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## ORIGINAL

### ANALYSIS OF INTERNAL AND EXTERNAL LOAD IN SMALL GAMES IN YOUNG FOOTBALL PLAYERS

### ANÁLISIS DE CARGA INTERNA Y EXTERNA DE FUTBOLISTAS JÓVENES EN JUEGOS REDUCIDOS

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#### ABSTRACT

Today, small-sided games (JER) are utilized as training football methods. Objective: Analyze and compare internal and external workload in young footballers in JER. Method: Descriptive, transectional. Sample: 36 players (Age: 16,0 ±0,9 years; body mass: 64,4 ±8,7 kg; height: 170,7 ±6,7 cm) belonging to the football CDUC of Chile. Procedure: Measure the workload in possession (4vs4 – 5vs5) and polarized games (4vs4 – 5vs5 + goalkeepers).

Materials: GPS Sport®, thoracic band receptor heart rate Polar® T31, laptop computer, software AMS Team® R1 2014.10, SPSS®. Conclusions: The type of small-sided game and the age group affect the results shown by players. Possession games with under 16 players showed higher mean values of external and internal workload with significant differences ( $p < 0,05$ ) in different study variables. In the search for optimizing game performance it is crucial to take into account the particular features of scheduled training tasks and also the characteristics of players at different formative ages.

**KEYWORDS:** Football, small-sided games, GPS, metabolic load, mechanical load, accelerations.

## RESUMEN

Hoy en día, los juegos de espacio reducido (JER) son utilizados como medios de entrenamiento en fútbol. Objetivo: Analizar y comparar la carga interna y externa de jóvenes futbolistas en JER. Método: Descriptivo. Muestra: 36 futbolistas (Edad=16,0  $\pm$ 0,9 años; peso=64,4  $\pm$ 8,7 kg; estatura=170,7  $\pm$ 6,7 cm), pertenecientes al CDUC de Chile. Procedimiento: Se controló la carga interna y externa en juegos de mantenimiento (4vs4 – 5vs5) y juegos polarizados (4vs4 – 5vs5 + porteros). Material: GPS modelo SPI Pro GPS sports®, banda torácica Polar® T31, ordenador, software AMS Team® R1 2014.10, SPSS®. Conclusiones: El tipo de JER utilizado y la edad condicionan las respuestas de jugadores. JER de mantenimiento y grupo Sub16 presentan mayores valores de carga interna y externa con diferencias significativas ( $p < 0,05$ ) en diferentes variables de estudio. En búsqueda de la optimización del rendimiento deportivo es fundamental contemplar las particularidades de tareas programadas y características de jóvenes en formación.

**PALABRAS CLAVES:** Fútbol, juegos de espacio reducido, GPS, carga metabólica, carga mecánica, aceleraciones.

## INTRODUCTION

Science can provide a valuable contribution to football, expanding our knowledge of the game itself, as well as its training methods, in particular small-sided games.

This type of activity “They are forms played, they are tasks of training with the characteristics of a collective duel” (Casamichana, Castellano, González-Morán, García-Cueto & García-López, 2011). Footballers with experience, have an impact on game understanding and in decision making (Davids, Arau, Correia & Vilar, 2013) all under the auto-regulation of individual performance. They could be classified as “Preferential Situation Simulators” (Seirul-lo, 2003 cited in Solé, 2006). The small-sided games (JER) are played in a common area and with simultaneous participation (Parlebas, 2001), in which the field dimensions, established format, number of players and rules that are enforced, can be modified with the purpose of achieving specific objectives. These games

optimize training sessions (Little & Williams, 2007), and replicate a high demand of movements, physiological intensity as well as technical (Hill-Haas, Dawson, Impellizzeri & Coutts, 2011), physical and tactical (Campos, 2012; Little, 2009), requirements allowing the development of all these aspects in unison (Flanagan & Merrick, 2002; Gabbet & Mulvey, 2008).

