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ORIGINAL

SPATIAL PERCEPTION OF SEMI-PROFESSIONAL SOCCER PLAYERS IN SMALL-SIDED GAMES: A CASE STUDY

PERCEPCIÓN ESPACIAL DE FUTBOLISTAS SEMIPROFESIONALES EN JUEGOS REDUCIDOS: UN ESTUDIO DE CASO

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ABSTRACT

This study aims to: i) describe the objective (area occupied by the team, AOT) and subjective (spatial perception of the occupied area, SPOS) tactical demands, ii) identify the inter-subject variability and the relationship between AOT and SPOS, and iii) compare the demands between offensive and defensive phases, during small-sided games. Twelve semi-professional football players were tracked using WIMU PRO® inertial devices. The results indicated an AOT (attack=257.6±60.6; defence=120.3±37.8 m^2) and SPOS (attack=3.5±0.7; 2.7±0.6 arb. unit). Differences were found between attack and defence phases in both variables ($p>0.001$; AOT, $d=2.72$; SPOS, $d=1.23$), as well as a strong relationship between both indicators ($r=0.92$). In conclusion, the variables AOT and SPOS discriminated the effect of the game phase and the training day. Future research with a larger sample is necessary to confirm the validity of the PSOS.

KEY WORDS: spatial perception, tactics, soccer, subjective perception.

RESUMEN

Este estudio pretende: i) describir las exigencias tácticas objetivas (área ocupada por el equipo, AOE) y subjetivas (percepción subjetiva del espacio ocupado, PSEO), ii) identificar la variabilidad inter-sujeto y explorar la relación entre AOE y PSEO, y iii) comparar las exigencias entre defensa y ataque durante la realización de juegos reducidos. Doce jugadores semiprofesionales de fútbol fueron monitoreados mediante dispositivos inerciales WIMU PRO®. Los resultados indican un AOE (ataque=257.6±60.6; defensa=120.3±37.8 m^2) y PSEO (ataque=3.5±0.7; defensa=2.7±0.6 a.u.). Se encontraron diferencias entre fase de ataque y defensa en ambas variables ($p>0.001$; AOE, $d=2.72$; PSEO, $d=1.23$) y una alta relación entre ambos indicadores ($r=0.92$). En conclusión, las variables AEO y PSEO discriminaron el efecto de la fase de juego y el día de entrenamiento. Son necesarias futuras investigaciones con un mayor tamaño muestral para confirmar la validez de la PSEO.

PALABRAS CLAVE: percepción espacial, táctica, fútbol, percepción subjetiva.

1. INTRODUCTION

One of the most commonly used strategies for the development of technical-tactical skills in team sports are small-sided games (SSGs), due to their ability to represent real game situations on a small scale (Reche-Soto, Cardona-Nieto, Díaz-Suárez, et al., 2019). SSGs are recreational and sporting situations that respect the collective duel structure, in which all the elements of the game interact together in a flexible way (Parlebas, 2008). Physical-physiological (Hill-Haas et al., 2011a), technical (Jones & Drust, 2007), tactical (Reche-Soto, Cardona-Nieto, Diaz-Suarez, et al., 2019b), strategic and psychological demands are reproduced during their practice in an integrated way (Flanagan & Merrick, 2002).

Currently, the development of technological tools has allowed the monitoring of athletes for their conditional optimisation during the competitive period (Rojas-Inda, 2018). The availability of *Electronic Performance and Tracking Systems* (EPTS) (Rico-González, Pino-Ortega, Nakamura, Arruda Moura, et al., 2020) as a monitoring method of kinematic (Gamonales-Puerto et al., 2018; Reche-Soto, Cardona-Nieto, Díaz-Suárez, et al., 2019), neuromuscular (C. D. Gómez-Carmona et al., 2019; Reche-Soto, Cardona-Nieto, Diaz-Suarez, et al., 2019a) and tactical parameters (Reche-Soto, Cardona-Nieto, Diaz-Suarez, et al., 2019b; Rico-González, Pino-Ortega, Nakamura, Arruda-Moura, et al., 2020) is feasible in both outdoor conditions through Global Navigation Satellite Systems (GNSS) (Dempsey, Gibson, Sykes, Pryjmachuk, and Turner, 2017; Muñoz-López, Granero-Gil, Pino-Ortega, & De Hoyo, 2017), and indoor conditions using Ultra-Wideband (UWB) technology (Bastida-Castillo, Gómez-Carmona, De la Cruz Sánchez, & Pino Ortega, 2018; Leser, Schleindlhuber, Lyons, & Baca, 2014) in a valid and reliable way (Akubat, Barrett, & Abt, 2014) and is being used more and more frequently (Rogalski, Dawson, Heasman, & Gabbett, 2013).

