DESIGN, VALIDATION, AND RELIABILITY OF AN OBSERVATIONAL INSTRUMENT ASSESSING PIVOT INFLUENCE ON TACTICAL EFFECTIVENESS IN TEAM-HANDBALL

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Abstract:

The objective of this study was to design and study the validity and reliability characteristics of an observational instrument to assess the tactical behavior of pivots in handball and its influence on tactical performance of the team. The process consisted of five stages. In the first two, a combined instrument using field formats and category repertoires was designed. The third stage consisted of validating the contents by consulting a panel of highly qualified experts. The fourth phase produced reliability indices, according to Cohen's kappa test, for both inter-observer and intra-observer performance, of over .86. Finally, the instrument was applied to a pilot study; a correlational study using Pearson's Chi-squared test yielded very significant dependence coefficients ($p<.001$) among variables, confirming the usefulness of the instrument in the search for tactical performance indicators related to the handball pivot.

Key words: *observational tool, team handball, pivot player, tactical effectiveness, match analysis*

Introduction

In collective invasion sports such as team handball, performance is based on a complex interaction of variables (Glazier, 2017). In a tactical approach to the game, it is necessary to determine which events or variables can be considered as performance indicators (Jones, Mellalieu, & James, 2004). These indicators must be quantifiable (O'Donoghue, 2010) and must provide meaningful information (McGarry, 2009). Researchers aim to find a relationship between tactical elements and subsequent outcomes, in order to produce objective and reliable indicators for coaches (Prieto, Gómez, & Sampaio, 2015). However, Sarmento et al. (2014) warn that the definition of tactical indicators is not sufficiently standardized. In fact, there does not seem to be a consensus on which indicators predict the performance of a handball team (Daza, Andrés, & Tarragó, 2017).

The study of the incidence of different specific positions in match analysis, with special emphasis on the effectiveness of the shot, has been a common variable in handball research (Volossovitch, 2013), differentiating the weight of each position on the final outcome (Bilge, 2012; Gutiérrez & Ruiz, 2013; Hassan, 2014; Montoya, Moras, & Anguera, 2013). To do this, several studies use the official data offered by the organizers, which has been validated in different investigations (Blanco, Ibáñez, Antúnez, & Hernández-Mendo, 2015; Meletakos, Vagenas, & Bayios, 2011).

The importance of the specific position of the pivot has been pointed out by several authors to the point that Meletakos et al. (2011) or Bilge (2012) conclude in their studies that the efficiency of the pivot is a variable that determines the quality of the teams, a statement that is in contrast with the conclusions of the research by Srhoj, Rogulj, and Katić (2001), which rules out the incidence of the pivot as an outcome variable compared to the relevance of other positions, or by Montoya et al. (2013) affirming that the percentage of goals scored by the

pivots remains constant among teams of different level. There does not seem to be a consensus on this. On the other hand, it must be considered that the pivot, due to his/her location inside the opposing defensive system, performs fewer actions with the ball than the other offensive positions, and the analysis of his/her impact on the result should not be reduced to actions with the ball that are usually collected in these investigations. In this sense, several studies such as those by Daza (2010); Santos, Fernandez, Oliveira, Leitão, and Anguera (2009), and Días Santos (2012) create "ad hoc" tools to collect data on the pivot's participation in the collective game, including the actions without the ball. Following the same perspective, Duarte Sousa, Sequeira, and Hernández-Mendo (2014) as well as Duarte, Prudente, Sequeira, López-López, and Hernández-Mendo (2015) include the pivot as a key element in the description of 2x2 offensive situations, which have been collected by a specific instrument designed and validated for it. It seems that the study of the specific position of the pivot is not only of interest to scientific community, but it should also aim at finding the instrument that would collect pivot's participation in the game without the ball as an essential part of it. However, we did not find studies, nor, consequently, have observational instruments designed to assess how the pivot's location on the court, his/her either presence in or absence from the playing zone next to the ball influences the defensive actions or actions of the attacker holding the ball. We think that this is a factor that is pertinent to know, as has been shown by the validation questionnaire of the contents of the instrument developed in the present research, which was passed to recognized handball experts. Including this factor in the assessment of tactical performance and the resolution of game situations can be of high value in the operational strategies of matches, as well as in the design of training tasks.

Observational research studies, thanks to the development and validation of *ad hoc* instruments, stand out for their flexibility and capacity to adapt to different contexts and objects of study (Chacón-Moscoso, et al., 2018), and are considered suitable for the collection of relevant information from the game (Anguera & Hernandez-Mendo, 2013, 2014).

