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Physiological and physical effect on U-12 and U-15 football players, with the manipulation of task constraints: field size and goalkeeper in small-sided games of 4x4 players

Efecto fisiológico y físico en los jugadores de fútbol Sub-12 y Sub-15, con la manipulación de las restricciones de tareas: tamaño de campo y portero en juegos reducidos de jugadores 4x4

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Abstract

Our study aimed to verify whether the task constraints manipulation has different effects according to age group. Another objective was to verify the physiological and physical responses in the different formats of small-sided games (SSG). Each team in the SSGs was composed of 4 players (4x4). The participants in the research were young football players U-12 (n=8) and U-15 (n=8), affiliated with a club certified as a training entity, and competing, respectively, in the 7 and 9-a-side regional football championships and the national championship of Portugal. The internal and external load data was collected in 5 formats of SSGs with three field sizes and in 2 used goalkeepers. We used the WIMU PRO™ inertial device for data collection. The registration of the internal charge, using heart rate (HR), was performed with the use by the players of Garmin bands, which send the data to WIMU PRO™ devices, through of Ant+ technology. The variance analysis (ANOVA) was used to verify the differences between SSGs and the effect size was determined by calculating partial eta-square (η_p^2) . Comparisons between the two age groups were evaluated using standardized differences with combined variance(Cohen's d). The results show that the manipulation of the playing areas and the use of goalkeepers participation promoted different effects in the two age groups in terms of distance, explosive distance, accelerations/decelerations and maximum sprint. As for the comparison between SSGs we found differences in the level of external load (distance, accelerations/decelerations and maximum sprint). At the level of internal load, the effects were more evident with field areas above 100m2. We can conclude that the task constraints manipulation, playing area and goalkeeper participation, promote different physical and physiological responses, and the coach should consider this fact, as well as the effects promoted in the age groups.

Key words: Small-sided games; task constraints; external load control; internal load control; youth football.

Resumen

Nuestro estudio tenía como objetivo verificar si la manipulación de las restricciones de tareas tiene diferentes efectos según el grupo de edad. Otro objetivo era verificar las respuestas fisiológicas y físicas en los diferentes formatos de juegos reducidos y acondicionados (SSG). Cada equipo en los SSGs fue compuesto de 4 jugadores (4x4). Los participantes en la investigación son jóvenes jugadores de fútbol Sub-12(n=8) y Sub-15(n=8), afiliados a un club certificado como entidad de entrenamiento, y compitieron, respectivamente, en los campeonatos regionales de fútbol 7 y 9 y en el campeonato nacional de Portugal. Los datos de carga interna y externa se recopilaron en 5 formatos de SSG con tres tamaños de campo y en 2 porteros usados. Utilizamos el dispositivo inercial WIMU PRO™ para la recopilación de datos. El registro de la carga interna, utilizando la frecuencia cardíaca (FC), se llevó a cabo con el uso por parte de los jugadores de bandas Garmin, que envían los datos a dispositivos WIMU PRO™, a través de la tecnología Ant+. El análisis de varianza (ANOVA) se utilizó para verificar las diferencias entre SSG y el tamaño del efecto se determinó calculando eta-cuadrado parcial (η_p^2). Las comparaciones entre los dos grupos de edad se evaluaron utilizando diferencias estandarizadas con varianza combinada (d de Cohen). Los resultados muestran que la manipulación de las áreas de juego y el uso de porteros promovieron diferentes efectos en los dos grupos de edad en términos de distancia, distancia explosiva, aceleraciones / desaceleraciones y sprint máximo. En cuanto a la comparación entre SSG encontramos diferencias en el nivel de carga externa (distancia, aceleraciones /desaceleraciones y sprint máximo). A nivel de carga interna, los efectos fueron más evidentes con áreas de campo por encima de 100m2. Podemos concluir que la manipulación de restricciones de tareas, área de juego y participación de portero, promueve diferentes respuestas físicas y fisiológicas, y el entrenador debe considerar este hecho, así como los efectos promovidos en los grupos de edad.

Palabras clave: juegos reducidos y acondicionados; restricciones de tareas; control de carga externa; control de carga interna; fútbol juvenil.

