Original Article

Point-scoring plays related to level of set win and in-game role during volleyball rules testing

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ABSTRACT

The aim of this study was to analyse the characteristics of point-scoring plays related to level of set win and in-game role under experimental rules tested at the U23 Men's Volleyball World Championship in Uberlandia, Brazil (21-point set, 15 seconds between points) from the 16th point in the first four sets and the 10th point in the fifth set. The analysis of 1335 points from 123 sets in 36 matches played by 144 males (average age 21.1±1.4 years) focused on in-game role (setter, outside hitter, middle blocker, opposite, libero), final score, finishing point actions (serve-ace, three attack types, three counter attack types, block), set outcome (Win-Lose), and level of set win (Walkover-Balanced-Tough). Pearson's *Chi-Square* test was used for data analysis. The results showed that the difference in the structure of won and lost points decreased from walkover to balanced to tough sets. Attack-spike and block were the most frequently executed technical elements. Outside-hitter was identified as the in-game role that finished more points, followed by Opposite and Middle blockers. If the tested rules are applied, developing the block, serve and attacks may have greater influence on set outcome in the future. **Keywords:** Scoring system, Set result, Final action.

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INTRODUCTION

Volleyball is a popular sport worldwide, with more than 221 associated federations in the International Volleyball Federation (Fédération Internationale de Volleyball [FIVB], n.d.-a). Over time, volleyball rules have changed to make the game a more exciting spectator sport (Ureña *et al.*, 2000). The point scoring system has also changed throughout the history of volleyball; the last change, from Side Out to Rally Point, was introduced in 2000 (FIVB, n.d.-b; Marelić *et al.*, 2004). The number of points per set was initially 15 (side out) and became 25 under the rally point system. At the Under 23 (U23) Men's World Championship in Brazil in 2013, the Fédération Internationale de Volleyball (FIVB) tested a new scoring system of sets to 21 points (excluding the fifth set, which remained at 15) with a two-point lead required at the end of sets. The rule changes were designed to modernise volleyball and make it more appealing for fans both attending games and watching matches on television (FIVB, 2013a).

In volleyball it is common practice to analyse the game actions of teams during a match, across tournaments and in competitions. Match analysis comprises objective recording and detailed examination of each game action during the competition (Lago, 2009). Each team has the chance to score points by serving, blocking or attacking and from opponent mistakes (Häyrinen *et al.*, 2004). All methods of scoring have specific importance, influence and terminating effect (Moreno *et al.*, 2005; Marcelino & Mesquita, 2006). Various studies have addressed each scoring element: serve (Marelić *et al.*, 2004; Asterios *et al.*, 2009; Joao *et al.*, 2012), block (Palao *et al.*, 2004) and spike (Häyrinen *et al.*, 2004; Palao *et al.*, 2004).

Every analysis of game actions is research pertaining to notational analysis (Dávila-Romero & García-Hermoso, 2012). Notational analysis comprises analysis of movement, technical and tactical evaluation, and statistical compilation (Hughes & Franks, 2004). Dávila-Romero and García-Hermoso (2012) analysed the variables positive and negative serve, attack, positive block and technical error (touching the net, double touch, invasion, stepping on serve line, second line attacker stepping on the three-meter line and long touch). Some of the variables used by Palao *et al.* (2015) in their analysis of the effects of team level on skills performance were technical actions of the serve, reception, set, attack, block, and court defence in relation to the player who intervenes; in-game role; manner of execution and execution zone; efficacy and result of the play; and how the point was scored. Because performance in attack, serve, block and number of points won by opponent error are the variables in top-level men's volleyball that best explain the difference between teams (Rodríguez-Ruiz *et al.*, 2011), these variables were chosen for this study as the only direct-scoring volleyball elements. For greater insight into the executors of final actions and which in-game role scores the points in the last part of the sets, it was also necessary to include in-game role (Palao *et al.*, 2015). Including in-game role in the analysis gives more detailed information about how each type of player executes points. To determine a pattern in final actions in the last parts of the sets and clearly differentiate between sets, score fluctuation was added as a final variable (Palao *et al.*, 2015). The parameters of each category of variables used in the study were attack-spike, as the action most correlated with team success (Häyrinen *et al.*, 2004; Palao *et al.*, 2004), attack-tipping, also known as the tip (Marcelino *et al.*, 2011), and attack-block out and counter attack, as analysed by Zetou *et al.* (2006).