Anguera and Hernandez-Mendo (2013, 2014) compiled 85 observational studies in sport from 1999 to 2013, while Ávila, Chirosa, Ureña, Lozano and Ulloa (2018), in their systematic review of tactical performance indicators, added other 59 observational studies to that list, noting that 24% of the 62 included in Ávila et al. (2018) used observational instruments developed *ad hoc* for each study.

However, for the data obtained by these observational instruments to have the required quality and validity, they must be designed following a process that allows their validation and guarantees the reliability of the data obtained. These processes must be explicitly incorporated into the different observational studies. There are also specific articles on the design, validation and quality control of different observational instruments for collective sports (Cuerva & Ruano, 2017; Hernández-Mendo, Montoro Escaño, Reina Gómez, & Fernández García, 2012; Jiménez & de Santos Gorostiaga, 2015; Oliva-Millán & Blanco-Villaseñor, 2011; Prudente, Garganta, & Anguera, 2010; Santos, Sarmento, Alves, & Campaniço, 2014; Sarmento, Anguera, Campaniço, & Leitão, 2010; Vaquera, Cubillo, García-Tormo, & Morante, 2013) and in particular in handball (Jiménez & Hernández-Mendo, 2016; Martín, González, Cavalcanti, Chirosa, & Aguilar, 2013; Morillo, Reigal, Hernández-Mendo, Montaña, & Morales-Sánchez, 2017; Prudente, Garganta, & Anguera, 2004).

A number of studies in handball have aimed to determine which variables of the game can be considered indicators of tactical efficacy. These studies collected variables from the game, along with the results (current score, final result or tournament ranking), and applied the necessary analysis to determine relations of dependence (Bilge 2012; Daza, Andrés, & Tarragó, 2017; Gomez, Lago-Peñas, Viaño, & Gonzalez-Garcia 2014; Meletakos, et al., 2011; Prieto, Gómez, & Sampaio, 2016; Rogulj, Srhoj, & Srhoj, 2004; Saavedra, Dorgeirsson, Chang, Kristjánsdóttir, & García-Hermoso, 2018; Saavedra, Þorgeirsson, Kristjánsdóttir, Chang, & Halldórsson 2017; Yamada, Aida, Fujimoto, & Nakagawa, 2014; Yamada, Aida, & Nakagawa, 2011).

Given the existing interest in the search for tactical performance indicators, differentiated by playing positions, the high use of observational methodology, and the lack of data on the pivot when he/she is not directly involved in tactical with the ball, this study tried to achieve the following objectives: 1) To design an observational instrument, henceforward named Pivot's Influence on the Final Situation (PIFS), capable of collecting the maximum information from the pivot's play (whether the pivot is the finisher player or not) at the end of the attack sequences, contextualizing accurately and in detail this final situation, and collecting outcome data. 2) To validate its contents. 3) To assess the quality of data collected. 4) To test whether the observational instrument is capable of generating meaningful data about the relationship between the pivot's involvement and the tactical effectiveness of attack sequences, thus determining tactical performance indicators.

Methods

The observational instrument designed and validated in this study combines field formats and category systems, enabling the measurement of

different dimensions of events (Sarmento, et al., 2016). The process described below has been faithfully followed and the data reported has not been manipulated or misrepresented at any time.

A five-stage design and validation process were used: an initial design of the instrument according to the set objectives; the second design, creation of an automatic data collection panel and checking of it; validation of the contents of the tool by experts; reliability assessment by the observers; a pilot study applying the observational tool in order to find out its ability to obtain meaningful data on tactical performance.

The first stage was the creation of the initial design, in which a mixed inductive and deductive process was used. Three initial sources were used: (1) a bibliographic review; (2) the experience of the researchers and coaches interviewed (Sarmento, et al., 2016). In this case, all researchers were university professors of handball with experience as coaches for the highest Spanish handball (ASOBAL) leagues; and (3) a "passive exploratory phase" using attack sequences in recorded matches (Prudente, et al., 2004; Sarmento, et al., 2010). This stage was specified in the first event recording instrument with the aim of reducing the sources of error (Losada & Manolov, 2015). In total, 136 valid records were collected that allowed the first debugging of the system (Prudente, et al., 2004).

