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ANALYSIS AND EVALUATION OF DEFENSIVE TEAM STRATEGIES IN WOMEN'S BEACH VOLLEYBALL – AN EFFICIENCY-BASED APPROACH

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ABSTRACT
Purpose. The aim of this study was to analyze and evaluate beach volleyball defensive strategies in terms of how often various tactics were employed, their effectiveness, reliability, and overall efficiency based on a sample of elite female volleyball players. **Methods.** A sample of 746 defensive actions performed by various teams that competed in the 2008 Summer Olympic Games (Beijing, China), the 2009 World Championships (Stavanger, Norway), and the 2009 and 2010 Swatch FIVB Beach Volleyball World Tour (Stare Jabłonki, Poland; Seoul, South Korea) were analyzed in terms of what defensive systems were employed and their outcomes. **Results.** Fourteen different defensive systems were used by the teams during defensive play. Out of the fourteen systems, four accounted for almost 75% of all defensive action. The most commonly used defense strategies were selected for more detailed analysis in terms of their activity, effectiveness, and reliability. **Conclusions.** One defensive system in particular was found to be the most prominent in terms of being the most commonly used as well as efficient among all of the observed systems; high-level teams should place additional focus on mastering this system. Nevertheless, effective team strategy should also include less commonly used systems as a way to take an opponent by surprise by the use of non-standard strategy.

Key words: beach volleyball, team actions, defense, actions efficiency

Introduction

Beach volleyball is a sport that is increasing in popularity [1] and ever more professionalized and commercialized. As with most sports, it is becoming increasingly more difficult to achieve sporting success in beach volleyball. This requires high-level athletes to take advantage of every available opportunity over their opponents, particularly by adopting better individual and team tactics and strategies [2–4]. Of some interest may be recent developments in volleyball game theory [5, 6], which can be applied to beach volleyball. For example, one approach used in studying indoor volleyball performance is to analyze the world's best volleyball teams and examine the defense strategies they employ.

Both volleyball and beach volleyball are games composed of two main forms of defensive actions [7], when receiving a service or when blocking against an attack. As was found in beach volleyball played at the highest levels [8], the skill needed to successfully receive a service makes it very difficult for a team to work together when defending themselves against attacks and therefore places large emphasis on its importance in winning a match. One interesting aspect is that women's beach volleyball is considered to employ more effective defensive strategies, due in part to their lower levels of strength, speed, and jump height [9], and causes their attacks to not be as dynamic as in men's volleyball. The larger number of defended attacks in women's volleyball when compared with men's volleyball can be confirmed by both subjective observations and empirical evidence [11]. João et al. [12] also confirmed this fact and concluded that the longer duration of rallies in women's beach volleyball was based on anthropometric and physiological differences.

Therefore, the aim of this study was to analyze high-level female beach volleyball players by observing which defensive systems they employed to defend against attacks and evaluate them based on a number of criteria, while answering the following questions:

1. Which defensive systems were used the most often against attacks made on the third hit?
2. How many times were the remaining defensive systems used?
3. How effective were these defensive systems?
4. How reliable were these defensive systems?
5. Which defensive systems were the most efficient in terms of their overall effectiveness, usage, and reliability?

Material and methods

Twelve women's beach volleyball teams were observed when participating in some of world's most important tournaments. Eleven of the twelve teams were ranked at least once in the world's top 30 beach volleyball teams by the FIVB (Federation Internationale de Volleyball), which ensured that the sample had a high level of sporting ability (Tab. 1). The research material consisted of the video recordings of ten games played in the 2008 Olympic Games in Beijing, the 2009 Sta-

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Table 1. The analyzed teams' world ranking in the 2008, 2009, and 2010 seasons [13]

