

# DESIGN, VALIDATION, AND RELIABILITY OF AN OBSERVATION INSTRUMENT FOR TECHNICAL AND TACTICAL ACTIONS IN INDOOR VOLLEYBALL

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## ABSTRACT

The purpose of this paper was to design, validate, and test the reliability of an observation instrument to analyse technical and tactical actions in indoor volleyball. The instrument collects information regarding: a) match context, b) game situations, c) technical actions of the serve, reception, set, attack, block, and court defence in relation to the player that intervenes, role, manner of execution, execution zone, and efficacy, and d) result of the play, and way the point was obtained. Instrument design and validation was done in seven stages: a) review of literature and consultation of experts; b) pilot observation and data analysis; c) expert qualitative and quantitative review of instrument; d) observer training test; e) expert review of instrument to establish content validity; f) measurement of the predictive ability of the instrument regarding the set's result; and g) measurement of the differences between practice and competition situations. The results show that the instrument allows for obtaining objective, valid, and reliable information about the players and team in offensive and in defensive actions.

**Key Words:** performance, evaluation, team sport, match analysis

## RESUMEN

El propósito de este trabajo fue diseñar, validar, y testar la fiabilidad de un instrumento observacional para analizar las acciones técnico-tácticas en voleibol. Este instrumento recoge información sobre: a) contexto del partido, b) situación de juego, c) acciones técnicas de saque, recepción, colocación, ataque, bloqueo, y defensa en campo en relación al jugador que ejecuta, su función de juego, la forma de ejecución, la zona de ejecución, y la eficacia, y d) resultado de la jugada y forma obtener el punto. El instrumento fue diseño y validación en siete etapas: a) revisión de la literatura y papel de expertos; b) estudio piloto de observación y análisis de datos; c) revisión cualitativa y cuantitativa del instrumento por expertos; d) entrenamiento de observadores; e) revisión del instrumento por expertos (validez de contenido); f) valoración de la capacidad de predictiva del instrumento en relación al resultado del set; y g) valoración de las diferencias entre situaciones de entrenamiento y competición. Los resultados muestran que el instrumento permite obtener información objetiva, validad y fiable sobre los jugadores y los equipos en sus acciones de ataque y defensa.

**Palabras clave:** rendimiento, evaluación, deporte de equipo, análisis de juego

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## INTRODUCTION

The study of the actions of one's own team and one's opponent (i.e. match analysis) is common in volleyball (Palao & Hernández-Hernández, 2014). The structure of volleyball (alternating participation, three contacts per team, all actions count, etc.) allows you to monitor the players' and teams' ball actions in live competition in peak performance. There is a lot of software that makes these tasks easier for coaches (e.g. Data Volley, Salerno, Italy). They offer the possibility to collect data that are integrated with video of the match. They also provide the opportunity to review video and data evaluation perspectives at the same time.

In volleyball, all players' interactions with the ball are usually registered with regard to technique used, manner of execution, and efficacy. The performance of the actions is measured in relation to the effect of the actions on the rally or the possibilities given to the team with possession of the ball. The coaches call this type of analysis "game statistics". This type of analysis seeks to objectively evaluate players in practice and in competition. It is difficult to establish where the use of this system began in volleyball. However, a key moment was when Coleman, Neville, and Gordon (1969) published an adaptation of the efficacy criteria used by the United States national team in the 1968 Olympic Games. The original system was created by Rod Schall in 1967. This system was later adapted and utilised in all competitions by the Federation International of Volleyball (FIVB), and it is known as the FIVB system.

Both for coaching and research, the use of these observation instruments is very common in volleyball, although always with adaptations to the team's needs or to the research problem (Palao & Hernández-Hernández, 2014). Most of the information available and the effort used to ensure the quality of these observation instruments (validity, reliability, and objectivity) is related to specific training, courses for observers, or monitoring observer reliability (inter- and intra-observer). In contrast, the effort or focus placed on the way this instrument is designed or validated is low. In research, most of the studies that were reviewed did not include information about the design and validation. Also, there is a lack of connection between the monitoring done by coaches and those by researchers (Esteves et al., 2010; Palao & Hernández-Hernández, 2014; Williams & Kendall, 2007). Therefore, the variation in the criteria for analysis and the lack of knowledge regarding the adequacy of the instrument used do not allow for a comparison of the data obtained by different teams, competitions, or researchers.

When analysing the situation from both perspectives, it appears that the day-to-day of coaches and researchers ensures that the instrument that they are using is adequate for the given use. To our knowledge, the observational

instruments used in indoor volleyball to evaluate efficacy of ball contacts have not been validated, although Schall tested the system in a funded project in 1982-1984 (Schall, 1985). The instrument can be used as a reference partially or in its entirety by coaches and researchers, while involving both in the development process (Tilp, Koch, Stifter, & Ruppert, 2006). Its development also tries to resolve the lack of validated instruments found in the literature. This observational instrument will provide information about how the technical and tactical actions are correlated to the game outcome (Hughes & Bartlett, 2002; Mesquita, Palao, Marcelino, & Afonso, 2013) and will help to provide more information related to the dynamic system that involves team sport confrontation (Glazier, 2010). The purpose of this paper was to design, validate, and test the reliability of an observation instrument to analyse the technical and tactical actions in indoor volleyball.