Investigators (Bangsbo & Krstrup, 2006; Hill-Haas, Rowsell, Coutts & Dawson, 2008; Hoff, Wisløff, Engen, Kemi & Helgerud, 2002; Rampinini, Impellizzeri, Castagna, Abt, Chamari & Sassi, 2007) consider the JER as an alternative method of aerobic, interval training for footballers. They also ensure the activation of specific muscular groups (Bangsbo, 1998). It has become a very popular training method for all ages and/or levels (Hill-Haas et al., 2011) and especially advantageous for young players (Casamichana, et al., 2015).

The use of tools and technology in these types of exercises is fundamental for accurate workload measurements as well as condition optimization of football players.

The technological systems of global positioning (GPS) have been validated and analyzed since their reproducibility (Castellano & Casamichana, 2014), widely used for the measurement of training workload (Casamichana & Castellano, 2014; Gaudino, Alberti & Iaia, 2014; Hill-Haas et al., 2008; Impellizzeri et al., 2005; Jones & Drust, 2007). It appears, the devices with greatest precision are those that have a higher frequency of samplings (Hertz), according to the findings of Castellano & Casamichana, (2014) Johnston, Watsford, Kelly, Pine & Spurrs. (2014) and also Varley, Fairweather & Aughey, (2012).

Versions of the GPS with high frequency can be considered to be acceptable instruments in the measuring of constant speed, acceleration and deceleration (Castellano et al., 2013). Thanks to the use of GPS that include an accelerometer, it is possible to obtain information to detect fatigue, optimize training exercises (Casamichana & Castellano, 2009; Casamichana et al., 2011; Casamichana et al., 2014; Hill-Haas et al., 2008; Jones & Drust, 2007) and prevent injuries (Colby, Dawson, Heasman, Rogalski & Gabbett, 2014).

The current development of these devices has permitted the evaluation of new performance variables. Amongst those that stand out, are mechanical workload (Lapuente, 2011), metabolic power and workload. (Osgnach, Poser, Bernardini, Rinaldo & Di Prampero, 2010). It is considered for mechanical workload of those accelerations and decelerations, that a subject carries out in 3-axis movement. Investigations with semi-professional footballers, have shown that JER require a proportionally higher workload in accelerations and decelerations than those required in a football match (Castellano et al., 2013). Akenhead, Hayes, Thompson & French, pointed out a decrease in changes of speed during a football match as the match went on (2013). These findings have allowed the study of player performance from another point of view, showing the importance of the acyclical intermitence of football and other variables such as; total distance and/or maximum speed, as well as less relevant actions (Casamichana, Román-Quintana, Castellano & Calleja-

González, 2012).

From the quantifying of accelerations, it is possible to determine components of fundamental workload when defining choice of training exercises, and/or utilize the “*New body load*” as an indicator of external workload and/or accelerometer, as proposed by the label GPS Sport®, obtained via the volume and intensity of accelerations and algorithms utilized, it is expressed in arbitrary terms (ua).

Aside from this, according to the method of Di Prampero, Fusi, Sepulcri, Morin, Belli & Antonutto (2005) and Osgnach et al., 2010, it is possible to obtain the metabolic power in footballers and/or estimate internal metabolic workload.

The estimation of absolute internal metabolic workload is obtained through variables such as speed of running, accelerations and decelerations that are shown in the anterior/posterior axis of movement. The expenditure of energy is calculated through the GPS Sport® and is expressed in kilo joules (kJ).

The limited information published about metabolic workload and mechanical workload could lead to an underestimation of the total activity and intensity carried out by football players (Varley, Fairweather & Aughey, 2012). At the same time, the expression of internal and external workload in small-sided games is not entirely clear and this provokes room for thought and questioning: How are these workloads expressed in different JER for different aged youth players? and which games generate more accelerations and/or energetic expenditure?

These questions leave unknown that will be tried to elucidate in this article.

## **OBJECTIVE**

Analyze and compare the internal and external workload of youth CDUC football players in different small-sided games.

