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ORIGINAL

IN-CONTEXT OBSERVATION OF ACTION LEVELS IN HANDBALL

LA OBSERVACIÓN EN CONTEXTO DE LOS NIVELES DE ACCIÓN EN BALONMANO

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ABSTRACT

The main aim of this research was to design a recording instrument that allows us to describe and to determine relationships among three action levels in handball (team play, collective play and individual play), relating them to the competition context and taking their effectiveness into account. Following observational methodology guidelines, a combined system of field formats and a category system was chosen, using an ideographic, punctual and multidimensional research design. Dartfish TeamPro V.4.5 software was used as recording instrument to analyse seven matches of the senior category and seven matches of the U14 category, generating concurrent and event-based data. Bivariate descriptive and inferential statistical techniques were used for the relationship analysis. The results confirmed the association between playing systems and collective actions, both offensive and defensive, as well as the difficulty to establish significant relationships between attack and defence.

KEY WORDS: handball, context, system, procedure, action, effectiveness.

RESUMEN

Esta investigación plantea como objetivo principal diseñar un instrumento de registro que permita describir y relacionar tres niveles de acción del balonmano (juego de equipo, juego grupal y juego individual), vinculándolos al contexto de competición y atendiendo a su eficacia. Siguiendo las directrices de la metodología observacional se opta por un sistema combinado de formatos de campo y sistema de categorías, utilizando un diseño de investigación de carácter ideográfico, puntual y multidimensional. Se utiliza como instrumento de registro el *software Dartfish TeamPro V.4.5* para analizar siete partidos de categoría absoluta, y siete partidos de categoría infantil, generándose datos de tipo concurrente y de evento. Se aplican técnicas estadísticas descriptivas e inferenciales bivariadas para el análisis relacional de los datos. Destacamos los resultados que constatan la asociación entre sistemas de juego y procedimientos colectivos tanto ofensivos como defensivos, y la dificultad en establecer relaciones significativas entre el ataque y la defensa.

PALABRAS CLAVE: Balonmano, contexto, sistema, procedimiento, acción, eficacia.

1. INTRODUCTION

There exist various approaches to sport analysis from a systemic perspective. Apart from disciplines like praxeology (Parlebas, 2008) and the structural horizontal models (Bayer, 1986), which analyse sport as a structure and function in relation to a context, there are other contributions from disciplines that analyse the athlete and/or team as a system: non-linear learning theories (Chow, Davids, Button, & Renshaw, 2016), complex systems (Kelso, 2014) and ecological psychology (Araújo, Ripoll, & Raab, 2009), all of them focused on the indivisible subject-environment relationship.

By integrating all proposals, a model for team sports can be outlined, in which context would be the focal point of observation, which would allow for verification of systemic relationships from the opposing teams and players (as systems) towards sport (transference) and from sport (as a system) towards the opposing teams (information) (Lasierra, 2017). Context would be conceived as the application of knowledge (Serra-Olivares & García-López, 2016) to continuously changing situations (González-Villora, García-López,& Contreras-Jordán, 2015).

Following the guidelines by Lago (2000), three levels can be established to approach the development of playing actions: team playing actions (playing systems), group playing actions (collective playing actions) and individual playing actions.

Context factors emerge from the concept of context as scene (Jiménez Jiménez, 2003) and they refer to the simultaneous existence of handball structural elements with a particular layout and the different interpretation of team playing models and players' skills, which modify the playing dynamics. We do not consider performance, outcome or effectiveness to be context factors, but the consequence of the competence showed by players and teams in each playing situation. Our view is summarized in figure 1.