#### METHOD

The design and validation of the instrument was done in seven stages. In the first two stages, the observation instrument and a category system (Anguera, 2003) were designed. In the other five stages, validity and reliability were established and calculated (Anguera, 2003; Trochim & Donnelly, 2007). The study was approved by the Ethics Committee of the University of Murcia. In the first stage, a draft of a list of behaviours was created from related scientific literature and expert review. A preliminary list of variables was established after analyses of the sport's characteristics, the variables studied in other research papers, and volleyball statistical systems. A review of the following databases was done: Web of Knowledge (WOK) of ISI (Thomson), Sport Discus, Google Scholar, Sponet, Scielo, and Dialnet. The key word of the search was "volleyball". A review of the abstracts was carried out to select the papers related to match analysis. The list of variables included the behaviour's definition and its possible categories. The variables and categories were mutually exclusive, and a numerical code was given to each variable. The unit of analysis was the rally. The data of the rally actions were collected concurrently, and the time when the rally started and ended was also registered. The information was registered using a spreadsheet. The variables were divided into four groups: match, set situations, technical situations, and result of the play. A report with data from the observational instrument was presented and reviewed by the coaches. The first draft of the categorical system and application was analysed and reviewed by three experts and the researchers. The experts had the following characteristics: they were coaches with more than five years of coaching experience in indoor volleyball, they were university professors, and they had their doctorates in physical activity and sport. The review at this stage was done by consensus, after an explanation of the

advantages and disadvantages of different ways to categorise the variables. When consensus was not reached, the experts discussed and defended their point of view.

In the second stage, the draft of the list of behaviours was used to carry out a pilot observation test. Two men's and two women's matches from the 2005-2006 season of the Spanish first division were observed by one of the researchers with a posterior view of the court (6-8m behind the court at an approximate height of three metres). They had the goal of adapting and establishing the criteria for the different variables to add them to the list of variables and category definitions. In this stage, an observation manual of the instrument was developed. A descriptive analysis of the values obtained in the observation was done. When the frequency of a variable's category was less than 10%, the category was reviewed by the researchers and the expert group in the first stage. The researchers analysed the data and compiled a report in order to ensure the applicability of the data, and the analysis and report were reviewed by the researchers and coaches. In this stage, the possibility of automating or indirectly calculating part of the observation was reviewed. After the pilot studies, a second list of behaviours was made, including the behaviours' modifications and variations.

In the third stage, the operationalisation, relevant content, and description of the instrument was reviewed by six experts (coaches or former coaches of higher Spanish divisions with at least of 10 years of coaching experience in indoor volleyball; four were university professors with their doctorates) through a qualitative and quantitative evaluation of the instrument. Experts were asked about (table 1): a) comprehension of the definitions of the behaviours from the observation instrument, b) pertinence of behaviours, and c) whether to include other behaviours in the observation instrument. The level of pertinence was defined as whether including the variable in the aspects to be observed was conceptually adequate. The level of comprehension was defined as whether the variable and category were properly defined and whether there were clear criteria for carrying out the observation. The quantitative evaluation of comprehension and pertinence consisted of a scale from 0 to 10. Items with average values  $<7$  were eliminated, items  $\geq 7$  and  $\leq 8$  were reviewed, and items that were  $> 8.0$  were accepted (Bulger & Housner, 2007). After this feedback, a new list of behaviours was established.

TABLE 1  
Sample questionnaire sent to the experts.

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**Execution of the reception**

(a) **Definition:** Technique used to neutralise the serve done by the opponent. It is a categorical variable. Three categories were differentiated: 1) bump, when the reception is done both using both of the forearms; b) overhead, when the ball is hit with the hands or forearms together and/or one over the other; and c) other techniques, the rest of the techniques not included in the previous categories.

Poorly defined 0 - 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10 Very well defined

Proposed definition, in case the previous one was not clear:

(b) **Pertinence:** Does it seem pertinent to include the "execution of the reception" as a variable to be observed?

Not Pertinent 0 - 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10 Very pertinent

(c) **Inclusion:** What other category would you add to the observation instrument for the initiation of ball possession?

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In the fourth stage, a third pilot study of observer training and an observation test were carried out. Three observers were trained in the use of the observation instrument during four two-hour sessions (a 10 minute break was given after 55 minutes). The observers had degrees in sport science, had the highest volleyball coaching certifications in Spain (level III), were former volleyball players, and had experience as observers (for research and sport scouting). The observation training followed the criteria established by Anguera (2003) and Behar (1993), and it was directed by one of the researchers. An observation manual (both on paper and video) was used in the training. During the observer training, the lack of agreement between observers produced several modifications in definitions as well as criteria of the categories in order to reach observer agreement. The final agreement was achieved in this phase by consensus. After the sessions, two men's and two women's matches from the 2005-2006 season of the Spanish first division were used for training with posterior views of the court (6-8m behind the court at an approximate height of three metres). These matches were different from the

ones used in the second stage. When no unanimous agreement was reached, the aspects were reviewed with the observers in an extra session. All problems in the comprehension of variables, categories, and modifications of the category criteria were registered. After this stage, a new list of behaviours was established. Another match from the 2005-2006 season of the Spanish first division was observed with a posterior view of the court to establish inter- and intra-observer agreement. Cohen's kappa was utilised to evaluate observer agreement, and a researcher was used as the reference to establish the reliability. The first observation was followed by the second observation a week later.