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Introduction

Small-sided games (SSGs) are exercises that coaches plan for the training session, modifying and using constraints according to the training goal (Sannicandro & Cofano, 2018). The correct manipulation of the task constraints (number of players, pitch area, rules, goals and training regime) allows the coaches to use the SSGs for physical, technical and tactical training (Clemente et al., 2014; Michailidis, 2013; Sarmento et al., 2018).

Studies have been conducted in different youth football age-groups, aiming to analyze the physical and physiological effects of manipulating the task constraints (Bujalance-Moreno et al., 2019; Sarmento et al., 2018). Monitoring the training load is essential to examine the individual responses of the players (Alemdaroğlu, 2020) and to maximize positive results of the training process (Curtis et al., 2020), being important in training with youth football age-groups, considering the various stages of the football player career. The effects of the training load resulting from the practice of SSGs are measured by the external and internal load. The external load reflects the physical performance (locomotor demands - distance, acceleration effort and non-locomotor activities - explosive actions), which promote responses in the internal load (physiological – heart rate, biomechanical and psychological) (Curtis et al., 2020; Impellizzeri et al., 2019). Accelerations as a result of gravity, movements in the horizonal plane and rotational movements are an important indicator of the neuromuscular load of training and competition (Reche-Soto et al., 2020).

Task constraints manipulation promotes differentiated effects in different age groups (López-Fernández et al., 2020; Martone et al., 2017; Nunes et al., 2020; Olthof et al., 2018). Recently, Nunes et al. (2020) verified in 4x4 SSG, manipulating the game areas (small, medium and large), an increase in external load (distance, maximum speed) in the U-11 age group, while in the U-15 and U-23 age groups the differences were not significant. Also, López-Fernández et al. (2020) verified, in the practice of 4x4 SSG, changes in the level of external (distance, maximum speed, accelerations and decelerations) and internal (HR_{max} and HR_{mean}) load, considering different age groups (U-14, U-16 and U-18). It was possible to observe statistically significant differences in accelerations and decelerations (>2.75 m/s^2) (U-14 vs. U-16; U-14 vs. U-18) and HR_{max} (U-14 vs U-16; U-16 vs U-18). Moreover, Olthof et al. (2018) found statistical differences in U-13, U-15, U-17 age groups and also U-19, in small and large games, in the practice of 4x4 SSG with goalkeepers (GK). It should be emphasized that the distance covered in high intensity increased with the increasing age of the players, in small and large games. However, sprint values increased from U-13 to U-15, but not in the U-17 and U-19 age groups. Martone & colleagues (2017) also notice that the increase in the playing area in SSGs affects the intensity of exercise in youth football players, when comparing U-12 to U-14 age groups.

Larger playing areas in SSGs promote the increase of physiological responses, such as heart rate (HR) (Bujalance-Moreno et al., 2019; Clemente et al., 2014; López-Fernández et al., 2018, 2020; Rampinini et al., 2007), and this fact is more evident in areas greater than 100 m^2 (Sarmento et al., 2018). Smaller game areas promote more braking, accelerations and changes of direction (Clemente et al., 2012; Martin-Garcia et al., 2019). Studies have found that at the level of external load, the increase in playing areas in SSGs promotes the increase of the distance covered, the distance covered at high intensity and the maximum speed (Martin-Garcia et al., 2019; Nunes et al., 2020; Olthof et al., 2018), which indicates that the pitch size influences the player's workload (Bujalance-Moreno et al., 2019).

Regarding the GK participation in SSGs, it was verified a decrease in the HR response associated to the practice of SSGs without GK participation (Koklu et al., 2015). Furthermore, Castellano et al (2013) found that in SSGs with GK there is a decrease in distance covered and distance covered at high intensity (>21Km/h) compared to SSGs without GK participation. However, Gaudino et al. (2014) verified an increase in total distance covered, very high speed (19.8–25.2 km/h) and maximum speed (>25.2 Km/h). With the participation of GKs in SSGs, it was also indicated in the literature that there is an increase in accelerations and decelerations (Castellano et al., 2013; Gaudino et al., 2014).