In the second stage, we redesigned the observational tool and created an automatic data collection panel. After presenting and discussing the instrument at the 13th Andebol Technical-Scientific Congress (Lisbon, 2016), the expert opinions were considered to improve the design of the tool and a registration panel was developed using the software Lince V 1.3 (Gabin, Camerino, Anguera, & Castañer, 2012), which had already been used in similar studies (García-Marín & Iturriaga, 2017; Lozano, Camerino & Hileno, 2016; Suárez-Cadenas, & Courel-Ibáñez, 2017; Trejo & Planas, 2018). To check the functionality of the instrument, it was used to collect data from the 2018 EHF Champions League Final Four matches.

In the third phase, the contents of the instrument was validated with the collaboration of a panel of experts (Costa, Garganta, Greco, Mesquita, & Maia, 2011; Mira Sánchez, Martín Tamallo, Chirosa Rios, & Carrera Villabona, 2016; Santos, et al., 2014; Vaquera, et al., 2013), to get an insight into the relevance and suitability of the items included in the tool. The panel was made up of four highly qualified experts: professors of handball with experience as coaches in high-level handball competition (ASOBAL league), three of whom had completed doctoral theses in observational methodologies in handball. They were given a questionnaire designed according to the structure proposed by Santos et al. (2014): 1) presentation of objectives; 2) a form to collect data on the qualification and academic level of the experts, as well as their professional experience in handball; and 3) description of the instrument by criteria and categories (including explanatory graphs), using a 5-point Likert scale to assess the instrument's relevance (interest of the instrument, criteria and categories) and suitability (clarity and adjustment of definitions), plus an open-ended question for comments (see Fig. 1). All categories and criteria used for the instrument got value above 4 on the scale and no value was below 3.

CRITERION	**Relevance** Does the criterion relate to the object of the study and its dimension?					**Suitability** Is the definition of the criterion understandable to the observer?				
	1	2	3	4	5	1	2	3	4	5
Number of defenders and distribution.										
Proposal for modification:										
CATEGORY	**Relevance** Does the category relate to the object of the study and its dimension?					**Suitability** Is the category definition understandable to the observer?				
	1	2	3	4	5	1	2	3	4	5
No defenders										
One defender										
Two aligned defenders										
Two staggered defenders										
Proposal for modification:										
No defenders										
One defender										
Two aligned defenders										
Two staggered defenders										

Note. Value from 1 to 5, where "1" is the minimum value and "5" the maximum value.

Figure. 1. Example of the experts' questionnaire for a criterion and categories.

The fourth stage assessed the reliability of the observation using the instrument (Cuerva & Ruano, 2017). After the observers (three participating researchers) had completed their training process, inter-observer reliability was checked in pairs between the three researchers, and subsequently the intra-observer reliability of the principal investigator was also assessed. In both cases the Cohen's kappa was applied to the data collected from the samples used.

Finally, in the fifth stage, a pilot study was carried out in which the instrument was applied to the four final matches of the European Championship of 2018 (semifinals, final and third/fourth place) and a valid sample of 357 offensive sequences was collected to find out if the instrument was operational and was it possible to collect data relevant to the objective for which the tool was created. The resulting instrument, PIFS, is structured around three large dimensions: contextual framework, final situation, and result (see Fig. 2). PIFS is a highly molecular instrument that, in addition to fixed markers, is composed of up to 19 categorical nuclei, with repertoires of up to twelve categories. The unit of observation is one attack sequence (Lozano, et al., 2016; Volossovitch, Dumangane, & Rosati, 2010).

The contextual framework places the observed moment within a strategic framework and within the competitive situation of the match (Teles & Volossovitch, 2015), allowing a static and dynamic analysis of the game (Prieto, et al., 2015; Volossovitch, 2013). The game, analyzed as a complex dynamic system, is constantly rebalancing with the environment, where sometimes the events of the game act as attraction elements and sometimes modifications of the environment serve this function (Lebed, 2013).