In the fifth stage, the review of the operationalisation, relevant content, and description were repeated by the six experts from the third stage. After this feedback, the list of behaviours was established. From the responses provided by this group of experts, a descriptive analysis was done (mean, median, and mode for all variables). To calculate the content validity, Aiken's V was utilised (Merino & Livia, 2009; Penfield & Giacobbi, 2004).

In the sixth stage, the ability of the instrument to discriminate different competition age groups was measured (Trochim & Donnelly, 2007). Twenty-eight sets from the U-14 Spanish women's National Championship (2007-2008 season) and 31 sets from the first Spanish division's club championship (2007-2008 season) were analysed. Only the first four sets of a match were considered. The manner of execution and efficacy of the different actions (serve, reception, set, attack, block, and dig) by the different teams were analysed. The matches were recorded from a posterior view of the court (6-8m behind the court at an approximate height of three metres). The observation was done by an observer that had a degree in sport science, had the highest volleyball coaching certifications in Spain (level III), and was a volleyball coach. The same protocol for observer training and data quality control that was described in previous stages was done. A discriminant inferential analysis of the data was done to find those statistical variables that are associated with the studied behaviors (Ntoumanis, 2001). Structural Coefficients (SC) greater than or equal to  $|\lambda| \geq 0.30$  (Tabachnick & Fidell, 2001) were considered relevant for the interpretation of the linear vectors. All of the statistical analyses were done with a level of significance of  $p \leq 0.05$ .

In the seventh stage, the ability of the instrument to differentiate between different practice and competition was considered (Trochim & Donnelly, 2007). Two weeks of practice and two matches from a male professional team's competitive season were analysed (2006-2007 season). A total of 14,017 practice actions and 3,355 competition actions were studied. The manner of execution of the different actions, their efficacy, play time, and efficacies of the different complex were analysed. The observation was done by an observer

that had a degree in sport science, had the highest volleyball coaching certifications in Spain (level III), was a volleyball coach, and had experience as an observer (research and scouting). The same protocol for observer training and data quality control as described in previous stages was done. An inferential analysis of the data was done using the SPSS 20.0 software (Mann-Whitney U for the continuous variables and Chi-Square Test and likelihood ratios for the categorical variables) with a level of statistical significance set at  $p < 0.05$ .

Regarding the observation instrument structure, each row of data included the information about a complex or phase of the rally, while the columns included the information about the observed variables. The variables were divided into four groups: contextual variables, game situation, technical and tactical actions, and rally result. For contextual variables, information about the match was collected. For game variables, information about the game or set was collected. For technical and tactical actions, information about the actions of the ball possession phase (complex), as well as the previous action, was collected. For each technical action, the observation instrument collected data about the player that executed, his/her position, the zone of execution, the technique and/or type, the direction and/or destinations, and efficacy. Information collected about the previous action varied throughout the rally. For the first complex or side-out, the previous action was the serve. For the other complexes, the previous action was the block. For the section about the rally result, information about the game or set was collected. The variables in this section were obtained indirectly from the previous section of variables.

## RESULTS

The list of behaviours from the observational instrument after the first and second stages of the observational instrument design (literature review, first group of experts, and pilot studies for observation and data analysis) is shown in table 2. After stages one and two, the list was composed of 54 behaviours. Nine variables described the context (five were from the literature review and four were from the experts and researchers). Seven variables were about observing the game situation (three were from the literature review, and four were from the experts and researchers; one was modified after the pilot test). Thirty-three variables were about observing the technical and tactical actions (ten were from the literature review, 15 were from the experts; 10 were modified either by the experts and researchers or after the pilot test). In the second stage, 5% occurrence was set as the limit to regroup with other variables. These criteria were not followed for the "acrobatic defence" as a defence technique or for the "second attack" and "penalty attack" in attack technique. Three variables were about the rally result (two were from the

literature review, and one was suggested by the experts and researchers; one was modified after the pilot test). After the first and second stages, no new variables or categories were included, only clarification of the variables was done.

TABLE 2  
Final behaviors of the first and second design stages of the observation instrument.