In short, we can verify that task constraints manipulation has different effects on the age group football players, and that the manipulation of the variable pitch dimension and the use or not of the GK seems to influence the internal and external load. In this basis, the aim of this study was to verify the internal and external load variations in two football players age groups (U-12 and U-15), related to the practice of SSGs with different pitch size and the participation, or not, of GK. The hypotheses of the study were: 1) task constraints manipulation has different effects according to the age of the players; 2) the increase in the playing area promotes the increase of internal and external load (distance, explosive distance, maximum sprint); 3) the use of GKs has a negative effect on internal and external load (distance, explosive distance and maximum sprint); and finally 4) the playing areas reduction and the introduction of GK participation increases the number of accelerations and decelerations.

Methods

Participants

Players U-12 (*n*=8) and U-15 (*n*=8) of a young football team certified as a training entity by the Portuguese Football Federation participated in the study. U-12 players had 7 years of experience in football and competed in the regional football championship and U-15 players had 10 years of practice and competed in the national championship of Portugal. The study considered all ethical aspects enshrined in the Helsinki declaration (Harriss & Atkinson, 2011), informed consents associated to the participants were also obtained.

Assessment Procedures

We used the WIMU PRO™ (RealTrack Systems, Almeria, Spain) inertial devices for data collection. The WIMU PRO™ consists of different sensors, having been certified by FIFA: four triaxial accelerometers (1000 Hz) with a full-scale output range of ±16, ±16, ±32, and ±400 g; three triaxial gyroscopes (1000 Hz) with a full-scale output range of 2000 degrees/seconds; a three-dimensional magnetometer; a 10 Hz GPS chip; and, a 20 Hz UWB chip (Granero-Gil et al., 2020). The external load was collected through GPS data tracking with a sampling frequency of 10 Hz and the movement data through the WIMU accelerometers with sampling frequency of 100 Hz (Bastida Castillo et al., 2018; Gómez-Carmona et al., 2018). HR registration was performed with the use by the players of Garmin bands (Garmin Ltd., Olathe, Kansas, United States), which send the data to WIMU PRO™ devices, using Ant+ technology (Molina-Carmona et al., 2018).

The studied variables at the level of internal load were the maximum heart rate - HRmax (bpm) and mean heart rate - HRmean (bpm).

About external load, the following variables were analyzed: distance (meters) - total meters covered; explosive distance (meters) - distance travelled at more than 12 km/h; accelerations/decelerations - number of accelerations (ac) and decelerations (dec) and maximum sprint (Km/h) - maximum sprint recorded. Impacts measures G force to which the body is subject ed in the different actions of the game (Román et al, 2019).

Preliminary Procedures

An hour before the training practice the research team arrived at the training center, with the WIMU PRO™ apparatus prepared and identified. Before placing the devices on the players, GPS´s were calibrated and synchronized using the following procedures (Bastida-Castillo et al., 2019): WIMU´s were turned on, afterward we waited about 30 seconds after being turned on, and pressed the button to start recording as soon as the system's operating system was booted. Subsequently, all data was analyzed using the WIMU SPRO software (WIMU SPRO, Almería, Spain).

The inertial device was placed in a Wimu-specific vest, adjusted to the players' bodies and according to the games, located on the back (back of the upper trunk).

Data collection was performed in training environmental, in the regular schedule training routine. The players were involved in a 15 minutes warm-up before the start of practice of the SSGs.

Table 1. Small-sided games characterization

SSG	Number	Pitch dimensions (Width x length)	Area per player (m^2)	Time	Rest
1	4x4	16 m x 24 m	48 m^2	3 min.	3 min.
2	4x4	20 m x 30 m	75 m^2	3 min.	3 min.
3	GK+4x4+GK	20 m x 30 m	60 m^2	3 min.	3 min.
4	4x4	24 m x 36 m	108 m^2	3 min.	3 min.
5	GK+4x4+GK	24 m x 36 m	86.4 m^2	3 min.	-

Note. Density (work x rest) = 1:1

SSG 1, 2 and 4 were forms of play that manipulate the size of the pitch and the objective was to maintain ball possession. In SSG 3 and 5, we manipulate the conditioning size of the pitch and introduce the use of GKs, and the objective was to score goals and don't concede.