Taking as a point of reference the position of each player (x-y coordinates within a time), variables have been proposed to evaluate collective behaviours in team sports (Rico-González, Pino-Ortega, Nakamura, Moura, et al., 2020) . These have been called composite positional variables because they integrate the individual positions of each team player into a meaningful description of a collective team pattern (Silva et al., 2014). These innovative variables reveal significant collective behaviours from a practical perspective and can be used to evaluate the idiosyncratic performance values of each team (González-Víllora, Serra-Olivares, Pastor-Vicedo, & da Costa, 2015).

In addition to these objective methods of quantification, it is always necessary to have variables on the perception of the players to compare the information and make more comprehensive decisions. One of the most commonly used methods to quantify the perceived load of players in an accessible, practical and non-invasive way has been the subjective perception of effort (SPE); (Borg, 1998; Suárez Rodríguez & Del Valle, 2019). Different authors have endorsed the validity of this tool to estimate load or fatigue, understanding it as the indissoluble integration of a double dimension: physical and psychological (Casamichana, Castellano, Calleja-González, San Román, & Castagna, 2013; Laurent et al., 2013). Therefore, it seems advisable to develop alternative tools that make it possible to estimate, in a practical way and with acceptable validity, the athlete's perception of different training and competition stimuli (Castro et al., 2019). The spatial perception is essential for the improvement of collective tactical patterns, but there is no research that subjectively gathers this information.

Consequently, the objectives of the present research were: i) to describe the objective and subjective tactical demands (area occupied by the team, AOT; subjective perception of the occupied space, SPOS), ii) to identify the inter-subject variability and explore the relationship between AOT and SPOS during

small-sides games, and iii) to compare the demands between the offensive and defensive phases of this type of sports training activities.

2. METHOD

2.1. Design

The present investigation aimed to identify the relationship between the objective tactical variable of the area occupied by the team and the subjective tactical variable of the athlete's perception of the occupied space. It followed the structure of a case study using an empirical research method to investigate a contemporary phenomenon focusing on the dynamics of the case within its real-life context (Roth, 1999; Yin, 2003) to respond to the proposed objectives.

The design of this study is framed within correlational research with the objective of identifying the relationship between the tactical variables of the objective area occupied by the team (OAT) and subjective perception of the occupied space (SPOS), as well as cross-sectional analyses of natural groups in order to characterise the objective and subjective tactical load and identify the effect of the game phase and the weekly training day (Ato et al., 2013).

2.2. Participants

Twelve national level semi-professional soccer players (Age: 24.2 ± 2.9 years; Weight: 77.2 ± 4.4 kg; Height: 1.8 ± 0.2 m), who compete in the Third Division category (Group XIII), voluntarily participated in this research that was organised by the Football Federation of the Region of Murcia (FFRM). The players met two inclusion criteria: (1) not having any musculoskeletal injury or health problem that prevented their participation in the training session and (2) being familiar with high monitoring during sports practice. Goalkeepers did not participate in the present investigation because their physical load differs from that of other field players (White et al., 2018).

Both the technical staff and the players were previously informed of the details of the investigation and its possible risks and benefits. The study was developed based on the ethical provisions of the Declaration of Helsinki (revised in Fortaleza, 2013), and approved by the Ethics Committee of the University of Murcia (registration number 2061/2018).

2.3. Variables

During the present research, the following independent and dependent variables were recorded:

- *Independent variables:* (1) participating team, team A and team B; (2) game phases, attack and defence.

- *Dependent variables*: They represented the tactical demands of the players during the performance of the tasks: the objective variable area occupied by the team (Frencken et al., 2011) and the subjective variable of the athlete's perception of the occupied space, both described in Table 1.

Table 1. *Dependent variables recorded in this research*.