	Ranking	Players	Country
2008 season	2	Ross – Kessy	USA
	3	Talita – **Renata**	BRA
	5	Antonelli – **Leão**	BRA
	7	Xue – Zhang Xi	CHN
	8	Branagh – Youngs	USA
	9	Juliana – Larissa	BRA
	20	Walsh – May-Treanor	USA
	49	Kadijk – Mooren	NED
	67	**Hinchley** – Palmer	AUS
	86	Keizer – Van Iersel	NED
2008 season	1	Larissa – Juliana	BRA
	2	Talita – Antonelli	BRA
	3	Ross – Kessy	USA
	5	Akers – Turner	USA
	6	Keizer – Van Iersel	NED
	11	Renata – **Leão**	BRA
	15	Branagh – Youngs	USA
	25	Vivian – Vieira	BRA
	27	Xue – Zhang	CHN
	32	Palmer – Bawden	AUS
2010 season	1	Larissa – Juliana	BRA
	2	Antonelli – Talita	BRA
	3	Xue – Zhang Xi	CHN
	4	Kessy – Ross	USA
	7	Akers – Turner	USA
	9	Keizer – Van Iersel	NED
	11	May-Treanor – Branagh	USA
	24	Bawden – Palmer	AUS
	25	Vivian – **Lima**	BRA
	29	Vieira – **Leão**	BRA

Players denoted in bold were not analyzed in the study

vanger World Cup, the 2009 World Tour in Stare Jabłonki and the 2010 World Tour held in Seoul and The Hague (Tab. 2).

Not all of the analyzed beach volleyball teams had as high of a ranking as the other teams or competed with the same players throughout the period selected for investigation. This was the case with the Dutch pair Kadijk/Mooren and the American team composed of May-Treanor/Walsh. Although Kadijk/Mooren were ranked 49th in the 2008 World Ranking, they managed to compete in the Olympic Games in Beijing finishing in 19th place, only to be later ranked 44th in 2009 [12]. The American duo, although not having always played together, are considered to be one of the most successful teams in recent years. These two players managed to win the gold medal twice in the Summer Olympic Games (Athens 2004 and Beijing 2008) as well as winning three gold models at the World Championships (2003, 2005, and 2007). Regardless of ranking or changes in the team's roster, the sporting level of these two teams did not differ in any sense from the rest of the teams considered for analysis.

Analysis was performed on the defensive systems (strategies) the teams employed only in the first and second set of each match, regardless of how many sets were actually played. The reason for narrowing the scope of the analysis was that the third set was played only in two matches and then up to 15 points, which would have had an impact on the results in term of playing effectiveness and the number of defensive systems that were employed. Additional selection criteria adopted was to include only defensive plays against attacks made on the third hit with the ball. Attacks made on the first or second hit were not taken into account due their relatively sporadic occurrence and also that entirely different defensive systems were used against these types of attacks. Furthermore, defensive

Table 2. Players, opponents, event, and round of the observed matches [13]

Game No.	Player names	Opponent's names	Event	Round
1	Xue/Zhang	Branagh/Youngs	2008 Beijing Summer Olympic Games	08/172008 – quarterfinal
2	Branagh/Youngs	Kadijk/Mooren	2008 Beijing Summer Olympic Games	09/08/2008 – Pool E knockout
3	May-Treanor/Walsh	Talita/Renata	2008 Beijing Summer Olympic Games	08/19/2008 – semifinal
4	Antonelli/Talita	Ross/Kessy	Swatch FIVB World Tour 2010 Seoul Open	05/30/2010 – match for 3rd place
5	Juliana/Larissa	Akers/Turner	Swatch FIVB World Tour 2010 Seoul Open	05/30/2010 – final
6	Juliana/Larissa	Antonelli/Talita	Swatch FIVB World Tour 2009 Mazury Open (Stare Jabłonki)	09/08/2009 – semifinal
7	Vivian/Vieira	Palmer/Bawden	Swatch FIVB World Tour 2009 Mazury Open (Stare Jabłonki)	09/08/2009 – semifinal
8	Juliana/Larissa	Palmer/Bawden	Swatch FIVB World Tour 2009 Mazury Open (Stare Jabłonki)	09/08/2009 – final
9	Antonelli/Talita	Xue/Zhang	Swatch FIVB World Tour 2010 Hague Open	08/29/2010 – final
10	Akers/Turner	Keizer/Van Iersel	Swatch FIVB World Tour 2010 Hague Open	8/29/2010 – match for 3rd place

Table 3. Number of defensive systems in the observed matches

No. of plays	Defensive systems													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Total, N = 746	22	**334**	**93**	29	**66**	15	2	**70**	32	11	30	33	7	2
Share of total N = 746 (%)	3%	**45%**	**12%**	4%	**9%**	2%	0%	**9%**	4%	1%	4%	4%	1%	0%
Share of the most popular n = 563 (%)		**59%**	**17%**		**12%**			**12%**						

Values in bold signify the most commonly used defensive systems

plays made after a mistake was made by the opponents (hitting the net, hitting the ball out, an illegal action made when attacking) were also not taken into consideration.