The results of set analysis can help coaches design appropriate physical preparation, determine adequate defence strategies and the best types of attack, avoid common mistakes, increase the overall effectiveness of a team and develop a training system for any age. Limiting the time between two points, as with the 15 seconds rule, should give structure to serve execution, which we aim to define in this study. Reducing sets from 25 to 21 points means that fewer points are won and the finishing actions that score points follow a unique model. The objective of this study was to determine the characteristics of point-scoring plays in the

final part of sets, defined as points 16 to 21 in the first four sets and points 10 to 15 in the fifth set, and to relate the findings to level of set win with reference to the two new rules tested at the inaugural U23 Men's Volleyball World Championship: 21 point set (excluding the fifth set) and 15 seconds between rallies (10 seconds from the finished point until the referee's whistle for service and five seconds for performing the serve).

METHODOLOGY

Study design

Data were collected from the matches played by the 12 participating teams at the U23 Men's World Championships in Uberlandia (Brazil) in October 2013. Variables were analysed from recorded matches after the Championships had finished. Analysis included statistical treatment of in-game role (setter, outside hitter, middle blocker, opposite and libero), final score and finishing point actions (serve-ace, three attack types, three counter attack types and block).

Participants

The study comprised observation (Anguera & Hernández-Mendo, 2013) of 123 sets and 1335 finishing actions delivered during 36 matches played by 144 male players under 23 years of age (M = 21.1 ± 1.4 years). This age group currently competes successfully in the highest men's volleyball leagues around the world and therefore the level is similar to elite men's volleyball.

Ethical approval

The study was performed in accordance with the Helsinki Declaration of 1975 and approved by the Human Research Ethics Committee of the University of Las Palmas de Gran Canaria. The ethical clearance number was CEIH-2016-05. The FIVB officially authorised the study and the use of all match videos and data from the VIS statistical recording programme and the FIVB website.

Procedure and measures

All 36 games studied were recorded from the same position behind the court at a height of 5 m above floor level (Claver *et al.*, 2013) to ensure the best view of the whole court. All games were filmed using the same PANASONIC HC-V720 HD digital camcorder in AVCHD format.

The matches followed the FIVB competition system. Competitions had two rounds, with 30 matches played in the first round (group phase) and eight in the second (Semi-final and Finals). The 12 teams were divided into two groups of six (A and B) and all teams played round-robin matches for classification from 1st to 6th. The team ranked 3rd in Pool A after the preliminary round played the team ranked 4th in Pool B. The team ranked 3rd in Pool B after the preliminary round played the team ranked 4th in Pool A. The losers of these semi-final matches played for 7th and 8th final places. The winners of the semi-final matches played for 5th and 6th places. The team ranked 1st in Pool A played the team ranked 2nd in Pool B. The team ranked 1st in Pool B played the team ranked 2nd in Pool A. The losers of the semi-final matches played for 3rd and 4th place. The winners of the semi-final matches played for 1st and 2nd place (FIVB, 2013b).

Performance variables

To analyse each game, a data recording form and analysis scheme are required, as well as a graphic representation of the playing area, so the variables can be defined and examined (Tsimpiris *et al.*, 2006). For the analysis of point-scoring plays related to level of set win and in-game role, the variables chosen were based on the literature and objective volleyball analysts' validation of the research problem. Eleven volleyball

elements had the status of dependent variables. Their empirical frequencies were analysed in relation to the three independent variables: set outcome (Win-Lose), level of set win (Walkover-Balanced-Tough) and in-game role.