In the "final situation" dimension, data are collected on the final moment of the attack sequence; spatial and opposition parameters, including the relationship of the pivot with the finisher (ball-

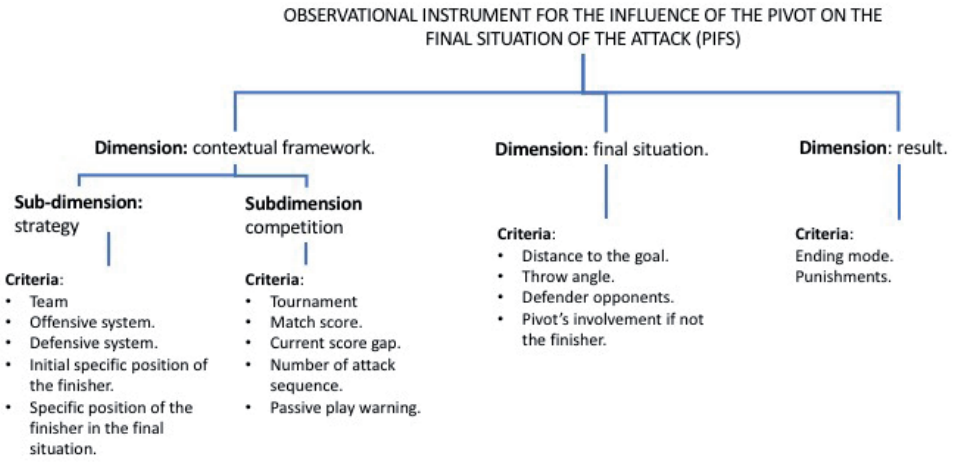

Figure 2. Structure of the PIFS instrument.

Table 1. Categories of the contextual dimension

CONTEXTUAL DIMENSION	
SUB-DIMENSION: STRATEGY	
CRITERIA:	CATEGORIES:
Team	Team observed.
Offensive system	3:3 one pivot; 3:3 two pivots; 2:4; 4:2.
Defensive system	6:0; 5:1; 4:2; 3:2:1; 5:1 combined; 4:2 combined; one-to-one; two-line defence.
Initial specific position	Pivot, right winger, left winger, right back, left back, center.
Specific position in the final situation	Pivot, right wing, left wing, right back, left back, center.
SUB-DIMENSION: COMPETITION	
Tournament	Tournament observed
Match score	Advantage of 4 or more goals, advantage of 3 or less goals, draw, disadvantage of 3 or less goals, disadvantage of 4 or more goals.
Current score gap	Wins by 4 or more goals, wins by 3 goals, wins by 2 goals, wins by one goal, draw, loses by one goal, loses by 2 goals, loses by 3 goals, loses by 4 or more goals.
Number of attack sequence	1st sequence, 2nd sequence, 3rd sequence, 4th sequence, 5th and following sequences.
Passive play forewarning signal	There is a forewarning signal, there is no forewarning signal.

handler) and the defenders. It is in this dimension that the instrument is very detailed, molecular, and makes its main contributions (see Table 2).

Finally, the dimension of result gathers the events that identify the way in which the sequence of attack ends (see Table 3), providing data that can be graded to rate effectiveness and determine performance indicators (Daza, et al., 2017).

Then, to find out if there were possible significant correlations between the different items, the Pearson's Chi-square test was applied.

Results

In the third stage (contents validation) all experts rated the objectives of the study as relevant. The relevance and suitability of the catalogue of criteria and repertoires of categories showed values between 4 and 5, with a level of reliability over .98. In the data reliability study (the fourth stage), inter-observer reliability showed a Cohen's kappa coefficient of over .89, with coefficients over .85 in all dimensions, and no criteria below .60. This check was carried out not only globally but also by dimensions and criteria to avoid some criteria, such as results or sequence numbers with results very close to one, concealing inadequate ratios in others. It is important to highlight that the contextual dimension coefficients were over .9 and the situational dimensions were .87.

In the principal investigator's intra-observer reliability test, with a 1-week interval between the observations, the results were .86 overall and all dimensions were over .80, with all criteria having indices higher than .60.

Once the reliability of the instrument was validated, the next objective sought in the fifth phase was to validate the quality of the data that the instrument allowed to collect, that is, whether the data collected by the observational tool allowed to evaluate the real incidence of the pivot's technical-tactical behavior and its influence on the tactical performance of the team.

To achieve this goal, a pilot research was carried out collecting data from four games that involved 357 recorded attack sequences. Two types of statistical analysis were applied to these data: descriptive and correlational.

The descriptive analysis indicated that the pivot was the finisher player in 13.2% of sequences. In only 28% of cases, the finisher acted without the close presence of a pivot. In the other 72% of cases, with the presence of a pivot, the pivot had a direct relationship with the finisher in 40.9% of the situations; this means there was only one defender between them. Therefore, the instrument allowed researchers to discriminate between three types of final situations of the attack sequences whose differentiated analysis may be relevant to the objectives for which the instrument was created: final attack situations completed by the pivot, situations completed by another player without pivot's presence, and situations completed by another player with pivot's direct presence next to the ballhandler.