## **MATERIAL AND METHODS**

Devices for global positioning GPS Sport® (Canberra) model SPI Pro, size 48 x 20 x 87 mm weight 76 gr (Australia, 2013) provide data for position, speed and distance in 5 Hz interpolating 15 Hz, with tri-axial accelerometer with an integrated 100Hz sample. All the devices were turned on 15 minutes prior to the tests to ensure an accurate satellite connection (Maddison & Ni Mhurchu, 2009), thoracic band Polar® modelo T31 cardiac frequency receptor, a laptop MacBook Pro 2012, software AMS team version R1 2014.10; software IBM® SPSS Statistics, version 21.0. for OS X Yosemite 10.10.1., chest bids, with a posterior padded pocket were utilized to place the GPS devices, goalposts, different colored chest bibs to differentiate teams and regulatory Puma® balls.

A quantitative descriptive and non experimental method was applied

(Hernández, Fernández & Baptista, 2003). A non random sample group was chosen from 36 youth players; Under 15=Age:15,0±0,3 years; weight: 64,5±10,2 kg.; height: 169,5±7,3 cm., Under 16=Age: 15,9±0,2 years; weight: 62,7±9,4 kg.; height: 170,0±7,2 cm. and Under 17=Age: 17,0±0,2 years; weight: 66,4 ± 5,1 kg.; height: 172,5 ± 5,5 cm. All the players were registered with Club Deportivo Universidad Católica of Chile, Cruzados SADP. All players were made aware of the design of the investigation and informed about the formats of the small-sided games to be studied. To be a participant the player required signed consent from parent/guardian, that complies with the established criteria of inclusion: Male subjects, registered with the club, during competitive season, with no signs of cardiac, respiratory or metabolic pathology, not within a period of injury rehabilitation, without taking part in recent physical activity, within the previous 24 hours of the tests, without having consumed coffee or tea within the 4 hours prior to evaluation, without having fasted within prior 3 hours.

## PROCEDURE

During a 12 weeks period of the competitive 2015 season of youth football in Chile. Internal workload (metabolic and cardiovascular) and external workload (physical and mechanical) were measured in 2 formats JER= Possesion games (4vs4 – 5vs5) and polarized games (4vs4P – 5vs5P) en 3 age groups (S15 – S16 – S17). Field surface: Natural grass, reglulation; for all the formats specified, the maximum number of ball touches per individual was established as 3. If the ball went out of the established field dimensions, play was continued (by foot) with the closest ball on the borders of the field. There were no corners, throw ins, nor was the offside rule considered. All formats were started with a standard warm up of 12 minutes (joint mobility, jogging, ball techniques and short drills modelling the study).

In each JER format 4 periods of 4 minutes were played, with a passive recovery of 2 minutes. The tests were carried out on thursdays in the following cronological order: 4vs4 – 4vs4P (goalkeeper) – 5vs5 – 5vs5P (goalkeeper) with a frequency 7 – 21 days, at normal training times (5pm aproximately) this is to avoid variables related to circadian rhythms. For each format of small-sided games the dimensions established can be seen in table I. This project was approved by the ethics committee of University Diego Portales of Chile obeying the Declaration of Helsinki and the Human Rights.

**Table I.** Dimension of playing area for small-sided games are included in the reasearch.

<b>Formats</b>	<b>Pitch dimension (m)</b>	<b>Absolute area (m<sup>2</sup>)</b>	<b>Relative area player (m<sup>2</sup>)</b>
4vs4 – 4vs4P	25x38	950	119
5vs5 – 5vs5P	30x40	1200	120

4vs4 - 5vs5= number of players per team (4,5) and players of opposition team (4,5)  
4vs4P- 5vs5P= number of players per team (4,5) and goalkeeper and players of opposition.

## VARIABLES OF THE STUDY

The dependent variables of the study are classified in two (2) groups.

External workload, internal workload, and are sub-divided in two (2) categories: physical-mechanical and metabolic-cardiovascular.