- *In-game role* – The role of each player in the team, classified as 1 = setter, 2 = outside hitter, 3 = middle blocker, 4 = opposite, 5 = libero.
- *Score fluctuation* – The winning point in the final part of sets, defined as points 16 to 21 in the first four sets and points 10 to 15 in the fifth set, with reference to the 21 point set (excluding the fifth set), one of the two new rules tested.
- *Serve-Ace* – The final action that leads to point scoring. Both types of Serve-Ace were taken into consideration: 1) Serve-Ace point scored after the ball directly touches the court, and 2) Serve-Ace point scored after the final touch by the service receiver.
- *Attack* – Termed "attack hit" by the FIVB (2012), this element is defined as all actions other than serve and block by which the ball is sent towards the opponent. Attack corresponds to three basic parameters: spike, tipping and block out.
- *Counter attack* – Also known as "attack after defensive action" (Sánchez-Moreno *et al.*, 2015), this variable similarly includes three parameters: spike, tipping and block out.
- *Block* – All blocks that score points, i.e., individual, double and triple block.
- *Opponent/unforced error* – This terminating action (Rodríguez-Ruiz *et al.*, 2011) includes the following parameters: unforced error by serve, attack/counter attack and technical fault (defined in this study as touching the net, double touch, invasion, stepping on the serving line, second line attacker stepping on the three-meter line and long touch).

Coding

The variables were assessed by methodical observation of all game actions. To achieve consistency in the criteria and quality in coding the data, the observer received 20 hours' training in the definition of the variables and a two-week data recording period until he obtained a Cohen's Kappa value higher than 0.90. The observer had three years' experience in data logging during previous volleyball research and six years' experience as a volleyball scout and coach.

Reliability

To ensure reliability of the calculation avoid any learning effect, 12% of the rallies were re-analysed after a six-week interval, exceeding the reference value of 10% (Tabachnick & Fidell, 2007). Two additional volleyball researchers and national coaches who had received 20 hours of training in data collection conducted secondary observation of the data. Cohen's Kappa ranged from 0.84 to 0.91 for inter-observer reliability and from 0.82 to 0.92 for intra-observer reliability. All values fulfilled the criterion of 0.75 suggested in the literature (Fleiss *et al.*, 2003).

Data analysis

All numerical data are presented by frequency, separated into each volleyball element analysed. Because all the statistical series had the characteristics of a nominal scale, Pearson's *Chi-Square* test was used as an appropriate data analysis procedure. Statistical analysis was conducted using IBM SPSS Statistics V19 software. Statistical inference was performed at the level of significance of $p < 0.05$.

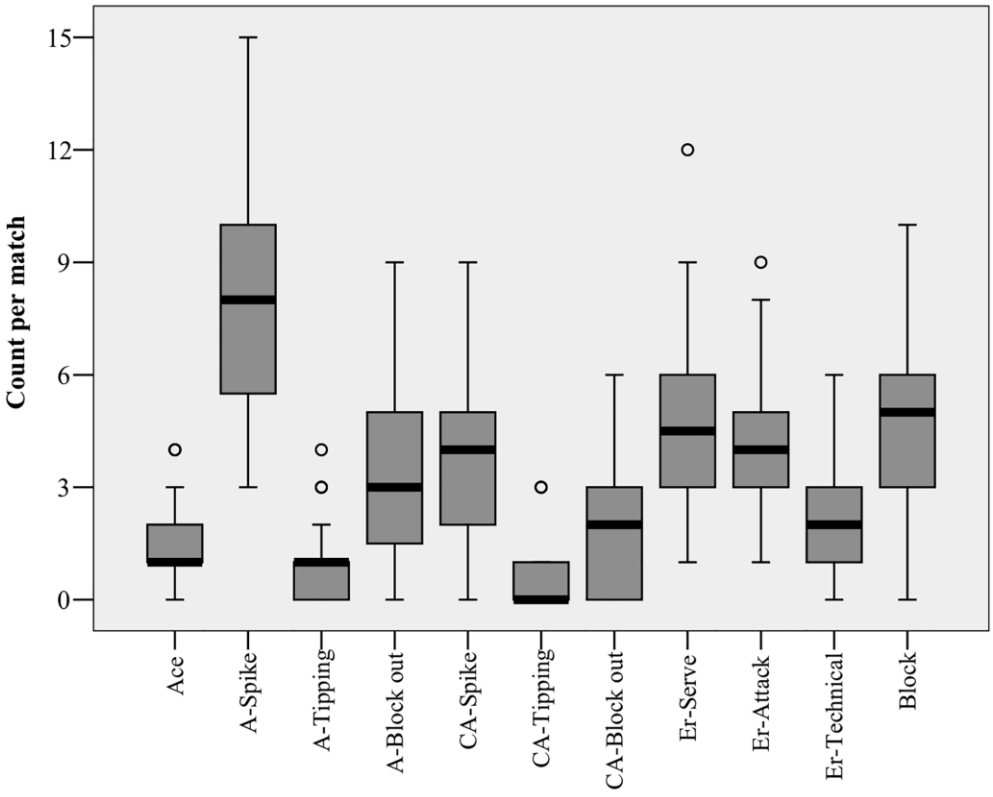
For a clearer view of the results, all data were analysed using two criteria - set outcome (*Winner vs. Loser*) and level of set win (*Walkover-Balanced-Tough*). *Walkover* was defined as set results of 21:15 (and less than