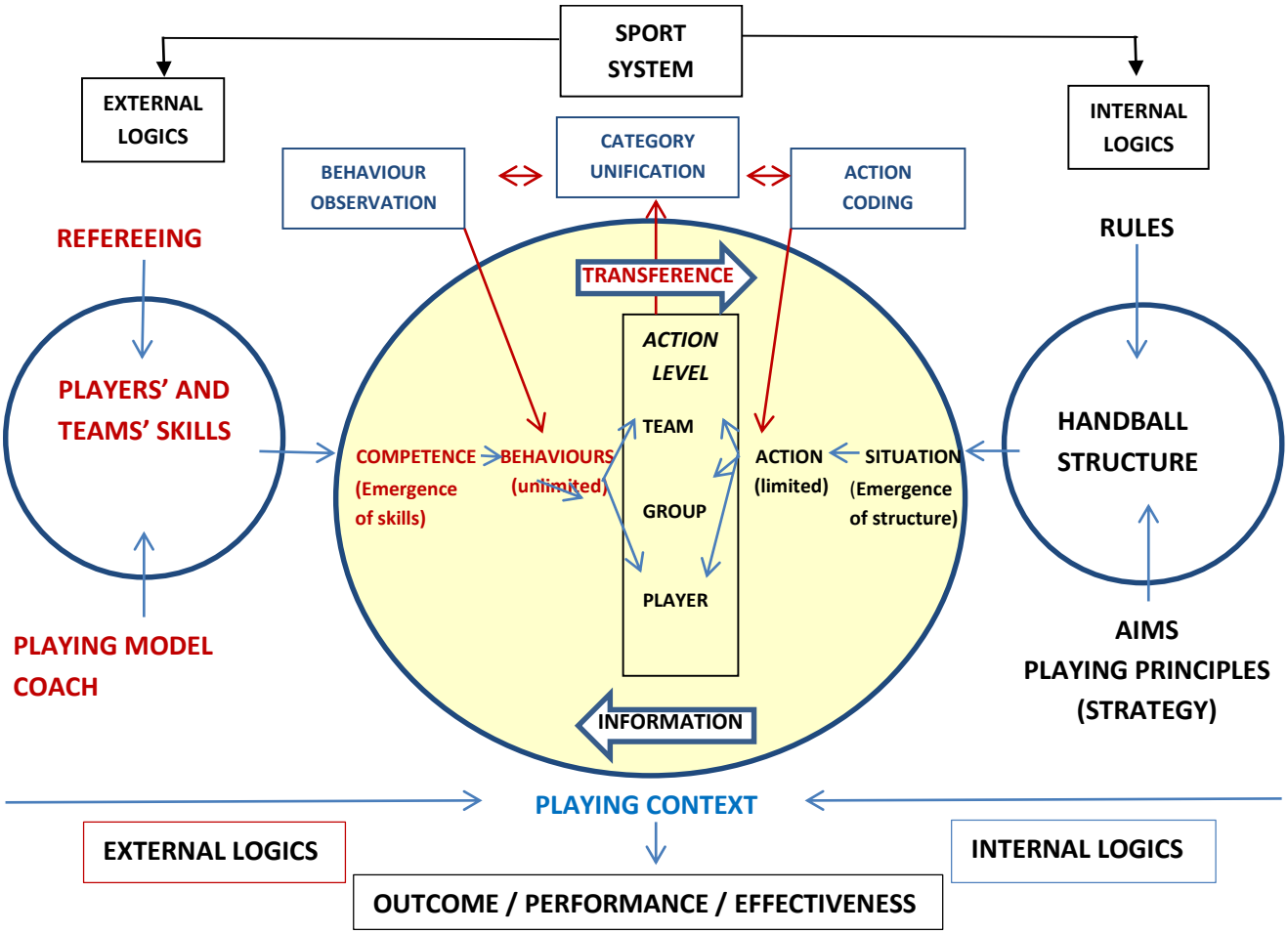

Figure 1. Action and behaviour observation in a playing context.

2. METHOD

The observational method (OM) (Anguera & Hernández Mendo, 2015) was chosen as research method, since it includes designs that share the following characteristics with our aim: idiographic study, transduction of reality, holism, molar observation unit, low level of environmental and sample control, high level of observer control, and qualitative-quantitative data analysis.

2.1. AIMS

The main aim was to design a recording instrument that allows us to describe and to determine relationships among three action levels in handball (team play, collective play and individual play), relating them to the competition context and

taking their effectiveness into account. The secondary aim was to apply one same design to the observation of two different competition categories (senior and U14).

2.2. PARTICIPANTS

For this empirical study, the sample was composed of eight male senior teams (SEN) who participated in 2012 Spanish King's Cup and eight male U14 teams (U14) who participated in 2012 Spanish Club Championship (players aged 12 to 14).