## **EXTERNAL WORKLOAD**

### **PHYSICAL**

Total distance run (DT): Mean distance run by participants in the study, measured in meters (m).

Distance covered to different speed zones. Mean distance covered by participating subjects in each speed zone determined in metres per zone (m). To determine the speed zones a default football setting was used from the AMS team version R1 2014.10 GPS Sport® software.

These zones are the following:

Zone distance 1 (DZ1)= 0 – 4 km/h; zone distance 2 (DZ2)= 4,1 – 9 km; zone distance 3 (DZ3)= 9,1 – 14 km/h; zone distance 4 (DZ4)= 14,1 – 18 km/h; zone distance 5 (DZ5)= 18,1 – 21 km/h; zone distance 6 (DZ6)= 21,1 – 36 km/h.

Maximum absolute velocity: Mean maxima velocity recorded by participants in the study, determined in kilometers per hour (km/h).

### **MECHANICAL**

Acceleration (ACZ): Increase in speed over a given movement by participants in the study, determined in meters per second squared ( $m/s^2$ ).

Deceleration (DCZ): Decrease in speed (negative) over a given movement by participants in the study, determined in meters per second squared ( $m/s^2$ ).

For each type, there are three (3) speed zones adapted from the study of Castellano et al., (2013), the average input from each study participant, an each speed zone is recorded.

Zone accelerations 1 (ACZ1)= 1 – 1,5  $m/s^2$ ; zone accelerations 2 (ACZ2)= 1,5 – 2  $m/s^2$ ; zone accelerations 3 (ACZ3)= 2 – 2,5  $m/s^2$ .

Zone decelerations 1 (DCZ1)= 1 – 1,5  $m/s^2$ ; zone decelerations 2 (DCZ2)= 1,5 – 2  $m/s^2$ ; zone decelerations 3 (DCZ3)= 2 – 2,5  $m/s^2$ .

Total accelerations (ACtotal) and Total decelerations (DCtotal): Amount of accelerations and decelerations recorded from each study participant.



*New body load* (NBL): External workload proposal by GPS Sport®. The recorded data is obtained from volume (quantity) and intensity (magnitude) of the accelerations reproduced in 3-axis-movement as performed by each study participant, determined by the average of arbitrary units (au) from the AMS Team® R1 2014.10 software.

## INTERNAL WORKLOAD

### METABOLIC

Absolute metabolic workload (CMA): Mean absolute metabolic expenditure measured from study participants. determined in kilo joul (kJ).

Relative metabolic workload (CMR): Mean relative energy expenditure taken from study participants, determined for absolute workload in kilo joules (kJ), divided by body weight (kg).

### CARDIOVASCULAR

Mean cardiac frequency (FCM): Mean cardiac frequency per minute for study participants, determined in beats per minute (l/m).

Maximum cardiac frequency (FCmax): Maximum mean cardiac frequency measured in study participants, determined in maximum beats (l/m).

## STATISICAL ANALYSIS

From a total of 397 repetitions (split) corresponding to 36 players a simple sample in a random shape of 99 split is taken, in this way eliminating, energetic (fatigue) and motivational variables. After this the test normal distribution of *Kolmogorov and Smirnof* was applied. Tests from independent samples were used, *Levene tests* of equality variation and *Student t*, showing a statistical bilateral significance ( $p < 0,05$ ) with a 95% interval of confidence for the differences between study variables.

## RESULTS

Despite homogeneity of the JER rule and relative area per player similar to the study, the number of players and game orientation influence the analyzed results of physical workload (table II). A disimilar behaviour is seen in the first zones of mean distance. Showing significant differences ( $p < 0,05$ ) in total distance (DT), zone distance 1 and zone distance 2 and zone distance 4, by which the formats of this study differ from lesser to higher speeds, with a difference of up to 18 km/h. The high speed zones presented no inequalities.