<p><b>Contextual variables</b></p> <ul style="list-style-type: none"> <li>- Competition <sup>1</sup></li> <li>- Gender <sup>1</sup></li> <li>- Team A <sup>2</sup></li> <li>- Team B <sup>2</sup></li> <li>- Result of the match <sup>1</sup></li> <li>- Set <sup>1</sup></li> <li>- Result of the set <sup>1</sup></li> <li>- Team A's points in the set <sup>2</sup></li> <li>- Team B's points in the set <sup>2</sup></li> </ul> <p><b>Game situation</b></p> <ul style="list-style-type: none"> <li>- Rotation of team A <sup>1</sup></li> <li>- Rotation of team B <sup>1</sup></li> <li>- Team in reception <sup>1</sup></li> <li>- Start time of the rally <sup>2</sup></li> <li>- End time of the rally <sup>2</sup></li> <li>- Total play time of the rally <sup>2 4</sup></li> <li>- Phase or complex <sup>1 2</sup></li> </ul> <p><b>Technical-tactical actions (A. Serve / Block) <sup>A</sup></b></p> <ul style="list-style-type: none"> <li>- Player that executes <sup>1 2</sup></li> <li>- Player's role <sup>1 2</sup></li> <li>- Type of serve or block in relation to attack <sup>2 4</sup></li> <li>- Zone of execution <sup>1 3 4</sup></li> <li>- Execution techniques (B) <sup>1 3 4</sup></li> <li>- Destination <sup>1 2</sup></li> <li>- Efficacy <sup>1</sup></li> </ul>	<p><b>Technical-tactical actions (B. Reception / Defense) <sup>A</sup></b></p> <ul style="list-style-type: none"> <li>- Reception system <sup>2 4</sup></li> <li>- Player that executes <sup>1</sup></li> <li>- Player's role <sup>1</sup></li> <li>- Zone of execution <sup>1 2 4</sup></li> <li>- Execution techniques (B) <sup>1 2 3 4</sup></li> <li>- Efficacy <sup>1</sup></li> </ul> <p><b>Technical-tactical actions (C. Set)</b></p> <ul style="list-style-type: none"> <li>- Player that executes <sup>1</sup></li> <li>- Player's role <sup>1</sup></li> <li>- Zone setter starts displacement from <sup>2</sup></li> <li>- Zone of execution <sup>1</sup></li> <li>- Depth <sup>2</sup></li> <li>- Execution techniques (B) <sup>1 2 4</sup></li> <li>- Efficacy <sup>1</sup></li> </ul> <p><b>Technical-tactical actions (D. Attack)</b></p> <ul style="list-style-type: none"> <li>- Player that executes <sup>1 2</sup></li> <li>- Player's role <sup>1 2</sup></li> <li>- Way of attacking <sup>1 2 3</sup></li> <li>- Zone of execution <sup>1</sup></li> <li>- Execution techniques (B) <sup>1 2 3 4</sup></li> <li>- Block intervention <sup>2 3 4</sup></li> <li>- Destination <sup>1 3 4</sup></li> <li>- Attack efficacy <sup>1</sup></li> </ul> <p><b>Rally result</b></p> <ul style="list-style-type: none"> <li>- Complex efficacy <sup>2</sup></li> <li>- Way or actions through which the point is obtained <sup>1 3 4</sup></li> <li>- Rally result <sup>1</sup></li> </ul>
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<sup>1</sup> Behaviors suggested by the review of literature (indoor volleyball); <sup>2</sup> Behaviors suggested or modified by experts and researchers; <sup>3</sup> Behaviors modified after the pilot tests; and <sup>4</sup> Behaviors modified after the pilot data analysis.

<sup>A</sup> In the analysis of side-out or complex I, the actions collected are the serve and the reception, and in the rest of the game phases, the actions collected are the block and the dig. <sup>B</sup> For the serve, standing serve, power jump serve floating jump serve, and others; for reception and defense, forearms, over-head, and others; for the set, overhead (jump), overhead (standing), forearm (bump), and others; for the attack, no ball contact, hit, control, and others; and for the block, one, two or three players carrying out the block.



In the third stage, after the evaluation by the second group of experts (n=6), seven behaviours were modified. The experts' observations were related to the definitions of the variables' categories. No variable was eliminated by the experts after the evaluation of comprehension and pertinence (all variables had an average score > 7.0 / 10). In the fourth stage (the second pilot test and observer training), twelve behaviours were modified or the number of criteria was increased to differentiate the categories of the variables. The observers had an inter-observer agreement coefficient > 0.82 and an intra-observer agreement coefficient > 0.98 for all the studied variables (Cohen's Kappa) (Table 3). In the fifth stage, the third group of experts (n=7) evaluated the list of behaviours, and they analysed categories, definitions, and criteria for differentiation. Aiken's V from the quantitative evaluation by the third group of experts is shown in table 4. Since all variables had an Aiken's V > 0.87, they were determined to be pertinent. The final instrument included 54 behaviours for observation (Table 5). All variables included their definition, variables, and the criteria to establish the different categories.

TABLE 3  
 Observers' inter- and intra-agreement after training in the use of the observation instrument (fourth stage).