2.3. OBSERVATION INSTRUMENT

An *ad hoc* system combining field formats and a category system was applied. It was recommended by OM for multidimensional studies (Anguera, Blanco-Villaseñor, Losada, & Hernández Mendo, 2000).

Five macro-criteria were proposed for the present study, which were divided into the criteria and categories showed in table 1.

Situational frame (not included in the table): it included five changing criteria that helped contextualise the different variables that can appear during the game. The criteria were: observed team (OT), match period (MP), score difference (SD), offensive play transition phase (TRC, TRG), offensive play positional phase (PA) and numerical situation (NS).

Strategic frame (playing systems): it included six criteria that fully described the structure and dynamics of the changes occurred in the playing systems, among and within the different positional attack sequences: starting offensive play (SOP), offensive formation change (OFC), ending offensive play (EOP), starting defensive play (SDP), defensive formation change (DFC) and ending defensive play (EDP).

Strategic frame (collective actions): it included four criteria that fully described the structure and dynamics of the changes occurred in the collective offensive and defensive actions of every playing sequence. The selected criteria were: collective actions with ball (CAB), collective actions without ball (CANB), position of the supporting player without ball (A, B, C, D, E, F) and collective defensive actions (CDA).

Strategic frame (individual actions): it included five criteria that fully described the changes occurred in the individual offensive and defensive playing actions. The following criteria were used: attack preparation (AP), final attack indicator (FAI), position of the player with ball (A, B, C, D, E, F), ending area with ball (EAB) and area of closest defender (ACD).

Effectiveness frame: it included seven criteria that fully described the outcome of any offensive playing situation observed in a match, which would later determine attacking and shooting effectiveness. The selected criteria were: rule

violation (RV), technical-tactical error or ball loss (TE), missed shot (MS), successful attack (SA), successful shot (SS), transition outcome (TO), intermediate outcome (IO).

Table 1. *Criteria and categories of the strategic frame (action levels) and the effectiveness frame.*

FRAME (Situational frame not included)	CRITERIA	CRITERION CODE	CATEGORY	CATEGORY CODE
PLAYING SYSTEMS	Starting offensive play	SOP	3:3 1 pivot zone	SOP331
			3:3 2 pivots zone	SOP332
			2:4 zone	SOP24
			4:2 zone	SOP42
			Others: individual / mixed	SOPIN / SOPMI
	Offensive formation change	OFC	1st line formation change	OFC1L
			2nd line formation change	OFC2L
			1st and 2nd line formation ch	OFC12L
	Ending offensive play	EOP	Same categories as SOP	
	Starting defensive play	SDP	3:3 Defence	SDP33
			4:2 Defence	SDP42
			3:2:1 Defence	SDP321
			6:0 Defence	SDP60
			5:1 Defence	SDP51
			Others: individual / mixed	SDPIN / SDPMI
	Defensive formation change	DFC	1st to 2nd line formation char	DFC12
			2nd to 1st line formation char	DFC21
			Formation change same def. l	DFCSL
	Ending deffensive play	EDP	Same categories as SDP	
COLLECTIVE ACTIONS	Collective offensive actions 1 (numbering based on the occurrence order of the CAB within a sequence)	CAB1	Support points	SUPO
			Give-and-go	GIGO
			Successive penetrations	SSPP
			Pass repetition	PPRR
			Crossing	CROS
			Position exchange	POEX
			Fixation/Mobilisation	FIMO
			Crossing without ball	CRNB
			Screening	SCRE
			Multiple-player screening	MPSC
	Collective defensive actions 1 (numbering based on the occurrence order of the CDA within a sequence)	CDA1	Slide-through	SLID
			Coverage/Preventive help	COPR
			Decisive help	DECH
			Change of opponent same lin	COSL
			Change of opponent different	CODL
			Double defence	DODE
			Collective block	COLB
	Supporting player 1	SUPP1	Playing position	A - B - C - D - E - F
	Collective actions without ball (numbering based on the occurrence order of the CANB within a sequence)	CANB1	Position exchange	POEX
			Fixation/Mobilisation	FIMO
			Crossing without ball	CRNB
			Screening	SCRE
			Multiple-player screening	MPSC
INDIVIDUAL ACTIONS	Attack preparation	AP	Number of previous passes	PASS1/PASS+5
	Final attack indicator	FAI	Individual/Collective start	INST/COST
	Position of player 1	PP1	Playing position	A - B - C - D - E - F
	Ending area with ball 1	EAB1	Field areas	A1 to A13
	Area of closest defender	ACD1	Field areas	A1 to A13
OUTCOME / EFFECTIVENESS	Final outcome: rule violation	RV	3 steps	STEP
			Illegal dribble	IDRI
			Offensive foul	OFOU
			Entering goal area	EGAR
			Passive play	PASS
			End of playing time	EPLT
			Foot	FOOT
			3 seconds	3SEC
	Final outcome: tech-tac error	TE	Ball loss	BLOS
	Final outcome: missed shot	MS	Goalpost	GPOS
			End of period or match	EPER
			Out	OUT
			Block	BLOC
	Final outcome: successful shot	SS	Goal	GOAL
			Goal + 2-min susp./warn./disc	GOAL+2
	Final outcome: successful attack	SA	7-metre throw	7M
			7-metre throw + 2-min susp./V	7M+2
			2-min susp./disqualification	2DIS
	Transition outcome	TO	Transition to positional attac	TPAT
			Transition to interm. outcome	TINT
			Transition to final outcome	TFIN
	Intermediate outcome	IO	Free throw	FTHR
			Referee time out	RETO
			Coach time out	COTO
			Recovery/Rebound	RECO
			Throw-in in favour	THIN
			Free throw + warning	FT+W

