSGs in U-15 and U-12 soccer players are useful daily training tools for physiological and motor enhancement. SSGs performed in the beginning of the soccer training session, after the warm-up, of 2 minutes in duration with a 3-minute rest interval in three consecutive different pitch dimensions

(5 × 10 m, 10 × 15 m and 15 × 20 m), allow young soccer players to perform at a high level and, consequently, to prepare for transfer to the competition level.

The physiological and motor display seems associated with the increase in the pith size, but tasks below 15 meters should be carefully analyzed, because the lack of space influences sprint capacity. Training prescription in soccer between different age-groups should be carefully analyzed and whenever possible, evaluated from an individual perspective, since performance levels differ between U-15 and U-12 soccer players.

External load measures should be considered in training monitoring in youth soccer, since HR alone does not provide reliable information regarding players' adaptations to the tasks. SSGs are useful in young soccer players but should be implemented in the training sessions with caution, since the physiological and motor enhancement may cause excessive physical and cognitive stress, which in turn can result in burnout and/or injury in young soccer players.

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Conflict of Interests

The authors declare no conflict of interest.

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