In total, the ten observed matches provided 746 defensive plays that fit the selection criteria. Based on an expert assessment of each team's formation, the formation of their opponents, the location of the ball, and the direction of travel when defending against an attack, as well as data from the available literature [11, 14–16], a total of 14 defensive systems were identified (numbered in the study from 1 to 14). Analysis found that a number of defensive systems were used particularly often (Tab. 3), of which four systems (classified later in this study as No. 2, 3, 5, and 8, see Fig. 1–4) were used at least 66 times. In addition, four additional defensive systems were also noted to be used quite often (No. 4, 9, 12, and 11, see Fig. 5), while the remaining six were used quite rarely. Analysis on how well the teams performed in these systems was mainly concentrated on the four most commonly used systems (No. 2, 3, 5, and 8), as they accounted for 563, or almost 75%, of all defensive play. For comparison, the systems of the second most commonly used group (4, 9, 11, and 12) were used only 124 times, which represented 16% of the sample.

A description of the most commonly used defensive systems

System No. 2

In this system, one player is a blocker positioned on one side of the net, covering half of the court (Fig. 1). The other player positions herself diagonally on the court in such a way as to be outside of the 'block shadow'. Here, the block shadow is the area of the court that is being defended by the player at the net and where, technically, the ball should not be grounded.

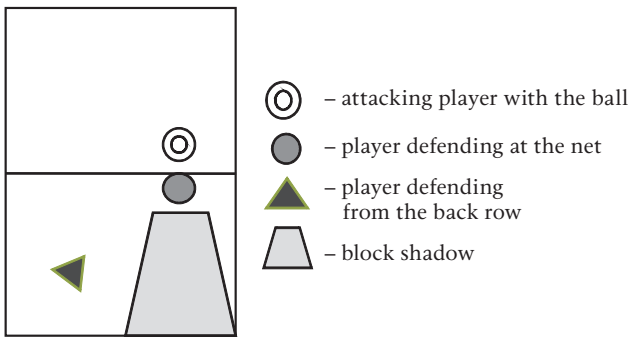

Figure 1. System No. 2

System No. 3

In this defensive system, the blocker moves quickly away from the net parallel to the sideline, while her partner moves from her starting position to the other side of the court (Fig. 2).

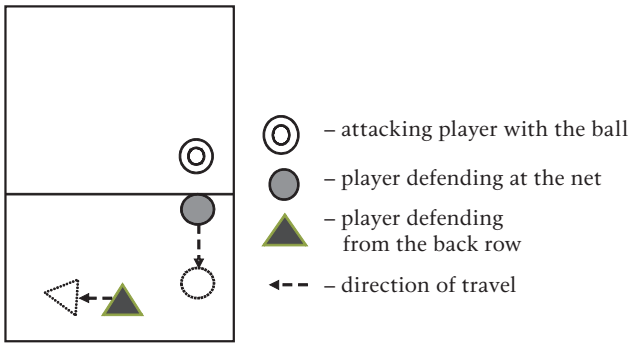

Figure 2. System No. 3

System No. 5

In this system, the block is performed on one side of the net covering a cross-section of the court, while the other player is on the outside of the block down the line of the court. (Fig. 3).