15 points), *Balanced* as set results of 21:16, 21:17 and 21:18, and *Tough* as set results with a two-point difference (21:19, 22:20… or 15:13, 16:14… in the fifth set).

RESULTS

Point-scoring plays in relation to level of set win

Results of the statistical analysis related to *Level of Set Win* showed that the difference in the structure of won and lost points decreased from walkover to balanced to tough sets. When all matches were calculated without dividing sets by *Level of Set Win*, the set *Winner* and *Loser* groups executed similar actions in each set (Figure 1). In all matches and in all teams the most frequently executed technical element was attack-spike (8.58 ± 4.44), followed by block (5.06 ± 3.22). Errors, mostly in serve and attack, also contributed strongly to the way points were finished.



** A = Attack; CA = Counter Attack; Er = Unforced Error*

Figure 1. Average number of finishing volleyball elements registered per match

Regarding *Level of Set Win,* a significant difference in the structure of winning and losing points (Chi-Square$_{10}$=75.476; p=0.000; Cramer's V=0.410) was found mainly in *Walkover* sets (Table 1).

Table 1. Point-scoring plays by winning and losing teams for walkover sets.

	Winner		Loser		Total	
Variables	n	(%)	n	(%)	n	(%)
Serve (Ace)	22	8.2	3	1.6	25	5.6
Attack-Spike	57	21.3	34	18.6	91	20.2
Attack-Tipping	12	4.5	2	1.1	14	3.1
Attack-Block out	16	6.0	15	8.2	31	6.9
Counter-Spike	31	11.6	15	8.2	46	10.2
Counter -Tipping	4	1.5	3	1.6	7	1.6
Counter -Block out	22	8.2	8	4.4	30	6.7
Unforced Error-Serve	45	16.9	30	16.4	75	16.7
Unforced Error-Attack	9	3.4	41	22.4	50	11.1
Un. Error-Technical fault	8	3.0	22	12.0	30	6.7
Block	41	15.4	10	5.5	51	11.3
Total	267	100	183	100	450	100

Chi-Square = 75.476*; p = **0.000** Cramer's V=0.410

Note. Asterisk (*) indicates a statistically significant difference.

A slightly lower significant difference (Chi-Square$_{10}$=23,154; p=0.010; Cramer's V=0.230) was found in *Balanced* sets (Table 2).

Table 2. Point-scoring plays by winning and losing teams for balanced sets.

	Winner		Loser		Total	
Variables	n	(%)	n	(%)	n	(%)
Serve (Ace)	11	4.2	4	2.2	15	3.4
Attack-Spike	68	26.3	44	24.6	112	25.6
Attack-Tipping	5	1.9	5	2.8	10	2.3
Attack-Block out	20	7.7	19	10.6	39	8.9
Counter-Spike	28	10.8	15	8.4	43	9.8
Counter -Tipping	6	2.3	0	0	6	1.4
Counter -Block out	14	5.4	8	4.5	22	5.0
Unforced Error-Serve	27	10.4	20	11.2	47	10.7
Unforced Error-Attack	22	8.5	32	17.9	54	12.3
Un. Error-Technical fault	13	5.0	16	8.9	29	6.6
Block	45	17.4	16	8.9	61	13.9
Total	259	100	179	100	438	100

Chi-Square = 23.154*; p = **0.010** Cramer's V=0.230

Note. Asterisk (*) indicates a statistically significant difference.