Variables	Description	Unit
Area occupied by the team (AOT)	It represents the area of the field covered by the entire team in each fraction of time.	Square meters (m2).
Subjective perception of the occupied space (SPOS)	It represents the subjective perception of the space occupied by the team, categorised using a Likert-type scale between values 1 (small occupied area) to 5 (very large occupied area).	Arbitrary units (a.u).

2.4. Material

The WIMU PRO® inertial devices (Realtrack Systems, Almería, Spain) were used to record the AOT. The inertial device is made up of different sensors, including four accelerometers, three gyroscopes, a magnetometer, a GNSS chip and an LPS (*Local Positioning Systems*) chip, among others. In addition, this device has its own microprocessor, an 8 GB flash memory and a high-speed USB interface, making it possible to record, store and transfer the data for later analysis. The device is powered by an internal battery with 4 hours of autonomy, weighs 70 grams and measures 81 x 45 x 16 millimetres.

The spatial recording of the positioning of the players was carried out using UWB technology with a sampling frequency of 18 Hz. This technology has shown high precision in distance and speed variables (Bastida-Castillo, Gómez-Carmona, De la Cruz Sánchez et al., 2018) as well as in x-y coordinates both in indoor (Bastida-Castillo, Gómez-Carmona, Hernández et al., 2018) and outdoor conditions (Bastida-Castillo, Gómez-Carmona, de la Cruz Sánchez, & Pino-Ortega, 2019).

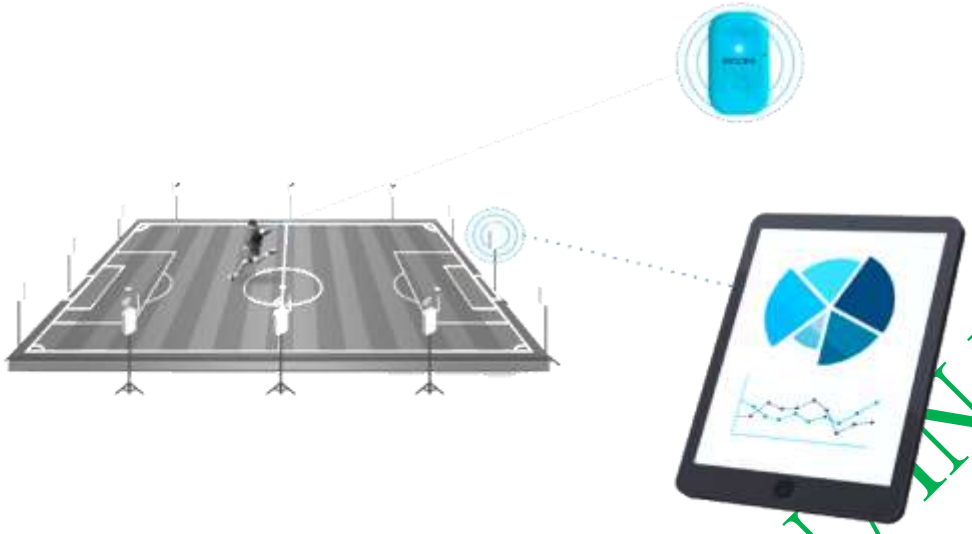
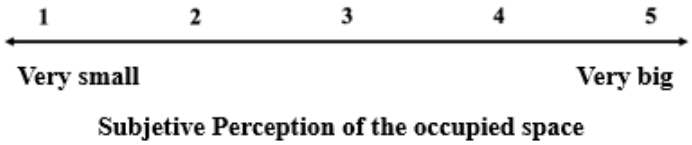


Figure 1. *Graphical representation of the recording system used in this research.*

A 1-5-point Likert-type scale was used to record the SPOS by both teams. On this scale the minimum value represented very low occupation of the space by the team while a maximum value on this scale represented very high occupation. Figure 1 shows the scale used in the present study. All the players experienced a familiarisation stage with the scale prior to the start of the study.