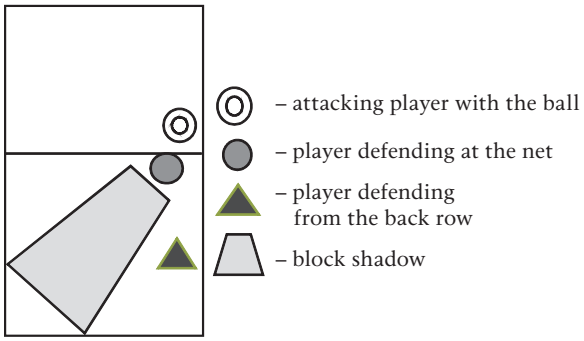

Figure 3. System No. 5

System No. 8

The player defending from the back row is positioned within the block shadow, so as to cover the middle of the court (Fig. 4). In this system, this player waits from

her starting position and observes and predicts which direction the attack will come from and moves to that side of the court.

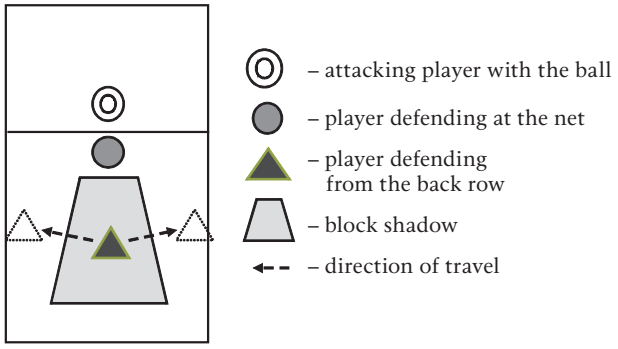

Figure 4. System No.

System No. 11

The player at the net performs an 'aggressive block', while the player from the back row is positioned within the "block shadow" in the middle of the court. This system is used when the ball is being set by the attackers close to the net. The player is ready to move from her starting position to defend attacks that are next to or outside of the block.

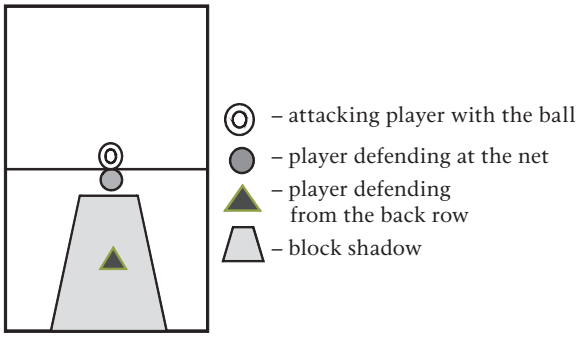

Figure 5. System No. 11

The number of times each system was used (U) as well as its effectiveness (E) and reliability (R) were calculated according to Panfil's formula [17]. As had been previously mentioned, a number of selection criteria were established to delineate the scope and sample of the study. The defensive situations considered for analysis included only those that were taken against attacks made by opponents on the third hit with the ball. Defensive actions taken after an error was committed by the opposing team (hitting the net, hitting the ball out, an illegal action made when attacking) were not included in the sample due to the difficulty in assessing the effectiveness of the defending as well as attacking team. The activity of the defensive systems was measured by the number of times they were used only in the first and second sets of the match. The frequency of the defensive system by the teams was the number of times they were used relative to the number of all observed defensive plays. The criteria used to evaluate the defensive plays in terms of their effectiveness was based on original research by the present author [18], which defined defensive team play as "scoring points either directly from an offensive block or redirecting the ball after an attack to allow teammates to immediately counterattack or continue to rally [11, pg. 18]. Effectiveness was therefore determined by the number of effective, ineffective, and counter-effective plays. Altogether, the number of defensive systems as well as their effectiveness were used to establish the reliability of each defensive system considered in the present study, by the formula:

$$R = \frac{E}{U}, \text{ where}$$

R – reliability;
E – effectiveness;
U – number of times used

Criteria for assessing the effectiveness of defensive actions

Effective play
- The players defended an attack in such a way as to keep it in play.
- The player defended an attack in such a way as to take offensive action on the second hit.
- The player scored a point using an offensive block.

Ineffective play
- The players defended an attack in such a way as to not keep it in play.
- The players defended an attack in such a way as to not allow take offensive action on the second hit.
- The blocker prevented the opposing team from directing the ball to their side of the court but allowed the opposing team to maintain possession of the ball.
- The players hit back the ball allowing the opposing team to continue play.
- Counter-effective play (losing a point)
- Having the ball grounded without it being touched.
- The blocker or defender defended an attack yet grounded the ball on their side of the court or had it land out.