The possession games (4vs4 – 5vs5) allow players to cover more distance at lower speeds that polarized games (4vs4P –5vs5P), in addition to this, the 4vs4

games stands out in mean distance covered. In the absolute maximum variable no differences were found.

The balance of age groups shows a similar behavior to those described in the various formats. One can appreciate differences in physical workload, specifically in the zones of mean distance covered a lower speed with exception of DZ2. The young players also showed their best performance in these same zones. In DT, the approximate average is 500 meters, of which approximately 200 metres were covered in DZ2 and almost 180 meters in DZ3, this indicates that 76% of movements on the field are done at low to medium speeds. Noteworthy is the performance of the S16 group who showed statistically significant results compared to other groups, especially DT DZ1 and DZ3. In the Under 15 (S15) and Under 17 (S17) we can't see these types of differences.

**Table II.** Mean external workload of distances and maximum absolute velocity, shown in mean, samples and standard deviations obtained from the JER format and study groups.

FORMATS		DT (m)	DZ1 (m)	DZ2 (m)	DZ3 (m)	DZ4 (m)	DZ5 (m)	DZ6 (m)	MV (km/h)
4vs4	Mean	531,8 (a) (b)	37,3 (a) (b)	210,0	201,3 (a) (b)	66,65 (a)	13	3,6	20,6
	N	24	24	24	24	24	24	24	24
	±	47,6947	9,2893	26,279	48,493	23,549	10,786	6,319	2,0141
4vs4P	Mean	475,3 (a) (c)	46,9 (a) (c)	200,0	163,0 (a) (c)	50,33 (a)	11,1	4,0	20,8
	N	24	24	24	24	24	24	24	24
	±	57,5104	10,0726	22,241	47,65	25,184	9,723	5,21	2,5082
5vs5	Mean	525,7 (c) (d)	38,8 (c) (d)	198,0	208,0 (c) (d)	66,41 (c)	11,9	2,6	20,5
	N	28	28	28	28	28	28	28	28
	±	52,9329	11,3991	24,317	52,582	27,65	8,939	4,8	2,0603
5vs5P	Mean	457,4 (b) (d)	49,4 (b) (d)	205,9	139,0 (b) (d)	46,84 (b)	12,8	3,3	21,2
	N	23	23	23	23	23	23	23	23
	±	45,3805	9,1405	18,263	34,675	23,3	7,452	5,45	2,2403
Total	Mean	499,1	42,9	203,2	179,5	58	12,2	3,3	20,8
	N	99	99	99	99	99	99	99	99
	±	59,6286	11,1898	23,223	53,998	26,352	9,195	5,387	2,1931
GROUPS		DT (m)	DZ1 (m)	DZ2 (m)	DZ3 (m)	DZ4 (m)	DZ5 (m)	DZ6 (m)	MV (km/h)
S15	Mean	486,6 (a)	45,8 (a)	204,42	168,0 (a)	53,9	10,3	4,1	21,1
	N	33	33	33	33	33	33	33	33
	±	53,9626	12,354	24,871	48,609	24,03	8,002	6,401	2,647
S16	Mean	523,6 (a) (b)	38,3 (a) (b)	203,6	199,3 (a) (b)	66,1	13,65	2,6	20,4
	N	35	35	35	35	35	35	35	35
	±	64,0563	10,4006	23,889	59,573	29,664	10,248	4,703	1,875
S17	Mean	484,7 (b)	44,9 (b)	201,43	169,3 (b)	53,1	12,59	3,23	20,8
	N	31	31	31	31	31	31	31	31
	±	52,6214	9,2829	21,216	47,686	23,156	9,071	4,971	2,0098
Total	Mean	499,1	42,9	203,2	179,5	58,0	12,2	3,3	20,8
	N	99	99	99	99	99	99	99	99
	±	59,6286	11,1898	23,223	53,998	26,352	9,195	5,387	2,1931

DT=Total distance, DZ1=(0-4 km/h), DZ2=(4,1-9 km/h), DZ3=(9,1-14 km/h), DZ4=(14,1-18 km/h), DZ5=(18,1-21 km/h), DZ6=(21,1-36 km/h), MV=Maximum absolute velocity, N=Sample, ±=Standard deviations, m=Meters, km/h=Kilometers per hour.