Statistical Analysis

Data analysis was performed descriptively, using the mean (*M*) and standard deviation (*SD*). The normality of data distribution was tested using the Shapiro Wilk test, since it is recommended for an n<30. The variance analysis (ANOVA) was used to verify the differences between SSGs, at the level of the internal and external load studied variables, for a degree of significance of $p<0.05$. The effect size was determined by calculating partial eta-square (η_p^2) (Levine & Hullett, 2002). Effect size is considered small (η_p^2 <0.06), moderate (0.06≤ η_p^2 <0.15), or large (η_p^2 ≥0.15) (Cohen, 1988). The post-hoc Bonferroni test was also performed in order to verify which pairs of means were significantly different ($p<0.05$). The statistical analysis was performed using the *IBM SPSS Statistics 24*.

Comparisons between the two age groups (U-12 and U-15) were evaluated using standardized differences with combined variance, derived from the *M* and *SD* of each variable, with 95% confidence intervals. The statistical limits for the effect sizes (Cohen's *d*) were trivial (0-0.2), small (0.2-0.6), moderate (0.6-1.2), large (1.2-2), very large (2-4) and extremely large (>4) (Hopkins et al., 2009).

Results

The results presented are related to the demands of external and internal load, associated to the practice of five formats of 4x4 SSGs, where the constraint pitch size and GK participation were manipulated. Table 1 refers to the comparison between the two groups (U-12 & U-15) in the five SSG formats.

Table 2. Variability in external and internal load, in the age groups, considering the different SSGs

SSG	Variable	U-12 *M±SD*	U-15 *M±SD*	Effect Size (Cohens's *d*)	*95% CI [LL; UL]*
1	Distance	294.82±17.13	361.15±29.21	2.77	[1.40;4.14]
	Exp Dist	52.65±5.87	70.76±10.73	2.09	[0.87;3.31]
	AC	86.88±5.77	84.38±5.93	-0.43	[-1.42;0.56]
	DEC	86.88±5.67	84.00±6.09	-0.49	[-1.48;0.51]
	Max Sprint	16.22±1.37	19.13±1.47	2.04	[0.83;3.25]
	Impacts	120.88±65.83	142.13±20.99	0.43	[-0.56;1.43]
	HRmax	184.63±10.14	185.13±11.68	0.05	[-0.93;1.03]
	HRmean	171.13±10.74	175.75±10.99	0.43	[-0.57;1.42]
2	Distance	323.36±23.98	392.54±23.18	2.93	[1.52;4.34]
	Exp Dist	53.57±5.71	69.68±7.34	2.45	[1.15;3.75]
	AC	107.00±6.09	79.00±3.93	-5.46	[-7.59;-3.33]
	DEC	107.00±6.09	79.25±3.96	-5.40	[-7.51;-3.29]
	Max Sprint	17.60±0.69	18.61±1.56	0.84	[-0.18;1.86]
	Impacts	131.38±61.65	150.13±8.36	0.39	[-0.60;1.38]
	HRmax	189.50±7.65	191.00±7.29	0.20	[-0.78;1.18]
	HRmean	172.63±10.46	178.50±9.34	0.59	[-0.41;1.59]
3	Distance	310.64±9.23	366.66±35.42	2.16	[0.93;3.40]
	Exp Dist	63.92±6.01	72.14±7.91	1.17	[0.11;2.23]
	AC	95.13±6.69	82.38±8.37	-1.68	[-2.82;-0.54]
	DEC	95.25±6.90	82.75±8.58	-1.61	[-2.73;-0.48]
	Max Sprint	18.80±1.74	22.85±2.97	1.66	[0.53;2.80]
	Impacts	123.63±47.70	136.38±17.77	0.35	[-0.63;1.34]
	HRmax	189.88±5.69	187.13±7.43	-0.42	[-1.41;0.58]
	HRmean	174.13±7.85	175.00±9.50	-0.10	[-0.88;1.08]
4	Distance	341.46±14.62	413.78±26.12	3.42	[1.88;4.95]
	Exp Dist	57.83±12.03	71.27±7.44	1.34	[0.26;2.43]
	AC	89.00±7.86	76.88±4.19	-1.93	[-3.11;-0.74]
	DEC	88.38±7.71	77.00±4.60	-1.79	[-2.95;-0.63]
	Max Sprint	18.73±1.02	20.41±2.41	0.91	[-0.12;1.94]
	Impacts	128.13±61.48	163.88±30.78	0.74	[-0.28;1.75]
	HRmax	192.75±6.96	191.50±6.99	-0.18	[-1.16;0.80]
	HRmean	177.63±9.36	177.38±8.91	-0.03	[-1.01;0.95]
5	Distance	340.01±34.89	394.61±23.12	1.84	[0.67;3.01]
	Exp Dist	63.20±13.43	74.42±5.81	1.09	[0.04;2.13]
	AC	97.38±8.02	74.75±5.20	-3.35	[-4.87;-1.83]
	DEC	97.25±7.78	74.13±5.17	-3.50	[-5.06;-1.94]
	Max Sprint	20.15±2.13	21.17±1.65	0.54	[-0.46;1.53]
	Impacts	125.88±49.68	154.88±30.16	0.71	[-0.30;1.72]
	HRmax	190.63±9.07	190.38±8.14	-0.03	[-1.01;0.95]
	HRmean	173.50±9.90	179.38±8.12	0.65	[-0.36;1.65]