Results

In answering the first research question, the most commonly used defensive systems the teams used during game play were systems No. 2, 3, 5, and 8 (Fig. 6), which accounted for 45%, 12%, 9%, and 9% of all observed plays, respectively. The number of total plays made with these four systems by the teams amounted to 563 plays, or 75%, of all defensive actions (Tab. 3). These four systems were then selected for further analysis. In answering the second research questions, among these most commonly used defensive systems, the most noteworthy are systems No. 2 and 3, which were used 334 and 93

times, respectively. Other systems that were also frequently used were No. 4, 9, 11, and 12, which were used 29, 32, 30, and 33 times, respectively.

In answering the third research question , the most effective defensive system out of the four most commonly used was No. 2. When compared with all of the observed plays (*N* = 746), system No. 3 was the most effective, followed by systems No. 8, 2, and 4. However, the largest percentage of counter-effective plays among the analyzed systems were, in order, No. 2, 5, 8, and 3, with systems No. 8 and 3 the same.

The largest number of ineffective plays among these four systems occurred using system No. 5, less so in No. 3, and the least amount in systems No. 2 and 8. Analysis was then performed on finding the percentage of plays that were either effective and ineffective, which found that for system No. 3 this was 63% of the total, 59% of the total for systems No. 5 and 8, and 37% of the total for system No. 2.

In regards to the fourth research question, analysis found that the most reliable plays were made using

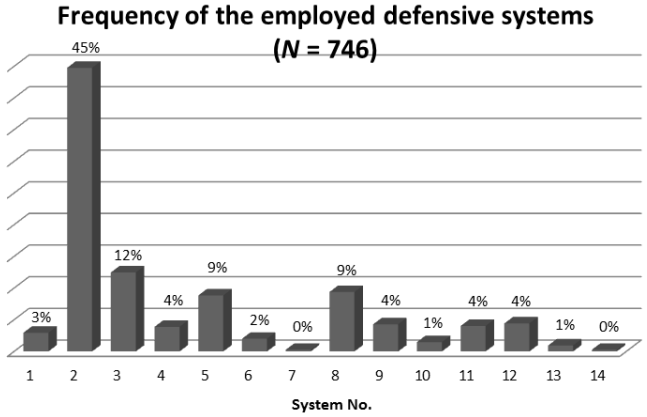

Figure 6. Percent share of the defensive systems employed by the observed teams (see Tab. 3)

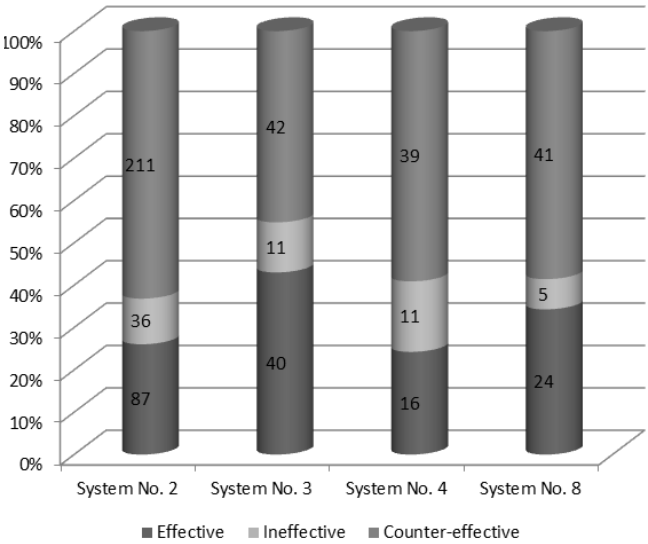

Figure 7. The effectiveness of the analyzed defensive systems based on types of play (see Tab. 4)