**(a)-(b)-(c)-(d)=** Statistically significant differences (p=<0,05).

The results in the higher speed zones are similar between groups. This allows us to recognize that external physical workload, doesn't show significant differences at high speeds of movement (>14 km/h).

Internal workload shows, as does physical workload, that possession games (4vs4 – 5vs5 >4vs4P – 5vs5P) develop a higher metabolic response. The significant statistical differences (p=<0,05) can be seen in absolute metabolic workload (CMA) for the majority of the formats, with



exception of 5vs5P games. The analysis of relative metabolic workload estimated only shows differences in the 4vs4 – 5vs5P drills ( $p=0,049$ ) for the medium of the groups. The mean cardiac frequency (FCM) and maximum (FCmax) show average values that are higher in the 4vs4 possession games, but no significant differences between the different JER formats in the study (table III).

At the same time, the study groups produced an estimated mean absolute metabolic workload of 246kJ in JER. The S16 group ( $p<0,05$ ) stood out, in the estimation of CMA and also various cardiovascular variables, and showing statistical differences from the other study groups. This group showed the highest workload in this type of training exercise, nevertheless, if the relative estimate of metabolic workload is considered, the relationship changes, given that the S15 players cancel out the difference with the S16 group and they then differ from the S17 group.

**Table III.** Internal metabolic and cardiovascular workload shown in mean, samples and standard deviations obtained from the JER formats and study groups.

FORMATS		CMA (kJ)	CMR (kJ/kg)	FCM (lpm)	FCMáx (lm)
4vs4	Mean	261,2 (a) (b)	4,2 (a)	176	193
	N	24	24	24	24
	±	26,8359	0,876	17,124	10,521
4vs4P	Mean	239,1 (a) (c)	3,8	173	189
	N	24	24	24	24
	±	34,0859	1,086	13,74	11,158
5vs5	Mean	257,6 (c) (d)	4,1	171	188
	N	28	28	28	28
	±	27,6621	0,9408	14,106	10,934
5vs5P	Mean	226,7 (b) (d)	3,7 (a)	175,52	191
	N	23	23	23	23
	±	27,7011	0,9268	8,857	8,393
Total	Mean	246,8	4,0	174	190
	N	99	99	99	99
	±	31,9127	0,9672	13,824	10,334
GROUPS		CMA (kJ)	CMR (kJ/kg)	FCM (lpm)	FCMáx (lm)
S15	Mean	237,6 (a)	3,9 (a)	173 (a)	190 (a) (b)
	N	33	33	33	33
	±	24,753	0,6969	14,276	9,3
S16	Mean	262,1 (a) (b)	4,3 (b)	180 (a) (b)	195 (a) (c)
	N	35	35	35	35
	±	35,7328	1,2851	11,635	8,917
S17	Mean	239,4 (b)	3,5 (a) (b)	167 (b)	184 (b) (c)
	N	31	31	31	31
	±	28,3624	0,5517	12,425	10,023
Total	Mean	246,8	4,0	173	190
	N	99	99	99	99
	±	31,9127	0,9672	13,824	10,334

CMA=Absolute metabolic workload, CMR=Relative metabolic workload, FCM=Mean cardiac frequency, FCMáx=Maximum cardiac frequency, N=Sample, ±=Standar desviations, kJ=Kilo Joul, kJ/kg= kilo Joul per body mass in kilograms, m=Meters, lpm=beats per minute.

(a)-(b)-(c)-(d)=Statistically significant differences ( $p<0,05$ ).