Very close sets (*Tough*) showed no significant differences between set winners and set losers. Both groups scored most points by Attack-Spike and made a similar number of unforced errors. The second most frequent method of winning points was by block, in which set winners obtained a slightly better result.

In unequal sets (*Walkover*), the *Winner* group scored a significantly higher number of winning points by block, first attack and counter-attack, and serve (ace). The *Loser* group had a significantly higher number of unforced errors in attack and unforced technical mistakes. The significant impact of the independent variables in unequal sets also confirms Cramer's V because it exceeds the theoretical limit proposed by Gravetter and Wallnau (2004).

In equal sets (*Balanced*), the main reasons for the difference were a significantly higher number of blocks for winning teams and a higher number of unforced errors during attack for the *Loser* group. The significant impact of the independent variables in equal sets also confirms Cramer's V because it exceeds the theoretical limit proposed by Gravetter and Wallnau (2004).

Point-scoring plays by in-game role

Comparison of points won or lost by in-game role between set winners and set losers showed no significant differences in *Walkover*, *Balanced* or *Tough* sets.

In most sets, *Winner* and *Loser* groups had similar values for in-game role from the 16th point to the end of sets. *Outside hitters* finished the highest number of points, followed by *Opposites* and *Middle blockers* (Figure 2). As expected, point execution by *Libero* was infrequent.

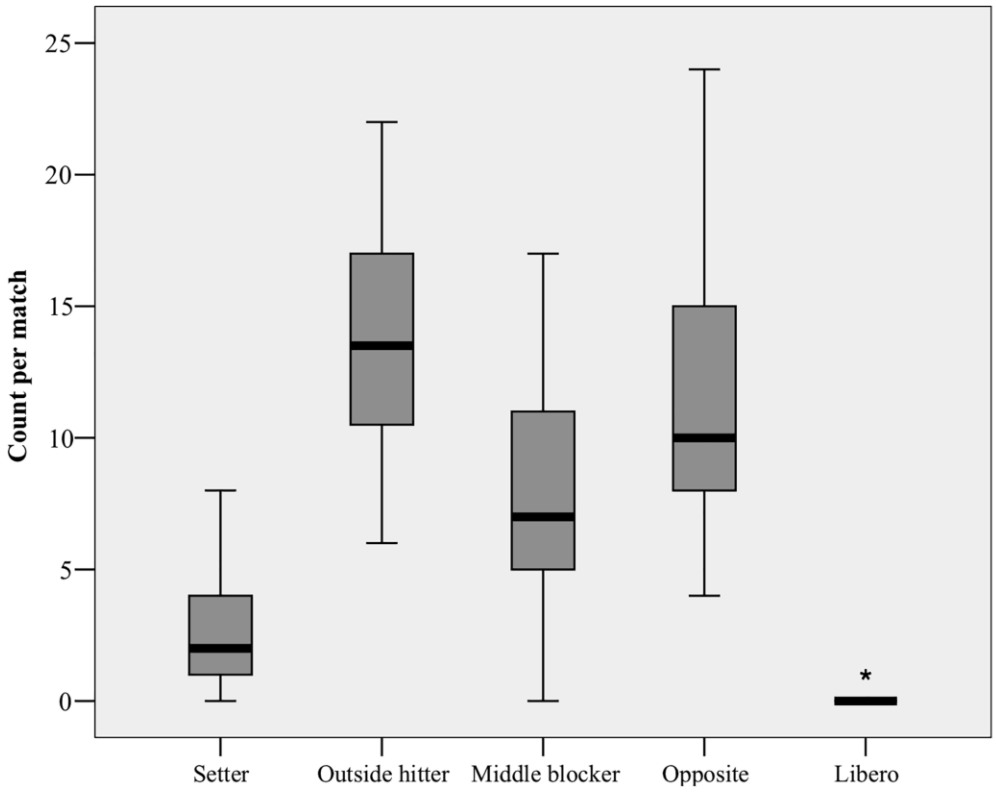


Figure 2. Average number of each in-game role in finishing points per match

In unequal and equal sets, the *Opposite* role in the losing team decided more points than the same position in the winning team, indicating a major difference between player quality in the team losing the set. In contrast, in unpredictable sets, *Outside hitters* and *Opposite players* from both groups (*Winner* and *Loser*) finished almost the same number of points, and the outcomes of other roles showed normal distribution. It follows that for *Tough* sets, the roles in each team were qualitatively equal.