2.4. RECORDING INSTRUMENT

The observation tool structure was directly transferred to the recording instrument. *Dartfish TeamPro V.4.5* software was chosen due to its multiple design possibilities.

2.5. PROCEDURE

Among the various types of observational designs available, quadrant II was selected (Anguera & Hernández Mendo, 2013) and an idiographic, punctual, multidimensional design was used.

This research process and phases present the following characteristics, based on OM guidelines:

a) Behaviour units: events and, occasionally, states considered as events were recorded.
b) Observation instrument: a combined system with field formats and a category system was created.
c) Observational sampling (subject sampling): the sample was composed of a selection of Spanish male clubs, divided into two competitive categories: U14 and senior.
d) Observational sampling (inter- and intra-session sampling): intra-session sampling was multi-event and continuous. As regards inter-session sampling, the observation period corresponded to the dates of the championships in scope.
e) Recording type and parameters: highly-systematic recording was obtained during the active or scientific phase, based on OM requirements and through a recording systematisation process. The recording parameters were based on primary units of frequency, order and duration.
f) Data quality analysis and instrument validation: the instrument validity was tested by a group of experts, as established in various studies (Gamonales, León, Muñoz, González-Espinosa, & Ibáñez, 2018; Serra-Olivares & García-López, 2016). In the present study, the expert selection criteria were: 1) academic degree: to hold a PhD or to be a PhD student, and 2) sport degree: to hold a national handball coach certificate. Six experts met these criteria and were responsible for modifying and accepting the criteria listed in a binary-answer questionnaire. Furthermore, a subgroup of three experts collaborated on the instrument reliability assessment process. They underwent theoretical and practical training, as well as two inter-observer reliability assessment sessions, in order to achieve statistically adequate reliability results. A Cohen's *Kappa* value of 0.985 was obtained.

2.6. DATA ANALYSIS

The data obtained can be considered of type II, i.e., concurrent (from the point of view of their occurrence) and event-based (according to the recording type). After recording all categories, most of them being qualitative and nominal-scale variables, a descriptive (data classification and organisation) and inferential

analysis (conclusion drawing) was conducted for every section and level proposed (Anguera & Hernández Mendo, 2015).

Descriptive techniques: the organisation of descriptive results included, as first step, counting the occurrences per category in absolute values or the percentage of each category compared to the total of categories in relative values. Subsequently, data centrality and/or dispersion were assessed.