Subjetive Perception of the occupied space

Figure 2. *Scale for the subjective evaluation of the occupied area during the performance of group tasks in group sports.*

2.5. Procedure

The study was carried out during 4 training sessions (number 36, 39, 42 and 45 of the season), all of them included in the competitive period of the 2018/2019 season. These sessions were the first training session of the week, 4 days before the official competition match. The participants were divided into two teams of seven players, without assigning specific roles (Team A, black; Team B, yellow). The teams were formed based on Casamichana & Castellano (2010) criteria: (a) minutes played in competition, (b) playing position and (c) subjective evaluation of the coach. The players were therefore distributed in balanced groups in relation to the three criteria mentioned above to reduce the bias by level or position (the teams did not suffer any modification during the 4 sessions). The players participating in the research wore the clothing and the usual footwear that they use on the artificial grass surface where they normally train. The teams were identified by vests. All the monitoring sessions were carried out in the same time slot, coinciding with the usual training sessions (7:00 p.m. to 9:00 p.m.). During the present investigation, the players were

instructed to maintain their regular lifestyle habits, which included 8 hours of sleep at night before each training session and optimal hydration and carbohydrate intake 24 hours prior to the training sessions.

The objective in attack phase was to maintain ball possession while in the defence phase it was to regain possession of the ball. Each time the defending team managed to regain possession of the ball, they returned it to the attacking team. To maximise playing time, additional balls were placed around the playing field and passed by the technical staff (Casamichana & Castellano, 2010) to the attacking player who was closest to their position. There was no limitation of contact with the ball, nor were goals used.

There were 8 repetitions of 1 minute of activity, where each team had the ball possession 4 times during the attack phase. There were one-minute rest periods between repetitions, following a 1:1 ratio, which is effective for the development of aerobic capacity, and maintaining physical-technical efficiency (Hill-Haas et al., 2011b). This design has been used in different recently published studies (Gómez-Carmona, Gamonales et al., 2018; Reche-Soto, Cardona-Nieto, Díaz-Suárez, Gómez-Carmona, & Pino-Ortega, 2019).

Before starting the recording, a playing field of 25x30 m was delimited, resulting in an area of 750 m^2 (area per player = 62,50 m^2), representing a reduction with regards to the competition (Casamichana, Bradley, & Castellano, 2018). In addition, the players were asked to arrive 15 minutes before the start of the training session to have the inertial devices fitted. These were calibrated and synchronised according to the manufacturer's recommendations and following protocols from previous studies (Gómez-Carmona, Bastida-Castillo, García-Rubio et al., 2018). For the placement of the devices, specially designed vests were used (anatomically adjusted to each participant). The devices were placed on the upper part of the torso. All the data obtained from the devices were analysed using the SPRO® software (Realtrack Systems, Almeria, Spain).

2.6. Statistical Analysis

In the first place, a descriptive analysis was carried out showing the data as means and standard deviations (mean ± SD) to describe all the requirements in the different SSGs analysed with respect to the chosen variables: (a) area occupied by the team and (b) subjective perception of the occupied space. The Kolmogorov-Smirnov test and Levene tests were performed to determine the normality of the variables, and both reported a normal distribution.

In the second place, Student's t-test for independent samples was used to compare differences depending on the phase of the game (attack vs. defence). The effect size was calculated using Cohen's *d* to assess the magnitude of the differences, and was classified as low effect (0-0.2), small effect (0.2-0.6), moderate effect (0.6-1.2), large effect (1.2-2.0) and very large effect (> 2.0) (Hopkins et al., 2009).

Subsequently, Pearson's correlation test was carried out to analyse the inter-subject relationship in the variable subjective perception of the occupied space among the players who made up each of the teams in the different phases of the game in all the sessions analysed, and the relationship between the objective variable area occupied by the team and the subjective perception of the occupied space indicated by each of the players. This test was interpreted according to Field (2013): insignificant (r^2 <0.1), small (0.1 <r^2 <0.3), moderate (0.3 <r^2 <0.5), large (0.5 <r^2 <0.7), very large (0.7 <r^2 <0.9), almost perfect (r^2 > 0.9) and perfect (r^2 = 1). SPSS software, version 24.0 (SPSS Inc., Armonk NY, USA) was used for the statistical analysis. The level of significance was established with the value of p <0.05.

3. RESULTS

Table 2 shows the descriptive analysis of AOT and SPOS in each of the sessions and their comparison according to the game phase. There are significant differences in the variables occupied area (attack = 257.6 ± 60.6 m2; defence = 120.3 ± 37.8 m2; p <0.001; d = 2.72 very large effect) and spatial perception (attack = 3.5 ± 0.7 au; defence = 2.7 ± 0.6 au; p <0.001; d = 1.23 large effect).