Table 2. Categories of the final situation

DIMENSION: FINAL SITUATION	
SPATIAL FACTORS	
Distance to goal	6 meters, between 6 and 9 meters, beyond 9 meters.
Throw angle	Wide, reduced, mínimum.
OPPOSITION	
Number of defenders and distribution	No defenders, one defender, two defenders aligned, two defenders staggered.
Situation with respect to the finisher	Away, close, in touch.
PIVOT'S INVOLVEMENT IF NOT THE FINISHER	
Presence	No pivot, one pivot, two pivots, more than two pivots.
Relationship with the finisher	Direct, indirect, two direct pivots, two indirect pivots, one direct and one indirect pivot.
Location with respect to the finisher	On throwing line, strong side, weak side, two on throwing line, two on strong side, two on weak side, one on strong side and one on weak side, one on throwing line and one on strong side, one on throwing line and one on weak side, more than two pivots in all locations.
Location with respect to the defenders	Behind, in front, beside, two behind, two in front, two beside, one in front and one behind, one beside and one in front, one beside and one behind.

Table 3. Categories of the result dimension

DIMENSION: RESULT	
Ending mode	Goal scored, goal throw, 7-meter, free throw, ball loss, ball loss by passing, final signal or time-out, outside.
Personal punishments	None, warning, suspension, disqualification.

Table 4. Contingency table, Pearson Chi-squared test application results

		CONTEXTUAL DIMENSION										SITUATIONAL DIMENSION										RESULT D.	
		OFFENSIVE SYSTEM	DEFENSIVE SYSTEM	TEAM	INITIAL SPECIFIC POSITION	FINAL SPECIFIC POSITION	TEAM	MATCH SCORE	SEQUENCE NUMBER	PASSIVE WARNING	DISTANCE TO GOAL	ANGLE	DEFENDERS NUMBER	DISTANCE TO DEFENDERS	PIVOT PRESENCE	PIVOT LOCATION	PIVOT RELATI WITH FINISHERS	PIVOT LOCATION TO DEFENDERS	ENDING MODE	PUNISH.
CONTEXTUAL DIMENSION	OFFEN. SYST.		52,615 ***	36,604 ***	49,712 ***	17,104	5,176	23,645	10,496	5,401	9,173	4,016	18,538 *	7,836	148,963 ***	130,821 ***	123,541 ***	129,205 ***	29,969	2,802
	DEFEN. SYST.			79,868 ***	32,456	42,333	47,513 ***	84,718 **	11,448	19,461 **	11,357	18,305	11,875	8,900	13,883	47,943	20,422	55,083	87,083 ***	1,344
	TEAM				25,525 *	25,528 *	174,831 ***	219,015 ***	39,889 ***	11,985 **	7,781	23,111 **	16,325	25,109 ***	47,073 ***	47,595 **	31,349 **	59,815 ***	35,272 *	7,652
	I. S. P.					1061,089	10,396	44,428	28,333	4,802	136,950 ***	138,634 ***	51,338 ***	14,822	101,939 ***	75,598 **	23,369	46,021	67,951 **	10,123
	F. S. P.						10,861	41,369	31,345	4,424	163,894 ***	215,971 ***	75,594 ***	21,569*	104,477 ***	76,478 ***	21,929	43,265	58,749 **	11,637
	M. SCORE							148,941	11,353	,305	7,109 *	,335	1,527	1,055	6,856	6,235	5,077	14,079	5,097	,773
	S. GAP								46,337 *	21,723 **	29,868 *	20,153	16,296	18,167	21,507	74,484	34,610	52,429	46,745	27,868*
	SEQUEN.									131,141 ***	14,110	8,878	16,169	10,822	8,879	25,776	16,577	27,110	20,295	2,961
SITUATIONAL DIMENSION	PASSIVE										4,417	3,357	7,279	,265	,881	10,342	4,951	7,063	14,908 *	1,003
	DISTANCE											47,490 ***	98,372 ***	53,349 ***	60,764 ***	57,366 ***	12,481	33,659 **	131,155 ***	4,392
	ANGLE												13,868 *	6,749	4,113	33,723 **	19,763 *	25,647	33,416 **	1,310
	DEFEND.													10,496	23,541 **	32,418	17,188	40,290 *	93,773 ***	1,767
	D. DIST.														50,625 ***	55,797 ***	23,479 **	27,084 *	97,740 ***	7,414
	PIVOT P.															262,034 ***	263,521 ***	257,864 ***	46,638 **	46,638
	P. L. F.																348,205 ***	328,162 ***	133,932 ***	11,157
	P. REL.																	273,385 ***	51,776 **	2,709
R. D.	P. L. D.																		62,998	19,700
	E. M.																			23,244
	PUNISH.																			