Inferential techniques for relationships among variables: research design focused on inferential analysis of variable comparison, both in cases where the same categories were compared between SEN and U14 and where SEN and U14 were considered as different variables, but without the intention of analysing them as groups. Under both circumstances, the first step was to build contingency tables to establish the relationship between two or more qualitative variables, through data collection expressed in absolute frequencies. Subsequently, the expected and observed values were compared in the contingency tables applying the chi-squared ($\square^2$) test. P values (*p*) were obtained, indicating statistical significance. The value obtained through the chi-squared test revealed the significance of a particular relationship, but not the strength of association. Cramer's V (*V*) was calculated to determine the degree of association.

3. RESULTS

The following significant relationships were obtained from the independent analysis of SEN and U14 categories, not comparing them, according to the intra- and inter-frame relationships considered.

3.1. SITUATIONAL FRAME AND ITS RELATIONSHIPS

Number and duration of attacking attempts: significant differences were detected between SEN and U14. The t-test *(t)* was applied to the criterion 'transition play', yielding a p value *(p)* that confirmed a significant difference between SEN and U14 (t = 4.489; p <0.0005*;* 95% CI 0.558 to 1.425 s). ANOVA *(F)* was applied to the different types of positional attack (F = 17.840; p <0.0005), revealing the shorter duration of consecutive attacking attempts of one same ball possession (SEN: PA1 = 11.21", PA4 = 6.33"; U14: PA1 = 7.79", PA4 = 5.2").

Participation in each sequence by playing position: significant differences between SEN and U14 were found. The relationships among the categories of the criteria 'playing position' and 'order of intervention in the playing sequence' were assessed. Weak associations were found, both in SEN ($\square^2$ = 769.69*; p* <0.0005*; V* = 0.092) and U14 ($\square\square^2$= 91.753; p <0.0005*; V* = 0.044). It was observed that the longer the sequence, the higher the involvement of the second offensive line (maximum value: SEN: Pivot = 31.8%, U14: Right wing = 50%).

3.2. ACTION-LEVEL FRAME AND ITS RELATIONSHIPS

Ending offensive play and collective actions with ball: significant differences between SEN and U14 were detected. The relationships among the categories of the criteria 'collective offensive actions' and 'ending offensive play' were examined. Weak associations were found, both in SEN ($\chi^2 = 49.563$; $p < 0.0005$; $V = 0.049$) and U14 ($\chi^2 = 45.165$; $p < 0.0005$; $V = 0.058$). Odd offensive systems—3:3(1) and 3:3(2)—were associated with the performance of crossing actions (CROS) (24.5% in SEN), and even offensive systems—2:4 and 4:2—with the performance of fixation actions (FIMO) (21.6% in SEN). The same trend was observed in U14, but with smaller differences.

Ending defensive play and collective defensive actions: significant differences were found between SEN and U14. The relationships among the categories of the criteria 'collective defensive actions' and 'ending defensive play' were analysed, yielding weak associations, both in SEN ($\chi^2 = 256.215$; $p < 0.0005$; $V = 0.088$) and U14 ($\chi^2 = 170.778$; $p < 0.0005$; $V = 0.084$). The 6:0 defence was associated with the defensive actions change of opponent within the same line (COSL) (SEN: 33%, U14: 16.7%) and collective block (COLB) (SEN: 45%, U14: 43%). The 5:1 defence was associated with the change of opponent in a different line (CODL) (SEN: 12.3%, U14: 11.4%).

Collective actions without ball between SEN and U14: U14 players performed a significantly smaller number of collective actions without ball than SEN players. The relationships among the categories of the criterion 'collective offensive actions without ball' between SEN and U14 were examined, yielding weak associations ($\chi^2 = 26.357$; $p < 0.0005$; $V = 0.150$).