Table 2. *Descriptive and comparative analysis of the tactical variables analysed in this research according to the game phase.*

Variables	Game phase	Repetitions				Total M±SD	*p*	*d*
		Session 1 M±SD	Session 2 M±SD	Session 3 M±SD	Session 4 M±SD			
Occupied area (m^2)	Attack	293.2±62.5	263.7±46.8	196.89±53.8	276.7±79.4	257.6±60.6	0.001	2.72
	Defence	113.1±30.7	117.2±50.8	122.8±37.6	128.1±32.2	120.3±37.8		
Spatial perception (a.u)	Attack	3.7±0.5	3.7±0.5	3.1±1.1	3.5±0.6	3.5±0.7	0.001	1.23
	Defence	2.3±0.5	2.6±0.8	2.8±0.4	2.9±0.5	2.7±0.6		

Note. *M: Mean; SD: Standard deviation; p: value of p; d: effect size using Cohen's d.*

Table 3 shows the correlation between the subjective perceptions provided by the players in all the sessions in each of the game phases. There is a high variability of the correlations in both attack (r = -0.76 - 0.94) and defence (r = -0.78 - 1.00) phases.

Table 3. *Relational analysis of the players participating in this research based on the subjective perception of the occupied space in accordance with the game phase.*

Game phase	Player	1	2	3	4	5
Attack	2	-0.76				
	3	0.12	0.21			
	4	-0.58	0.41	0.41		
	5	0.22	0.15	0.12	0.31	
	6	-0.33	0.53	0.94	0.72	0.82
Defence	2	0.66				
	3	-0.27	0.47			
	4	-0.11	0.89	0.95		
	5	-0.09	0.54	0.87	1.00	
	6	0.69	0.58	-0.46	-0.69	-0.78

Figure 3 displays the relationship between the objective variable area occupied by the team and the subjective variable athlete's perception of the occupied space. There is a high correlation between both variables (r = 0.92), being higher in the attack phase (r = 0.84) than in the defensive phase (r = 0.82).

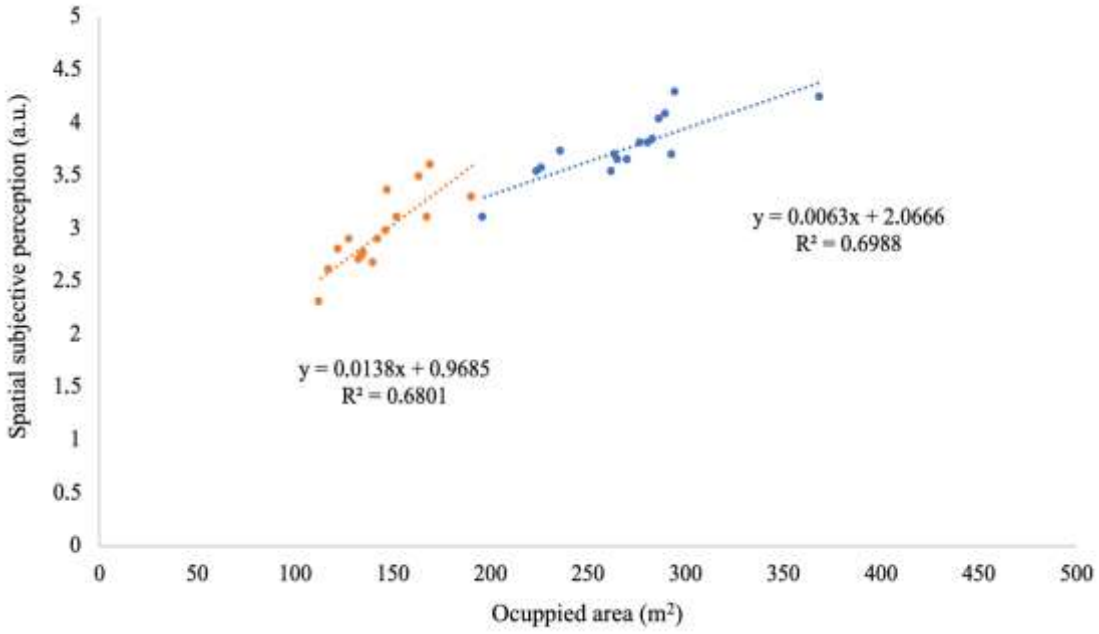


Figure 3. *Correlation graph between the objective variable occupied area and the subjective variable spatial perception of the occupied space for the analysis of tactical behaviour recorded in the present study.*

4. DISCUSSION

The objectives of this research have been: i) to describe the objective (area occupied by the team, AOT) and subjective (athlete's perception of the occupied space, SPOS) tactical demands, ii) to identify inter-subject variability and explore the relationship between AOT and SPOS during small-sided games, and iii) to compare the demands between offensive and defensive phases in this type of sports training activities.