The analysis of mechanical workload shows higher median values in total acceleration and decelerations for polarized games (table IV), but no statistical significant differences can be observed. However, the 5vs5P drill shows a lesser value to 4vs4P, 4vs4 and 5vs5 with a statistical difference in the *New body load* value (NBL;  $p=0,040$ ,  $p=0,003$  and  $p=0,035$ ).

In the group results, the S16 stands out, once again, statistically ( $p < 0,05$ ) in the acceleration, in zones 1 (ACZ1) and along with the S17 and zone 3 (ACZ3) with the S15, and especially in volume of acceleration (ACtotal) and NBL in both groups. There is also a difference with the S15 in decelerations (DCZ1;  $p = 0,031$ ), zone 2 (DCZ2;  $p = 0,018$ ), zone 3 (DCZ3;  $p = 0,008$ ) and total quantity (DCtotal). On the other hand the S15 group showed lower median values for ACtotal and volume of decelerations (DCtotal) compared to other groups. It is probable that these situations are due to individual factors and/or play dependent factors (Casamichana et al., 2015). None of the groups showed signs of mechanical workload  $> 2,5 \text{ m/s}^2$ .

In parallel with the objectives of this study, a comparison is made between mechanical workload between tactical positions of the participating players. Defensive midfielders (VD) are those who present the biggest difference ( $p < 0,05$ ) from players of other positions, as they showed higher median values, especially in ACZ1, ACtotal than central defenders, attacking midfielders, wingers and centre forwards, as well as a statistical difference in DCZ2 ( $p = 0,020$ ) and DCtotal ( $p = 0,08$ ). At the same time, they show significantly inferior values in absolute maximum spent compared to wingers (wide attackers).

**Tabla IV.** External mechanical workload for accelerations and decelerations for zones and totals. *New body load* shown in mean, samples, standard deviations obtained from the study groups.

GROUPS		ACZ1 (ct)	ACZ2 (ct)	ACZ3 (ct)	ACtotal (ct)	DCZ1 (ct)	DCZ2 (ct)	DCZ3 (ct)	DCtotal (ct)	NBL (ua)
S15	Mean	13 (a)	9	5 (a)	27 (a)	11 (a)	9 (a) (b)	9 (a)	29 (a) (b)	16,0 (a)
	N	33	33	33	33	33	33	33	33	33
	±	3,934	3,709	2,781	5,3996	3,409	3,368	3,392	6,5467	4,42733
S16	Mean	15 (a) (b)	10	8 (a)	33 (a) (b)	13 (a)	11 (a)	13 (a) (b)	37 (a) (c)	23,6 (a) (b)
	N	35	35	35	35	35	35	35	35	35
	±	4,307	4,055	3,473	6,9593	3,214	4,42	5,993	9,0107	10,2401
S17	Mean	13 (b)	9	5	27 (b)	12	11 (b)	10 (b)	33 (b) (c)	17,4 (b)
	N	31	31	31	31	31	31	31	31	31
	±	4,549	3,79	2,559	6,4852	3,511	2,716	3,85	5,7605	7,45028
Total	Mean	14	9	6	29	12	10	11	33	19,2
	N	99	99	99	99	99	99	99	99	99
	±	4,37	3,897	3,033	6,7329	3,42	3,709	4,769	7,8557	8,44386

S15=Under 15, S16=Under16, S17=Under 17, ACZ1=(1-1,5  $\text{m/s}^2$ ), ACZ2=(1,5-2  $\text{m/s}^2$ ), ACZ3=(2,-2,5  $\text{m/s}^2$ ), ACtotal=Accelerations total, DCZ1=(1-1,5  $\text{m/s}^2$ ), DCZ2= (1,5-2  $\text{m/s}^2$ ), DCZ3= (2,-2,5  $\text{m/s}^2$ ), DCtotal= Decelerations total, NBL=*New body load* N=Sample, ±=Standar desviations, ct=Quantity, ua=Arbitriary units.

(a)-(b)-(c)=Statistically significant differences ( $p < 0,05$ ).