VARIABLES	Reliability		VARIABLES	Reliability	
	Intra	Inter		Intra	Inter
<b>Contextual variables</b>			<b>Technical-tactical actions (B. Reception / Defense) <sup>A</sup></b>		
Competition	1.00	1.00	Reception system *	0.98	0.98
Gender	1.00	1.00	Player that executes	0.96	0.99
Team A	1.00	1.00	Player's role	0.96	1.00
Team B	1.00	1.00	Zone of execution ***	0.91	0.98
Match result	1.00	1.00	Execution techniques ***	0.99	1.00
Set	1.00	1.00	Efficacy **	0.90	0.98
Set result	1.00	1.00	<b>Technical-tactical actions (C. Set)</b>		
Team A's points	1.00	1.00	Player that executes	1.00	1.00
Team B's points	1.00	1.00	Player's role	1.00	1.00
<b>Game situation</b>			Zone setter stars displacement *	0.92	0.98
Team A's rotation	0.91	0.98	Zone of execution	0.90	0.98
Team B's rotation	0.91	0.98	Depth **	0.89	0.98
Team in reception	1.00	1.00	Execution techniques ***	0.99	1.00
Start time of the rally	0.94	1.00	Efficacy ***	0.90	0.98
End time of the rally	0.92	1.00	<b>Technical-tactical actions (D. Attack)</b>		
Total play time of the rally	0.84	1.00	Player that executes	1.00	1.00
<b>Technical-tactical actions (A. Serve / Block) <sup>A</sup></b>			Player's role	1.00	1.00
Player that executes	1.00	1.00	Zone of execution	0.85	0.98
Player's role	0.98	1.00	Execution techniques ***	0.83	0.98
Type of block in relation to attack **	0.97	1.00	Block intervention **	0.82	0.98
Zone of execution	0.89	0.98	Destination ***	0.87	0.98
Execution techniques	0.94	1.00	Efficacy	0.93	0.99
Destination ***	0.84	0.98	<b>Rally result</b>		
Efficacy **	0.88	0.98	Complex efficacy	1.00	1.00
			Way point is obtained	1.00	1.00
			Rally result	1.00	1.00

\* Behaviors modified and included by expert judges during third stage; and \* Behaviors modified and included by expert judges during fifth stage.

A In the analysis of side-out or complex I, the actions collected are the serve and the reception, and in the rest of the game phases the actions collected are the block and the dig.

TABLE 4  
Evaluation by eight expert judges about observation instrument (fifth stage).

VARIABLES	AIKEN'S V		VARIABLES	AIKEN'S V	
	Definition	Pertinence		Definition	Pertinence
<b>Contextual variables</b>			<b>Technical-tactical actions (B. Reception / Defense) <sup>A</sup></b>		
Competition	1.00	1.00	Reception system	0.96	1.00
Gender	1.00	1.00	Player that executes	1.00	1.00
Team A	1.00	1.00	Player's role	1.00	1.00
Team B	1.00	1.00	Zone of execution	1.00	0.90
Match result	1.00	1.00	Execution techniques	1.00	1.00
Set	1.00	1.00	Efficacy	1.00	1.00
Set result	1.00	1.00	<b>Technical-tactical actions (C. Set)</b>		
Team A's points	1.00	1.00	Player that executes	1.00	1.00
Team B's points	1.00	1.00	Player's role	1.00	1.00
<b>Game situation</b>			Zone setter stars displacement	1.00	1.00
Team A's rotation	1.00	1.00	Zone of execution	1.00	1.00
Team B's rotation	1.00	1.00	Depth	0.98	0.95
Team in reception	1.00	1.00	Execution techniques	0.99	1.00
Start time of the rally	1.00	1.00	Efficacy	1.00	1.00
End time of the rally	1.00	1.00	<b>Technical-tactical actions (D. Attack)</b>		
Total play time of the rally	1.00	1.00	Player that executes	1.00	1.00
<b>Technical-tactical actions (A. Serve / Block) <sup>A</sup></b>			Player's role	1.00	1.00
Player that executes	1.00	1.00	Zone of execution	1.00	1.00
Player's role	1.00	1.00	Execution techniques	0.90	0.95
Type of block in relation to attack	1.00	0.90	Block intervention	0.91	0.95
Zone of execution	1.00	1.00	Destination	1.00	0.98
Execution techniques	1.00	1.00	Efficacy	1.00	1.00
Destination	1.00	0.95	<b>Rally result</b>		
Efficacy	1.00	1.00	Complex efficacy	1.00	1.00
			Way point is obtained	1.00	1.00
			Rally result	1.00	1.00

*A In the analysis of side-out or complex I, the actions collected are the serve and the reception, and in the rest of the game phases the actions collected are the block and the dig.*

TABLE 5  
Final behaviors and categories of the observation instrument.