As expected, *Setter* had the lowest percentage of point finishes. In both equal and unequal sets, *Setter* executed a higher number of points in *Winner* groups than in *Loser* groups. The opposite occurred in unpredictable sets.

Middle blockers in the set winning group finished more points in *Walkover* and *Balanced* sets, with a difference of about 10%, in contrast to *Tough* sets, where the middle blockers from the *Loser* group won slightly more points than those from the *Winner* group.

DISCUSSION

Point-scoring plays in relation to level of set win

Because this study is one of the first of its kind, no comparable models are available. In all the studies consulted, the sample matches were played under the current official rules. Walkover, balanced and tough distribution of the final parts of sets in relation to a winning or losing outcome with observation of in-game role provides detailed insight into all final actions and trends under the new rules tested. This in-depth study analysed elements such as the type of attack and unforced errors to obtain a clearer overview of the final points structure in 21 point sets (excluding the fifth set, to 15 points). Because a set can be won or lost due to one of two reasons (Rodríguez-Ruiz *et al.*, 2011), this study focused on how the points were scored specifically in the final scoring interval (from point 16 to the end of the set) and by which in-game role.

The *Walkover* (Chi-Square_{10}=75.476; p=0.000; Cramer's V=0.410) and *Balanced* (Chi-Square_{10}=23,154; p=0.010; Cramer's V=0.230) group of sets showed that block and attack were critical factors in winning sets, concurring with the findings of Yiannis and Panagiotis (2005). Monteiro *et al.* (2009) found a significant relation ($\text{Chi-square}_{(3)}$=9.034; p=0.029; Phi=0.099) between attack and set outcome, and Tsivika and Papadopoulou (2008) defined the attack as an element strongly correlated with match winning in volleyball. Various studies (Häyrinen *et al.*, 2004; Palao *et al.*, 2004; Marcelino & Mesquita, 2006; Marcelino *et al.*, 2008) have stressed the importance of the spike as the principal winning factor in volleyball matches. The significant difference regarding unforced errors in attack between *Winner* and *Loser* groups of teams in *Walkover* and *Balanced* sets is not in correlation with the results of Monteiro *et al.* (2009). In *Tough* sets there is no significant difference, concurring with these authors.

In relation to the new rules tested, winning teams in the *Walkover* group showed a slightly lower significant difference in the serve than in blocking in winning the sets, whereas Patsiaouras *et al.*, (2011) found that the serve had similar significance to blocking in winning or losing a match. An earlier study (Marcelino *et al.*, 2008) reported that high effectiveness of the block is closely related (Marelić *et al.*, 2005) to increasing the risk in the serve. Marcelino *et al.* (2008) reported that teams winning more points with serves also win more block points (r=0.70) and have more block faults (r=-0.44). Regarding *Level of Set Win*, our study obtained higher values for block in *Winner* than in *Loser* groups in all sets, in particular *Walkover* (Cramer's V=0.410) and *Balanced* (Cramer's V=0.230) sets, where a significant difference was found. This is in agreement with findings by Palao *et al.* (2004), Marcelino *et al.* (2008) and Patsiaouras *et al.* (2011).

In the *Walkover* and *Balanced* groups, and to a lesser extent in the *Tough* group, the set losers made more unforced errors, concurring with findings by Patsiaouras *et al.* (2011). Given that an unforced error results in a lost point entirely because of a player's own blunder, it is closely connected to the technical quality of each player, indicating that better results during competitions will be achieved by players with better technical skills, as reported by Grgantov *et al.* (2006).