3.3. EFFECTIVENESS FRAME AND ITS RELATIONSHIPS

Collective defensive actions (the last of each sequence) and attacking effectiveness: significant differences were detected between SEN and U14. The relationships among the categories of the criteria 'collective defensive actions' and 'attacking effectiveness' were analysed in SEN and U14, yielding weak, but significant (except with rule violation in U14) associations with: technical-tactical error ($\chi^2 = 45.602$; $p < 0.0005$; $V = 0.152$), rule violation (SEN: $\chi^2 = 91.777$; $p < 0.0005$; $V = 0.217$; U14: $\chi^2 = 34.659$; $p > 0.05$; $V = 0.149$), missed shot (SEN: $\chi^2 = 257.927$; $p < 0.0005$; $V = 0.170$; U14: $\chi^2 = 90.828$; $p < 0.0005$; $V = 0.120$) and successful attack (SEN: $\chi^2 = 249.663$; $p < 0.0005$; $V = 0.107$; U14: $\chi^2 = 897.480$; $p < 0.0005$; $V = 0.253$). The collective defensive actions that presented the strongest negative associations with attacking effectiveness were the collective block (COLB) (SEN: 43.9%, U14: 44%) and the double defence (DODE) (SEN: 44%, U14: 36.2%). The collective defensive actions that presented the strongest positive associations with attacking effectiveness were the slide-through (SLID = 63.3%) and the decisive help (DECH = 60.6%) in SEN and the change of opponent in a different line (CODL = 69.2%) and the slide-through (SLID = 60.6%) in U14.

Collective actions without ball and attacking effectiveness: significant differences between SEN and U14 were found. Weak associations were obtained with technical-tactical error □□□ = 10.544; *p* <0.0005; *V* = 0.238) and missed shot in SEN (□□^{2}= 42.598; *p* <0.0005; *V* = 0.164). Lastly, successful attack showed a strong significant association (SEN: □^{2} = 872.457; *p* <0.0005; *V* = 1.033; U14: □^{2} = 305.089; *p* <0.0005; *V* = 0.919).

Attacking and shooting effectiveness depending on playing position and ending area (Figure 2): significant differences between SEN and U14 were observed regarding the association between shooting area and shooting effectiveness. Weak significant associations were found in SEN (□^{2} = 27.34*; p* =0.0001; *V* = 0.295), while they were moderate and significant in U14 (□^{2} = 49.33*; p* =0.0001; *V* = 0.441). The results confirmed a relationship between shooting distance-verticality and shooting effectiveness. Thus, the central part of the goal area after a player's jump was the most effective for SEN and U14 (A11: SEN = 82%, U14 = 88.4%). Besides, a significant difference regarding attacking effectiveness was confirmed between SEN and U14, the latter being the category in which the highest number of technical-tactical errors were made (□^{2} = 15.271*; p* =0.0005; *V* = 0.166). By contrast, U14 performed more successful shots than SEN. The difference in shooting effectiveness among playing positions was significant in SEN (□^{2} = 12.5*; p* =0.029; *V* = 0.198), due to the pivot's higher effectiveness, compared to the rest of playing positions.