<b>Contextual variables</b>	<b>Technical-tactical actions (A. Serve / Block) Cont.</b>	<b>Technical-tactical actions (D. Attack)</b>
<ul style="list-style-type: none"> <li>- Competition</li> <li>- Gender</li> <li>- Team A</li> <li>- Team B</li> <li>- Match result</li> <li>- Set</li> <li>- Set result</li> <li>- Team A's points</li> <li>- Team B's points</li> </ul>	<ul style="list-style-type: none"> <li>- Execution techniques (four types for serving (standing, power jump, floating jump, and other<sup>3</sup>) and two for blocking (one player, two players, or three players))</li> <li>- Destination (six zones for serving (three lanes and two rows<sup>1</sup>) and four options for blocking ( jump and no contact, block-out, court of the spiker, and court of the blocker))</li> <li>- Efficacy (scale of zero to four points in relation to the effect on the rally and the options it allows the opponent team)</li> </ul>	<ul style="list-style-type: none"> <li>- Attack system (universal roles, four spikers and two front setters in zone 3, four spikers and front two setters in zone 2, four spikers and two back setters, and five spikers and one setter)<sup>3 6</sup></li> <li>- Player that executes and prepares the attack</li> <li>- Player's role (setter, opposite, middle blocker, outside-hitter or swing-spiker, and libero)<sup>3 4</sup>.</li> <li>- Way of attacking (no jump, first tempo, second tempo, third tempo, second contact, and penalty)<sup>3 6</sup></li> <li>- Zone of execution (nine lanes, two rows and out of court)<sup>3 6</sup></li> <li>- Execution techniques (no jump, hit, tip, resource, and others)<sup>3 6 7</sup></li> <li>- Block intervention (block jump but no contact, block-out, ball to court of the spiker, ball to the court of the blocker, no block jump)</li> <li>- Destination (six zones -three lanes and two rows- and out of the court).</li> <li>- Efficacy (scale of zero to four points in relation to the effect on the rally and the options it allows the opponent team)<sup>5</sup></li> </ul>
<b>Game situation</b>	<b>Technical-tactical actions (B. Reception / defense) A</b>	
<ul style="list-style-type: none"> <li>- Rotation of team A (player serving for team A)<sup>1</sup></li> <li>- Rotation of team B (player serving for team B)<sup>1</sup></li> <li>- Team in reception</li> <li>- Start time of the rally</li> <li>- End time of the rally</li> <li>- Total duration of the rally</li> <li>- Phase or complex (side-out or complex 1, complex 2, complex 3 or defence phase by team in side-out, and complex 4 or defence phase to the counter-attack of side-out team)<sup>2</sup></li> </ul>	<ul style="list-style-type: none"> <li>- Reception system (2 receivers, 2 + 1 receivers, 3 receivers, 3 + 1receivers, 2 + 2 receivers, 5 receivers)<sup>3 6</sup></li> <li>- Player that executes</li> <li>- Player's role (setter, opposite, middle blocker, outside-hitter or swing-spiker, and libero)<sup>3 4</sup>.</li> <li>- Zone of execution (six zones (three lanes and two rows) and out of the court)<sup>1</sup>.</li> <li>- Execution techniques (three types for serving -bump, overhead hit, and others- and five for digging (bump, two hands hit, free-ball, acrobatic defence, and other))<sup>3 6</sup></li> <li>- Efficacy (scale of zero to three points in relation to the effect on the rally and the options it allows the offense)<sup>5</sup></li> </ul>	
<b>Technical-tactical actions (A. Serve / Block) A</b>	<b>Technical-tactical actions (C. Set)</b>	
<ul style="list-style-type: none"> <li>- Player that executes (one player serving and total of players involved in block)</li> <li>- Player's role (setter, opposite, middle blocker, outside-hitter or swing-spiker, and libero)<sup>3 4</sup>.</li> <li>- Type of block in relation to attack (first tempo, second tempo, third tempo, second contact, and penalty)<sup>3 *</sup> Only for evaluating block actions.</li> <li>- Zone of execution (six zones for serving (three lanes and two rows) and nine zones for blocking (1 meter)<sup>1</sup></li> </ul>	<ul style="list-style-type: none"> <li>- Player that executes</li> <li>- Player's role (setter, opposite, middle blocker, outside-hitter or swing-spiker, and libero)<sup>3 4</sup>.</li> <li>- Zone setter starts displacement (six zones, team rotations)<sup>1</sup></li> <li>- Zone of execution (nine zones (1 meter) and out of court)<sup>3 6</sup></li> <li>- Depth (three distances ( net to 1,5 m, 1,5 to 3 m, and more than 3 m))</li> <li>- Execution techniques (jump set, overhead, bump, and others)<sup>3 6</sup></li> <li>- Efficacy (scale of zero to three points in relation to the effect on the rally and the options it allows the offense)<sup>5</sup></li> </ul>	
		<b>Rally result (variables calculated automatically)</b>
		<ul style="list-style-type: none"> <li>- Complex efficacy (scale of zero to four points in relation to the effect on the rally and the options it allows the opponent team)<sup>5</sup>.</li> <li>- Way or actions through which the point is obtained (serve point, serve error, attack point, attack error, block point, block error, other errors).</li> <li>- Rally result (win or loss).</li> </ul>

Legend: <sup>1</sup> FIVB (2008); <sup>2</sup> Palao (2004); <sup>3</sup> Adapted from Selinger & Ackermann-Blount (1986); <sup>4</sup> Gualdi-Russo & Zaccagni (2001); <sup>5</sup> Coleman, Neville, & Gordon (1969); <sup>6</sup> Adapted from AVCA (1987); <sup>7</sup> Adapted from Burchuk & Burchuk (1993).

<sup>A</sup> In the analysis of side-out or complex 1, the actions collected are the serve and the reception, and in the rest of the game phases the actions collected are the block and the dig.