Note. Exp Dist – Explosive Distance; AC – accelerations; DEC – decelerations

In SSG1 (4x4 - 16x24 m), we found that the U-15 age group presented higher values in all the studied variables, except AC and DEC. We could also observe in the comparison between age groups, a very large effect size for total distance (ES = 2,77), explosive distance (ES = 2,09) and maximum sprint (ES = 2,04).

In SSG2 (4x4 - 20x30 m), SSG3 (GK+4x4+GK - 20x30 m), SSG4 (4x4 - 24x36 m) and SSG5 (GK+4x4+GK - 24x36 m) we observed a higher value of accelerations and decelerations in the U-12, while higher values were recorded for the U-15s in the remaining variables, except HR_{max} in SSG3, SSG4 and SSG5 and also HR_{mean} in SSG4.

In SSG2, we verified a very large effect size, according to age groups, for distance (ES=2.93), explosive distance (ES=2.45) and extremely large for accelerations (ES=-5.46) and decelerations (ES=-5.40). The size of the effect, in the comparison between age groups, in SSG3 was too large for the distance variable (ES=2.16), large for explosive distance (ES=1.17), accelerations (ES=-1.68), decelerations (ES=-1.61) and maximum sprint (ES=1.66). Furthermore, in SSG4, very large effect size was observed for distance (ES=3.42) and large for explosive distance (ES=1.34), accelerations (ES=-1.93) and decelerations (ES=-1.79). Finally, in SSG5, very large effect size for accelerations (ES=-3.35) and decelerations (ES=-3.50) and large for distance (ES=1.84).

Figure 1 illustrates the standardized differences (Cohen's *d*) in the studied variables during the different forms of play in SSGs, according to the age groups.