In *Walkover* sets, elements such as block, attack, serve, opponent's unforced errors in attack and technical unforced errors were identified as significant factors for defining the set winner, as reported by Rodríguez-Ruiz *et al.* (2011) for whole sets and in a different order of importance. The block was clearly the most significant factor, with a value 9.9% higher for *Winner* than for *Loser* groups. Counter attack-spike and counter attack-block out were both significantly higher, with a 7.2% better result obtained by the set winners. The *Winner* group achieved better results in performing aces during the serve, with a difference of 6.6%, although other authors (Asterios *et al.*, 2009; Drikos *et al.*, 2009) defined the serve as a decisive action in team performance. Marcelino *et al.* (2008) placed the serve after the spike as a decisive element. The difference between set winners and set losers for attack-spike and attack-tipping was 6.1%.

In the *Balanced* group of compared sets, the *Winner* group achieved 8.5% more blocks. Marcelino *et al.* (2010) (t = -4,564; p=0.000) and Häyrinen *et al.* (2004) (p<0.05) also found that the *Winner* group executed significantly more blocks. Set *Winners* performed better than the *Loser* group in counter attack-spike and tipping (by 4.7%). In contrast, the *Loser* group had higher values in all types of unforced errors during attack (by 9.4%) and in technical faults (by 3.9%).

Rodríguez-Ruiz *et al.* (2011) found the block to be a decisive factor (p<0.05) in even sets and matches (sets with more than 25 points or tie break sets). In this study the highest percentage difference in the block for set winners was found in the *Tough* group of sets, although no significant differences were observed. However, this is important from the point of view of the final outcome of the teams observed. Marcelino *et al.* (2008) confirmed that the number of block points (r=0.68) is a good predictor of the final match outcome. According to Häyrinen *et al.* (2004), international volleyball matches at the highest level are often very even because of equal skills level, tactics and physical abilities.

Point-scoring plays by in-game role

Because of the lack of quantitative research about point wins by in-game role in men's high-level volleyball, a detailed explanation is given about each role and its scoring characteristics. As expected, attacking was the highest-scoring game action, concurring with other authors (Häyrinen *et al.*, 2004; Marelić *et al.*, 2004; Palao *et al.*, 2004; Yiannis & Panagiotis, 2005; Rodríguez-Ruiz *et al.*, 2011).

In the combined *Walkover* and *Balanced* sets, the percentage of points scored by setters in the set winning teams is 4.4% higher than in the set losing teams. In contrast, in *Tough* sets, setters from the losing teams scored 3.1% more points than setters from the winning teams, which can be explained by setters forcibly trying to score points when the set or the whole match is almost lost. The higher scoring percentage for *Loser* groups by the opposite player by more than 5% in *Walkover* sets and nearly 10% in *Balanced* sets can be explained by inequality in the level of players; i.e., the set losers relied on the opposite players much more than the set winners did. However, in *Tough* sets the players' level was similar, as shown by the very similar results obtained.

In *Walkover* and *Balanced* sets, the *Winner*'s middle blocker finished points almost 10% more often than the same position on the *Loser* teams. This difference could be explained by the higher result in finished points

from the serve by winning teams and much higher number of unforced errors in the attack by players in set-losing teams. When the receiving team has difficulty to receive the serve, the attack is weak and therefore the opposing block has more chances of scoring.

CONCLUSIONS

Potential limitations of the study: in this study 36 of the 38 matches played were observed. It would have been preferable to include all 38 games, although the results would not differ because of those two matches, as they were played by average level teams. This study on the relation of experimental rules (21 point sets and 15 seconds between rallies) and point-scoring plays in the final parts of the sets has identified the block as a decisive element in volleyball. As attack efficacy becomes similar between teams, the development of blocking and serving may have a much stronger influence in future on the result of the final set and the match.

Attack-spike is still the main point-scoring play in volleyball and coaches should continue working on it with slightly more focus on developing attack-block out and attack-tipping, given that set losers showed the high possibility of winning points by these actions. The outside-hitter, as dominant position in the team for finishing points, must be well prepared physically, including precise technical training with appropriate development of physical skills from an early age. The analysis by *Level of Set Win* distribution showed that individual players forcibly try to score points because of the imbalance in the quality of players in the team.

Further study is required in relation to the setter and the actions of this player to trick the block, as well as the block and weak aspects of this position. If the rules are changed, more attention should be placed on technical elements, quality of early selection and daring tactical innovation in future development of volleyball.

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