In the sixth stage, the discriminate analysis showed that the instrument included variables that allow us to discriminate between competition age groups, taking into consideration efficacy variables [Wilks' Lambda: 0.044; Canonical Correlation: 0.978; Chi-square value: 142.269; Chi-square test:  $p < .001$ ], technical actions [Wilks' Lambda: 0.061; Canonical Correlation: 0.969; Chi-square value: 130.2; Chi-square test:  $p < .001$ ], and temporal variables [Wilks' Lambda: 0.070; Canonical Correlation: 0.964; Chi-square value: 136.611; Chi-square test:  $p < .001$ ]. The actions that best discriminated the competition age groups in regard to efficacy were the set and block efficacy; in regard to technique, they were the use of different techniques in all volleyball elements; and in regard to temporal actions, they were attack and block tempo. In the seventh stage, significant differences were found in all variables related to the way actions were executed temporally, spatially, and with regard to technique and efficacy between the practice and competition of a men's volleyball team (Table 6).

TABLE 6  
Differences found using the observation instrument between competitions and training (seventh stage).

VARIABLES	Competition vs. training	VARIABLES	Competition vs. training
<b>Contextual variables</b>		<b>Technical-tactical actions (B. Reception / Defense) <sup>A</sup></b>	
Competition	-	Reception system	-
Gender	-	Player that executes	-
Team A	-	Player role <sup>2</sup>	p<.001
Team B	-	Zone of execution <sup>2</sup>	p<.001
Match result	-	Execution techniques <sup>2</sup>	p<.001
Set	-	Efficacy <sup>2</sup>	p<.001
Set result	-	<b>Technical-tactical actions (C. Set)</b>	
Team A's points	-	Player that executes	-
Team B's points	-	Player role	-
<b>Game situation</b>		Zone setter starts displacement <sup>2</sup>	p<.001
Team A's rotation	-	Zone of execution <sup>2</sup>	p<.001
Team B's rotation	-	Depth <sup>2</sup>	p<.001
Team in reception	-	Execution techniques <sup>2</sup>	p<.001
Start time of the rally	-	Efficacy <sup>2</sup>	p<.001
End time of the rally	-	<b>Technical-tactical actions (D. Attack)</b>	
Total play time of the rally <sup>1</sup>	p<.001	Player that executes	-
<b>Technical-tactical actions (A. Serve / Block) <sup>A</sup></b>		Player role	-
Player that executes	-	Zone of execution <sup>2</sup>	p<.001
Players role	-	Execution techniques <sup>2</sup>	p<.001
Type of block in relation to attack <sup>2</sup>	p<.001	Block intervention <sup>2</sup>	p<.001
Zone of execution <sup>2</sup>	p<.001	Destination <sup>2</sup>	p<.001
Execution techniques <sup>2</sup>	p<.001	Efficacy <sup>2</sup>	p<.001
Destination <sup>2</sup>	p<.001	<b>Rally result</b>	
Efficacy <sup>2</sup>	p<.001	Complex efficacy <sup>2</sup>	p<.001
		Way point is obtained <sup>2</sup>	p<.001
		Rally result	-

<sup>1</sup> Mann-Whitney U was used to establish the differences between age groups of competition.

<sup>2</sup> Chi-Square Test and likelihood ratio was used to establish the differences between age groups of competition.

<sup>A</sup> In the analysis of side-out or complex I, the actions collected are the serve and the reception, and in the rest of the game phases the actions collected are the block and the dig.

#### DISCUSSION AND CONCLUSIONS

The present paper describes the stages done to design, validate, and test the reliability of an observational instrument to analyse technical and tactical actions in indoor volleyball. For the process of designing the instrument, in addition to the review of literature and testing the instrument through observation (Anguera, 2003), several procedures were done to ensure the future applicability of the data. These procedures include participation of

volleyball coaches, data analysis that included both a descriptive analysis and preparing reports, and observer training. This approach is similar to that followed by Tenga, Kanstad, Ronglan, and Bahr (2009), Tilp, Koch, Stifter, and Ruppert (2006), and Villarejo Ortega, Gómez, and Palao (2014). For the design process, the analysis of the sport's characteristics, information from previous studies, and instruments related to the topic were the basis for developing the structure of the instrument (e.g. actions were collected by complex). Most of the coaches' contributions were in regard to the molecular level of the variables, terminology, and application of the data obtained from the instrument. The use of the complex or game phase differed from the unit of analysis utilised in the literature, which used the players' actions, the set, or the match (e.g. Silva, Lacerda, & Joao, 2014; Rodriguez-Ruiz, et al, 2011; Patsiaouras, Moustakidis, Charitonidis, & Kokaridas, 2010). The collection of data of the actions of a ball possession phase as well as the previous action allowed us to analyse the individual actions and the team actions, to calculate data for the set and the match, and also to analyse the relationship between the actions done in the complex (Eom & Schultz, 1992a,b)

The observers' previous experiences, the training process of the observers, carrying out the observation, and the data analysis were important in the development of the instrument, such as e.g. clarifying the criteria for distinguishing between categories. During the different pilot studies, another aspect that was taken into consideration in the design was to make the instrument more user-friendly for the observer regarding the registration sheet design or software (e.g. the order of data collection, or automation). Also, there was an attempt to keep variables to a minimum by calculating some variables indirectly from others, such as number of jumps and collective efficacy. In this process, the establishment of the goals, the applications, and the final data to be obtained through the instrument was critical.