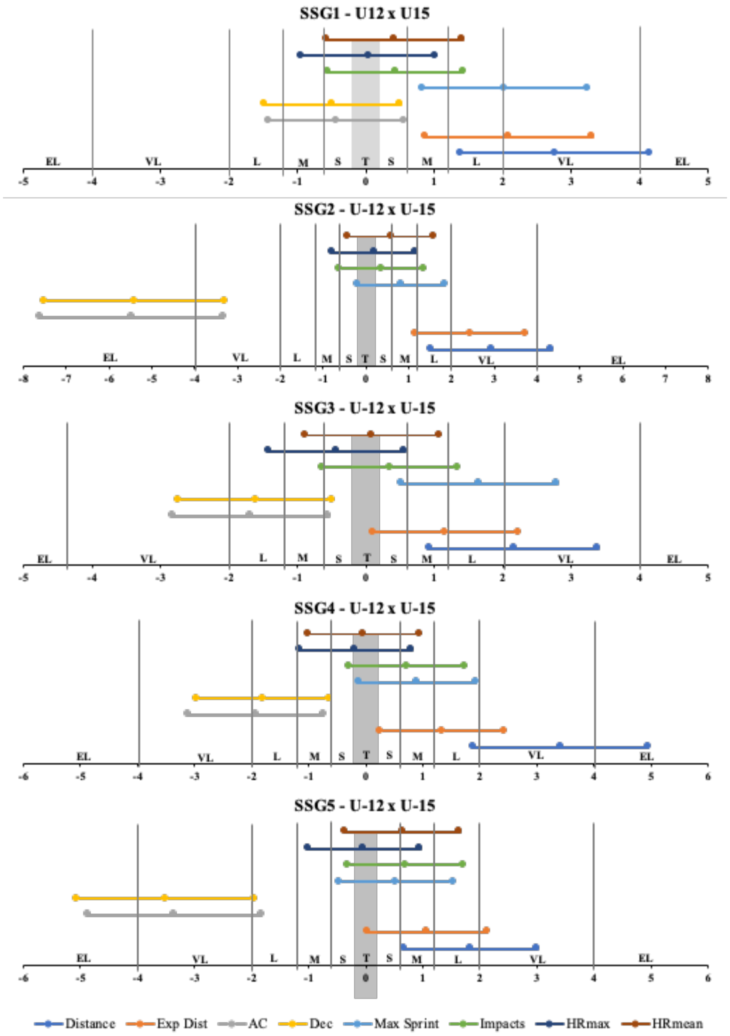

Figure 1. Standardized differences (Cohen's *d*) of external and internal load, according to age groups. The error bars indicate uncertainty in the true mean changes with 95% confidence intervals.

The difference associated to the studied variables of internal and external load are presented in table 2, differences considering the manipulation of the conditions in the different SSGs (space/pitch size and GK participation, or not) in the U-12 and U-15 age groups.

Table 3. Comparative analysis between SSGs in age groups

Age Groups	Variable	*F*	*ρ*	η_p^2	Post-Hoc (Bonferroni Test)
U-12	Distance	6.59	0.00	0.43	1<4; 1<5
	Exp Distance	2.56	0.05	0.22	
	AC	10.43	0.00	0.54	1<2; 1<5; 2>3; 2>4
	DEC	10.93	0.00	0.55	1<2; 1<5; 2>3; 2>4
	Max Sprint	7.88	0.00	0.47	1<3; 1<4; 1<5; 2<5
	Impacts	0.03	0.99	0.00	
	HR_{max}	1.10	0.37	0.11	
	HR_{mean}	0.49	0.73	0.05	
U-15	Distance	4.86	0.00	0.35	1<4; 3<4
	Exp Distance	0.39	0.80	0.04	
	AC	3.73	0.01	0.29	1>5
	DEC	3.78	0.01	0.30	1>5
	Max Sprint	5.19	0.00	0.37	1<3; 2<3
	Impacts	1.35	0.27	0.13	
	HR_{max}	0.85	0.50	0.08	
	HR_{mean}	0.30	0.87	0.03	

Note. Exp Dist – Explosive Distance; AC – accelerations; DEC – decelerations

In the U-12 age group, considering the SSG format, we found that the pitch size and GK participation is associated to a statistically significant effect of extremely large dimension on distance (*F*=6.59; *p*=0.00; η_p^2 =0.43), accelerations (*F*=10.43; *p*=0.00; η_p^2 =0.54), decelerations (*F*=10.93; *p*=0.00; η_p^2 =0.55) and maximum sprint (*F*=7.88; *p*=0.00; η_p^2 =0.47). Very large effect was observed in explosive distance (*F*=2.56; *p*=0.05; η_p^2 =0.22). According to post-hoc testing we found statistically significant differences in distance covered (SSG1<SSG4 and SSG1<SSG5), accelerations/decelerations (SSG1<SSG2, SSG1<SSG5; SSG2>SSG3 and SSG2>SSG4) and maximum sprint (SSG1<SSG3; SSGG1<SSG4; SSG1<SSG5 and SSG2<SSG5).