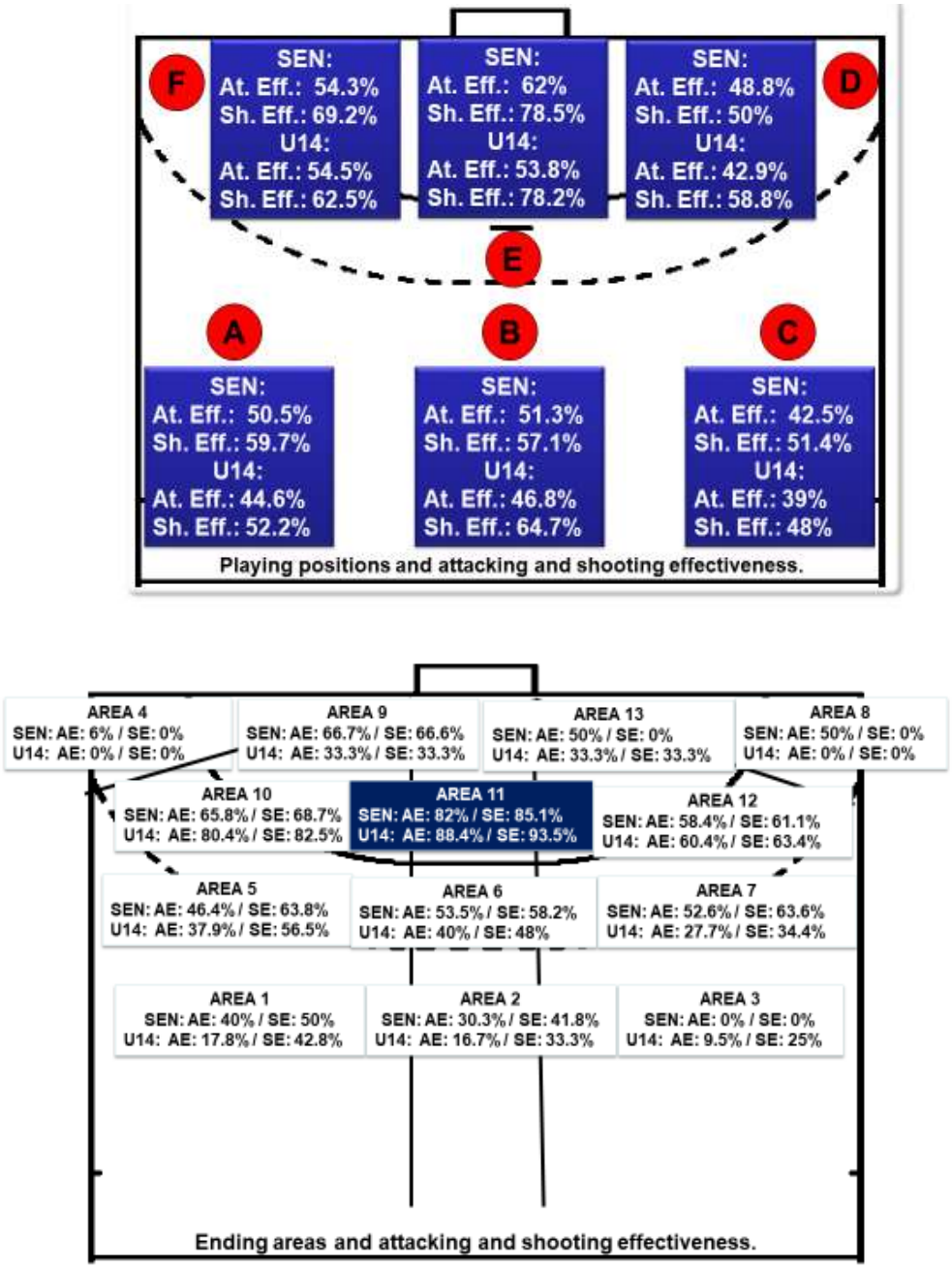

Figure 2. Playing positions, ending areas and attacking and shooting effectiveness.

4. DISCUSSION

4.1. SITUATIONAL FRAME

In the present study, it was decided not to use either possession (Antón, 1990) or competition unit (Álvaro et al., 1995) as observation units, since it was considered that, due to their duration, they did not allow for appropriate distinction of playing phases. Therefore, some of our results cannot be compared to studies based on those units (Gutiérrez, 2006; Lozano, 2014; Montoya, 2010).

The results of this study confirmed the shorter duration of consecutive attempts of one same possession. These findings agree with Daza (2010), but not with Rocha Santos (2004).

It was verified that, the longer the sequence, the higher the involvement of the second offensive line. Our results for SEN are in keeping with Rogulj, Srhoj and Srhoj (2004). Nonetheless, it was not possible to compare our results for U14 to previous research.

4.2. ACTION-LEVEL STRATEGIC FRAME

Playing systems have traditionally been conceived as the continuous recording of action mechanics. Their description focuses on searching for coordination patterns in the offensive (García Herrero et al., 2006) or defensive system (Antón, 2000).

We believe that a certain playing system cannot be explained without taking into account the opposing team's system. Therefore, in our design we have tried to examine those relationships by observing the actual working and evolution dynamics of the defence based on the attacking team's proposal and vice versa. Nevertheless, our findings did not aim to establish a clear mutual attack-defence relationship. Consequently, in both categories observed, the game development based on the playing systems did not to show any evidence of being affected during a specific sequence by the opposing team's proposal.

Odd offensive systems were associated with collective actions that define position-exchange play, while even systems triggered actions that define positional play. That strong relationship between offensive systems and collective actions is, in general, in line with Lozano (2014).