Data from the different validation processes that were carried out show that the instrument is valid to measure the technical-tactical behaviours. T expert review and the use of Aiken's V allowed for measuring the content validity of the items. The values of the quantitative evaluation were higher for all the items than the minimum that was proposed ( $V_o = 0.70$ ) by Penfield and Giacobbi (2004). Although the number of experts who participated in the present study was low (stage 1,  $n=3$ ; stage 3,  $n=6$ ; and stage 5,  $n=6$ ), the fact that their participation was used in several stages and for different aspects (design, application, usability, etc.) helped the design and evolution of the instrument. The qualitative evaluation helped specifically to more clearly identify the definitions of the variables and categories as well as to establish the pertinence of the variables and categories (Escurra, 1989; Padilla, Gómez, Hidalgo & Muñiz, 2007; Zhu et al., 1998). Criteria set by experts regarding the

molecular level of the variables were followed (e.g. types of advanced attack technique; for more information, review Burchuk and Burchuk, 1993).

Data from the discriminate analysis done shows the ability of the instrument to discriminate the competition age group from the variables measured in the instrument (Tilp et al., 2006). Data found show that the instrument has the ability to provide information about technique and tactics at different competition levels. The ability to differentiate competition age groups may vary when taking into consideration the groups that were compared (Inkinen, Häyrinen, & Linnamo, 2013). In this paper, extremes within the age groups were studied in order to analyse the general characteristics of the instrument and its possibility to be used in peak performance and in initial stages of performance. Although previous studies have found differences among similar age groups (Inkinen, Häyrinen, & Linnamo, 2013). In the seventh stage, the results found show the ability of the instrument to differentiate between different situations, practice and competition, in all the variables of the instrument related to ways of execution and efficacy. Different studies have shown the differences between the situations generated in practice, such as motivation, goals, opponent's characteristics, etc., and those of competition (Bahr & Bahr, 2014; Manzanares, Palao, & Ortega, 2014). The results show that the instrument allows us to describe and differentiate the two situations.

The level of agreement between observers confirmed that after the observer training, the instrument is adequate with regard to reliability (Bakeman, Quera, McArthur & Robinson, 1997). The manual for the observers' training that was developed in previous stages was critical in allowing observers to acquire their abilities (Losada & Manolov, 2015). Experts' feedback in the first and second stages helped to develop the manual for observer training and the variables' explanations. The version used for the observer training integrated text and video, and a Frequently Ask Questions section was included at the end of the manual. However, it must be emphasised that the observers who participated in this study knew the sport well and had previous experience in the analysis of this sport. During their training, there was an emphasis on monitoring the quality of data collection and provide the observers with feedback to prevent the influence of previous experiences.

The results found in the different stages that were followed to design and validate the instrument show that the instrument may be suitable for measuring the technical and tactical actions taken (i.e. ball contacts) in indoor volleyball. The combination of different processes in the design, the types of validation, and the reliability testing helped to develop the instrument. More attention should be given to developing, validating, and testing the reliability of observational instruments, as this process is not always done or is only done partially (e.g. Sarmiento, Leitão, Anguera, & Campaniço, 2009; Tenga et al, 2009;



Thomas, Fellingham, & Vehrs, 2009). This instrument has the ability to describe the manner of execution of volleyball actions (serve, reception, set, attack, block, and dig). The instrument does not record information about the players and the team without possession of the ball. Data regarding spatial variables as well as some temporal variables are collected using subjective notational analysis, which, although it has been shown to be a reliable method (Dogramac, Watsford, & Murphy, 2011), requires a proper training of the observers. The instrument only analyses the team in possession of the ball and the actions of the player with the ball. Indoor volleyball, as with the rest of team sports, works as a dynamic system (Mac Garry et al., 2002). Therefore, this instrument does not allow us to collect all aspects that can influence players' actions (Lebed, 2006). However, the instrument can provide information that allows coaches and researchers to monitor, analyse, and make decisions about the game, teams, and players. Performance analysis requires a complex and multidisciplinary approach (Glazier, 2010). This instrument can provide researchers information about the way that players carry out their actions and its relationship with the game outcome.

In summary, the observational instrument that was developed allows for obtaining information about players and teams in actions during training and competition. The way data are collected allows us to study the relationships between actions (Eom & Schutz, 1992a,b; Palao, 2004) and indirectly collect information from physical actions (e.g. work and rest times, jumps, hits). This instrument provides information about the way indoor volleyball teams play. It allows us to study aspects such as the evolution of the sport, the differences between winning and losing teams, players' roles, etc. The structure of the instrument allows us to use it in its entirety or certain parts or criteria can be utilised. Future studies are needed to provide information about performance indicators and normative profiles for different genders, age groups, and levels of competition (Palao & Morante, 2013).

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Note: The observation instrument can be obtained from the first author or at the following website <https://sites.google.com/site/tevolmanual/> [Free download and use of all the material - Creative Commons Attribution-NonCommercial-ShareAlike].

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