For the under-15 age group, we verified that manipulating the SSG area and involving GK in the SSGs is associated to a statistically significant effect of extremely large dimension on distance (*F*=4.86; *p*=0.00; η_p^2 =0.35), and maximum sprint (*F*=5.19; *p*=0.00; η_p^2 =0.37), also of very large effect size in accelerations (*F*=3.73; *p*=0.01; η_p^2 =0.29)and decelerations (*F*=3.78; *p*=0.01; η_p^2 =0.30). The post-hoc test showed statistically significant differences in distance covered (SSG1<SSG4 and SSG3<SSG4), accelerations/decelerations (SSG1>SSG5), and maximum sprint (SSG1<SSG3 and SSG2<SSG3).

Discussion

The aim of this study was to verify the internal and external load variations in two football players age groups (U-12 and U-15), related to the practice of SSGs with different pitch sizes and the participation, or not, of GK. SSGs of different formats are used in daily training for the acquisition of skills, conditioning and developing players and team (Nunes et al., 2020), the effectiveness of this purpose can be influenced by the level of the players (Clemente et al., 2019). In this way we can say that our first hypothesis was proven. In our study, in accordance with the expectations, and in line with the previous studies (López-Fernández et al., 2020; Martone et al., 2017; Nunes et al., 2020; Olthof et al., 2018), the task constraints manipulation promoted different effects in U-12 and U-15 football players. However, in our study, the effect size on the internal load of the athletes (HR_{max} and HR_{mean}) was small. Only in SSG5 there was a moderate effect size for HR_{mean}, being higher in the U-15. To some extent, our results are not in agreement with Martone et al. (2017), since in the authors study 4x4 SSGs played in the larger areas, there were statistically significant differences between U-12 and U-14. In such a way, in smaller playing areas the effect of age was not evident. López-Fernandez et al. (2020) also found that in the 4x4 SSGs performed by different age groups (U-14, U-16 and U-18), no differences occurred in internal load (HR_{mean} and HR_{max}).

At the level of the external load, we verified a large and very large effect size in distance, explosive distance and maximum sprint in the SSGs in which we manipulated the area without GK participation (SSG1, SSG2 and SSG4) and in the SSGs with larger areas and GK participation (SSG3 and SSG5). In SSG2 this assumption was not observed for the maximum sprint variable (moderate effect size). In the mentioned variables the highest values were recorded for U-15. Our results seem to be aligned with studies where there is an increase in external load associated to age, however, it can also be verified that in the U-18, U-19 and U-23 levels these differences become less evident (López-Fernández et al., 2020; Nunes et al., 2020; Olthof et al., 2018).

All SSGs participation was associated to a greater number of accelerations and decelerations in the U-12 age group, with a large effect size in SSG3 and SSG4, very large in SSG5 and extremely large in SSG2. López-Fernández et al. (2020) also found in the lower age group of the research team study (U-14) more than accelerations/decelerations compared with U-16 and U-18, more specifically in those performed at high intensity. As for the horizontal impacts, we did not verify, in the five performed SSGs formats, a great effect of the age of the football players. However, it was in the U-15 age group that we observe the highest average values in all SSGs.

Regarding the effect of field size on internal and external load variables, we coud partly prove the formulated hypothesis. We found in both age groups no statistically significant differences in HR. However, it was possible to verify, in a more evident way in the U-12 level, a higher physiological response in playing areas above $100m^2$, which is in line with previous research (Sarmento et al., 2018). Our results also indicate that field size influences the workload, more specifically in distance and maximum sprint. There was no significant effect on explosive distance and horizontal impacts. Nunes et al. (2020) verified the effect of the field size on the explosive movements for U-11 football players, however the same was not the case for the U-15 and U-23 age groups. In SSGs, low intensity movements are predominant (Gómez-Carmona et al., 2018). Comparing SSGs with the objective of maintaining ball possession and GK participation, where there is a decrease in the playing area, the study by Goméz-Carmona et al (2018) did not record significant differences for the number of impacts.

With respect to our fourth hypothesis, we can affirm that the decrease in the playing areas and the induction of GK promotes the number of accelerations and decelerations, a fact that cannot be proven in the two age groups of the study. When analyzing the GK participation, studies point to a decrease in the effects on the level of internal and external load (Castellano et al., 2013; Koklu et al., 2015). In our study we could verify this assumption at the level of HR and distance. However, regarding the maximum sprint we found higher values in the SSGs with GK, which is in line with the study conducted by Gaudino et al (2014). Although, there were no statistically significant differences and the explosive distance was higher in the SSGs with GK participation.