It is challenging to understand the movements of a player, a group of players or an entire team in relation to their rivals based on the information provided (Stein et al., 2017). Regarding the first objective of this research, we found high variability in the inter-subject correlations of subjective spatial perception both in the attack (r = -0.76 - 0.94) and in the defence (r = -0.78 - 1.00) phases. This is due to the level of experience of the players and the constant adjustment of position that players perform on the field as a result of their decision-making processes (Sampaio & Maçãs, 2012). It should also be noted that tactical knowledge is not inherent in players, it is developed and learned (González-Víllora et al., 2015). The analysis of how players position themselves in relation to the playing field and other players can provide us with key information on different styles of the game (Lapresa, Del Río, Arana, Amatria,& Anguera, 2018).

There is a constant need for teams to play defence and offense, so they must have mobility in the offensive phase and be balanced in the defensive one (Wade, 1998). Regarding the second objective, there are significant differences in the variable area (p <0.001; d = 2.72 *very large effect*) and spatial perception (p <0.001; d = 1.23 *large effect*) between the attack and defence phases. The dynamics of the area in attack and defence are related (r = *0* .62). This means that there is an adaptation of the tactical disposition of the defence depending on the tactical disposition of the attack (Reche-Soto, Cardona-Nieto, Diaz-Suarez, et al., 2019b). There are studies, such as the one carried out by Bartlett, Button, Robins, Dutt-Mazumder, & Kennedy (2012) in which a relationship was found between the centroid of the attacking team and the defending team with a correlation on the x axis of r = 0.93 and on the y axis of r = 0.76 in 5 SSGs. In this same investigation, it was also found that an increase in the area of the team in the attack phase caused an increase in the area of the defending team. On the contrary, opposite results can also be found in other studies such as that of Arruda, Barreto, De Oliveira, Machado, & Cunha (2012) and by Frencken et al. (2011), in which correlations close to 0 are observed between the two phases (r = 0.03; r = 0.07; r = - 0.01). Therefore, the results may depend on the type of SSG proposed (Frencken et al., 2011) On the other hand, the practice of soccer itself entails unstable moments caused by technical-tactical actions that break with the dynamics. Thus, in order to be successful in attack, this aforementioned instability will have to be caused to find spaces and achieve the objective.

Focusing on the third objective of this study, there is a high correlation between both indicators (r = 0.92). It is evident that space is one of the most used indicators in soccer analysis (Arana, Lapresa, Anguera, & Garzón, 2016; González-Víllora et al., 2015). However, despite the fact that the evaluation of the observable tactical behaviour of players has been a subject of great interest in recent years (del Villar Álvarez and González, 2014; González-Víllora et al., 2015; Otero-Saborido & González-Jurado, 2015), no study has been found regarding the relation of objective indicators with the subjective perception of space. In our opinion, these findings have a great practical application in formative soccer because, in most cases, there is no access to technological devices that allow quantifying tactical aspects, this indicator being a great tool for quantifying tactical demands. These methods and results can provide

support for further studies, particularly those addressing physiological requirements (Dyson, Griffin, & Hastie, 2004).

5. CONCLUSIONS

The reported results make it possible to identify clear differences in the AOT in the attack and defence phases in the reduced spaces. Additionally, regarding the SPOS, on the one hand, there are considerable variations in the inter-subject perception but, on the other, a high correlation is maintained between the reported AOT and SPOS. This allows us to assert that the results obtained in this research suggest that the SPOS is a valid variable to quantify the tactical demands of the SSGs, bearing in mind the specific characteristics of each player.

The game phase as well as the SSG format have a direct influence on the evaluated tactical analysis variables.

6. LIMITATIONS

This research had a reduced sample, twelve players from a national third division (Group XIII) category team, that was analysed in training sessions, so the results obtained cannot be extrapolated to the general population.

For future research lines, we propose the study of the variables analysed in this research during an official competition.

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