*p < .05. **p < .01. ***p < .001.

For the correlational study among the different variables of the attack sequences that were not completed by the pivot, Pearson's Chi-square test was applied to the results (Table 4). It is accepted that when a significance value p<.05 is given, the non-parametric variables have bidirectional dependence between them. In Table 4, we found out that the test produced significant values p<.05 in 14 correlations, p<.01 in 18, and p<.001 in 41 of them. Significant values were found for the relationships among three of the four variables relating to the pivot and the result of the attack sequence: p<.001 for the situation of the pivot with respect to the finisher (133,932), p<.01 for the level of relationship between the pivot and the finisher with the way of solving the final situation (51,776), and for the number of pivots present in the final situation with the way of finishing the attack sequence by the ballhandler (46,638). Significant results were also found for the variables that defined the final situation with the pivot's variables: p<.001 for the distance of final situation with the presence of the pivot (60,764) and the pivot's situation (57,366); the distance of defenders to the finisher with the presence of the pivot (50,625) and the pivot's situation (55,797). Therefore, we can say that the data collected by the observational tool allowed us to obtain significant information about the objective it was created for.

Discussion and conclusions

The instrument fulfils the first objective of the study: designing an observational instrument to assess the tactical behavior of pivots in handball and the influence of that behavior on tactical performance of the team. This instrument, Pivot Influence on Final Situations (PIFS), lets researchers collecting detailed information on the final situation (distance, angle, number of defenders and their distribution, and situation of defenders with respect to the finisher) and information about the pivot (presence, relationship to the finisher, location in relation to the finisher, and location in relation to the defenders), adding variables to those investigated in previous specific studies of the pivot (Duarte, et al., 2014, 2015). The structure of the tool (PIFS) in different dimensions allows to relate the situation of the pivot in the finishing situations to the manner of finishing and its outcome, thus determining its influence on the tactical effectiveness of the attack.

The validity of the content was amply achieved thanks to very highly qualified experts: professors with doctorates in handball research and with experience in ASOBAL.

The inter-observer and intra-observer reliability tests yielded values over .85, validating the quality of the data obtained by the instrument and thus fulfilling the third objective of the research. This is notable considering the 19 categories and the complex observations including relationships between players at specific times. Martín et al. (2013) and Cuerva and Ruano (2017) achieved results over .70, while Duarte Sousa et al. (2014) obtained values ranging .85-1.

The quality of the data is determined by the possibilities of reaching meaningful conclusions

about the influence of the pivot on the effectiveness of the attack. Data obtained from the pilot study revealed a high level of pivot's in the completion of the sequence of attack, both as the finisher (13.78%) and by his/her presence (72%) in the situations finished by a teammate. The correlational analysis also supports the usefulness of the data obtained using the instrument. The instrument detected dependences between registered variables, 41 of them at $p<.001$, and produced relevant data for the analysis of the influence of the pivot on the tactical efficiency of attacks. Significant correlations were found among the variables relating to the pivot, the final situation and the result. So, the observational instrument (PIFS), generated by the research is relevant, reliable and able to gather data of good quality.

The main contribution of this observational instrument lies in the inclusion of items not found in other similar studies, such as the distribution of defenders and their relationship to the finisher, and the location of the pivot with respect to the finisher and the defenders, being able to describe and grade the relationship of the pivot with the finisher, making it possible to study the pivot's influence on the final situation even if there are no game actions in which the pivot participates directly.

Using the instrument, it is possible to collect data that enable analysis of the relationships between the type of final situation, the involvement of the pivot, and the outcome. This should make it possible to define tactical performance indicators related to the pivot, which are of practical use for coaches.

However, the thoroughness in the description of the final situation requires high precision in determining the moment to collect data. For this reason, a training process for observers and data quality control is necessary, and sample size may be limited.

Despite this limitation, knowing the differentiated performance of ballhandlers in the presence or absence of the pivot has practical implications for match strategy and for the design of training activities.

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