In the 4th hypothesis we affirm that the decrease in the playing areas and the induction of GK promotes the number of accelerations and decelerations, a fact that cannot be proven in the two age groups of the study. Accelerations are a valid indicator of analysis and quantification of neuromuscular demands (Reche-Soto et al., 2020). Studies indicate that small SSGs playing areas (Clemente et al., 2012; Martin-Garcia et al., 2019) and the introduction of GK (Castellano et al., 2013; Gaudino et al., 2014) promote acceleration and deceleration movements. Assuming the totality of the analyzed SSGs format, in the U-12 age group, we verified the hypothesis raised by us, except for SSG1, which has the lowest acceleration/deceleration values. This evidence is shown by the post-hoc results, confirming the value of the effect size. Considering only games without GK participation, we have verified values that go against what is expected between SSG1 and SSG2/SSG4, however between SSG2 and SSG4 the values are in accordance with the formulated hypothesis. In SSGs with GK, it was found that increasing the field size leads to a reduction in the number of accelerations and decelerations. GK participation increases the number of accelerations/decelerations compared to the non-participation, a fact that occured between SSG4 and SSG5, but it was not evident between SSG2 and SSG3. For the U-15 age group, a smaller effect size was recorded, which is evidenced in the post-hoc analysis. We have found that SSG1 presented statistically significant higher values of accelerations and decelerations compared to SSG5. In the SSG, without GK, we found that increasing the field size produces a decrease in accelerations and decelerations. With GK this reality was also evident.

According to the verified, we can state that the correct manipulation of the task conditions, pitch size/playing area and GK participation, promote effects on different external and internal load, and the age of players influences these effects. Thus, the correct fit of the training exercise according to age (as previous indicated by Nikolaidis et al., 2016) and specific association with the requirements of the competition are fundamental criteria not to compromise the adaptations and development of the skills of the football players. In this sense, the intensity of training derived from HR and running should be subject to proper control and manipulation, in order to allow desired and appropriate internal and external workload effects, as previously indicated by Mendez-Villanueva et al. (2012). Given the importance of SSGs in youth football training, once it allows team players to be prepared for the demands of the competition from a tactical, technical, physical and physiological point of view (Michailidis, 2013; Sarmento et al., 2018), it is necessary to continue to investigate the effects of manipulating task constraints in different age groups football players.

Our study presents some limitations that should be considered. One of the limitations of the study is related to the location of inertial devices in the back, since it can influence the reliability of the recorded data. Acceleration and player load data is more reliable with devices located on the knee and ankle (Reche-Soto et al., 2020). The number of our sample makes it difficult to generalize the obtained results. We also did not consider the peak height velocity of growth of players, which can help in explaining the results, indicator to be considered. Another issue that can be raised in our study is related to the competitive level, since it can influence the results. Future research should consider age groups and the competitive level. Also, should support the physical and physiological response associated to technical and tactical aspects. For this, other constraints (e.g. different types and number of goals, field format, placement of out-of-game lines, tactical functions, etc.) should be manipulated in order to verify how the different variables modify and relate.

Conclusions

We have noted that the manipulation of pitch size and participation, or not, of GK promotes different effects in internal and external load of youth football players according to the age group. Thus, youth coaches should expect a greater physical response in the U-15, however for U-12 a more neuromuscular activity, resulting from the greater number of accelerations and decelerations.

Our study also showed that the increase in playing areas produces a greater physiological demand above 100m^2. Increasing field size promotes great effects on distance and maximum sprint, in both groups studied. The decrease in the playing areas and the use of GK increases neuromuscular demands (accelerations/decelerations). The use of the GK in the SSGs promotes the decrease in HR, distance and increase of the maximum sprint and explosive distance. In SSG 4x4, with GKs, coaches can promote greater muscle tension in players, resulting from accelerations/decelerations, sprints and changes of direction.

The results of our study provide important indicators on the use of SSG 4x4, with and without GKs, which can help coaches in training planning decisions, as well as be more appropriate to use them in the microcycle.

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