It was found that every defensive playing system triggered specific defensive collective actions. It was not possible to compare this significant relationship between defensive systems and collective actions.

Collective actions are defined as the group coordination of consecutive movements that constitute a playing system. An action is only defined by the coordinated displacement of the players involved (Neves, 2004). The various degrees of collective action complexity has been discussed, entailing difficulties to establish a clear line between complex collective actions and playing systems (Sierra-Guzmán, Sierra-Guzmán, Sánchez, & Sánchez Sánchez, 2015). The general trend is to analyse the most significant collective actions or those contained in the last records of a sequence (Sousa, Prudente, Sequeira, López-López, & Hernández Mendo, 2015).

In this research, collective actions were limited to a few common recording criteria: the relationship between two players involving ball transmission (collective offensive actions with ball), the collaboration of another player without ball (collective actions without ball), and the simultaneous collective action of two players in defence (collective defensive actions). All these

collective actions were recorded in every sequence analysed. As a result, it was observed that the most frequently used collective actions with ball were the support points, barely mentioned in the specialised literature.

It was confirmed that the use of collective actions without ball was significantly higher in SEN than in U14. This should lead to reflection regarding the alleged preference for open defences that should facilitate playing without ball. It was not possible to compare these results.

4.3. EFFECTIVENESS FRAME

As regards effectiveness, we deemed it appropriate to assess shooting effectiveness (Gutiérrez, 2006) in order to explain players' individual level, using possession as observation unit. However, it must be noted that shooting effectiveness data yielded hardly any significant relationship in our study, based on sequence units. Consequently, we aimed to analyse attacking effectiveness as well.

It was verified that U14 players made more attacking errors, but also more successful shots. Besides, the higher attacking effectiveness of SEN players was associated with higher occurrence of intermediate outcomes, i.e., higher number of offensive sequence interruptions with the aim to keep ball possession. It was not possible to compare these results.

Attacking effectiveness did not depend on whether the playing system involved formation change or not. While in U14 differences in favour of shooting effectiveness were found after formation change, SEN players were more effective when shooting without previous formation change. These results were in keeping with Ávila Moreno (2003).

There are other criteria we consider to be more representative to associate success or failure with specific playing systems. Some examples, for which significant differences were obtained in this study, are: 1) shooting area (closer to the centre and with wider angle) and 2) number of rule violations and technical-tactical errors compared to the number of successful attacks.

With regard to the assessment of attacking effectiveness related to the application of collective actions, and due to the significant differences obtained in the present research, we would suggest paying attention to collective action indicators that: 1) are associated with successful defence, as they keep defensive balance: block and double defence, and 2) are associated with successful attack, as they lead to defensive imbalance: decisive help and slide-through.

Lastly, the significant relationship found in this study between collective actions without ball and attacking effectiveness both in SEN and U14, compared to the absence of these actions, must be highlighted. It was not possible to compare the results to previous studies.

5. LIMITATIONS, PRACTICAL APPLICATIONS AND CONCLUSIONS

The major limitation of the present research was the difficulty to compare our results to previous studies involving sports training during childhood and youth. This reveals the need for studies that provide relevant data on early training stages.

Based on the model proposed in this research, a practical assessment was conducted in team sports using small-sided games (handball, basketball and volleyball) in university students from INEFC-Lleida during the academic year 2018-2019. The study was presented at the *30th FIEP World Congress* (Lasierra, Serna, Salas & López-Ros, 2019).

Considering the proposals of other authors (López-Herrero & Arias-Estero, 2019; Morales-Belando & Arias-Estero, 2015; Pérez et al., 2019) and taking into account future research lines emerged from our practical experience, we aim to validate and to apply our instrument to the assessment of specific motor competence in team sports in primary (sport game assessment) and secondary (specific modality assessment) schools. Different levels of specification of the recording instrument would be used, according to the educational level.

The following conclusions of the present study must be highlighted:

With regard to the main aim: a recording instrument that combined the three action levels existing in team sports and that related them to the effectiveness frame was validated and applied in handball competition situations.

With regard to the secondary aim: significant and non-significant relationships were established by comparing elite and youth competition categories using one single observation instrument, what confirms its usefulness and transferability.

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