## DISCUSSION

The small-sided games (JER) replicate multiple situations of a real game, promote and efficient transfer to the competitive environment (Williams & Owen, 2007), are a valid option to optimize football training methods (Little & Williams, 2007). They can considered be a mean to increase influential experience in the proces of decision making (Davids et al., 2013) and are especially advantageous for young players (Casamichana et al., 2015) during their sporting development.

The objective of this study was to analyze and compare internal and external workload of young footballers in different small-sided games, demonstrated situations in the treatment of this investigation. This allows the recognition of how decisive these training methods can be in the conditioned responses of developing youth players. Each small-sided game showed a specific internal and external workload in this study, as also reported in a variety of publications by Casamichana et al., 2009; Casamichana et al., 2011; Casamichana & Castellano, 2014b and Hill-Hass et al., 2008. Possession games stood out about polarized games by showing a higher physical and metabolic demand (4vs4 – 5vs5 □ 4vs4P – 5vs5P), similar results were found by Gaudino et al. (2014), as well as energy expenditure and its relationship to possession ball games.

In consideration, the cardiovascular response, Casamichana & Castellano, (2014) published significant differences in favor of possession games. All the same, that study obtained its results in percentages of maximum cardiac frequency and mean frequency, a situation not found in this investigation for the later variable.

The study of age groups produced differences in the S16 group above other age groups. At the same time, there was also a difference in the physical workload for total distance, distance for speed zones, relative and absolute metabolic workload and mechanical workload shown as volume and intensity of accelerations (S16>S15>S17) and decelerations (S16>S17>S15). Similar heterogenous responses were found by Harley, Barnes & Portas, 2010, for S16 subjects compared to other age groups. This means that variability of responses of young sports players are key factors in training of developing adolescents.

The positional comparison of different participating players stands out, as it shows higher workloads for defensive midfielders (VD) for mechanical workload. It is interesting to notice this phenomenon, as despite the higher acceleration values, the mean response for maximum absolute speed is lower than the responses of wide attackers ( $p<0,05$ ). Suárez Arrones, L. Torreño, N., Requena B., Sáez de Villarreal E., Casamichana D., Barbero-Álvarez J. & Munguía-Izquierdo, D. (2014) reported that midfielders, when compared to other positions, present higher values of internal and external workload in official matches.

## CONCLUSIONS

The analysis of training workload shown in small-sided games in this study, presented different responses according to format and age group, both in internal and external load. The differences in workload between different formats (4vs4 – 5vs5 – 4vs4P – 5vs5P) stood out, which means that particular features and the grade of specificity of programmed tasks can not be overlooked.

Using these training methods in the formative stages, specifically when working with different age groups, it is necessary to consider the workload, number of participants and orientation of the game within the design of the training session, this is because, despite the uniformity of the rules of the JER, results can be very different between young players.

The comparison between players in this study, showed higher values in the majority of training workloads for S16, S15 and S17. Especially in the ball possession games, it is probable that they respond as a result of a higher contribution of their conditional structure. At the same time, it is believed that S17 players have more experience in JER and in situations of these characteristics, with a wide understanding of the tactical roles of game strategy, meaning that the individual auto-regulation would be presented mostly, via cognitive structure, and through dependent player demand factors. These situations could be further analyzed in future investigations.

This investigation, invites football coaches and trainers to consider and to assess physical workload in JER solely from distance covered, or to analyze the intensity exclusively according to maximum speed in km/h, given that, JER doesn't allow the replication of high displacement speeds.

These situations in particular, could underestimate mechanical workload and intensity of accelerations and decelerations determined in  $m/s^2$ . On the other hand, basing conclusions principally on cardiac means or maximums as absolute indicators of internal workload, could limit the assessment and fail to consider the importance of the metabolic workload in these types of training sessions.

In the search for optimization of player performance in different formative age groups, it is fundamental to assess the performance variables shown in training sessions correctly, respecting the particular features and specificities of the programmed tasks, considering the type of JER format or drills.

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