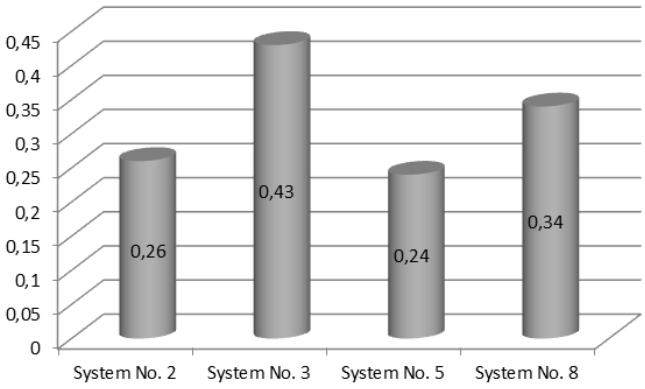

Figure 8. The reliability of the analyzed defensive systems

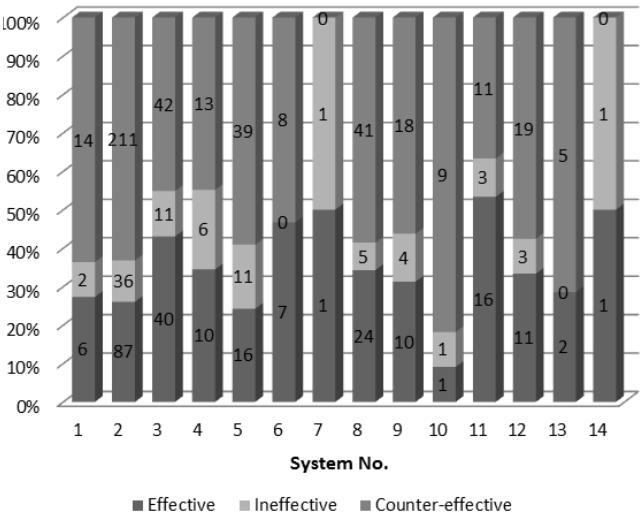

Figure 9. The effectiveness of plays made in each defensive system (*N* = 746)

systems No. 3 (0.43) and 8 (0.34) (Fig. 8). Slightly lower scores for reliability were found for systems No. 2 (0.26) and 5 (0.24).

In answering the fifth research question, taking into account all of the evaluation criteria, the most efficient systems were No. 3 and 11 (Tab. 5). System No. 3 was one of the most commonly used (93 times, or 12% of all defensive plays), with a high level of reliability (0.43). In addition, the sum of effective and ineffective plays was larger than the number of counter-effective plays (51 and 42, respectively). System No. 11 (Fig. 9) was also used quite often (30 times, or 4% of all defensive plays) with a high level of reliability (0.53) (see Fig. 10). This system was also favorable in terms of the number of effective and ineffective plays made in relation to how many were counter-effective (19 effective/ineffective to 11 counter-effective plays).

Discussion

The majority of studies analyzing the formation, type of play, and tactics used in various sports have concentrated mainly on offensive action carried out by

Table 4. The amount of plays and their effectiveness and ineffectiveness among the analyzed defensive systems

Evaluation criterion	Defensive systems			
	System No. 2	System No. 3	System No. 5	System No. 8
Effective	87	40	16	24
Share of effective plays	26%	43%	24%	34%
Ineffective	36	11	11	5
Share of ineffective plays	11%	12%	17%	7%
Counter-effective	211	42	39	41
Share of counter-effective plays	63%	45%	59%	59%
Effective + ineffective	123	51	27	29
Share of effective and ineffective plays	37%	55%	41%	41%
Total	334	93	66	70
Reliability	0.26	0.43	0.24	0.34

Table 5. The amount of plays and their effectiveness and reliability among all defensive systems

Evaluation criterion	Defensive systems													
	1	**2**	**3**	4	**5**	6	7	**8**	9	10	11	12	13	14
Effectiveness	6	**87**	**40**	10	**16**	7	1	**24**	10	1	16	11	2	1
Ineffectiveness	2	**36**	**11**	6	**11**	0	1	**5**	4	1	3	3	0	1
Counter-effective	14	**211**	**42**	13	**39**	8	0	**41**	18	9	11	19	5	0
No. of plays	22	**334**	**93**	29	**66**	15	2	**70**	32	11	30	33	7	2
Reliability	0.27	**0.26**	**0.43**	0.34	**0.24**	0.47	0.50	**0.34**	0.31	0.09	0.53	0.33	0.29	0.50

Values in bold signify the most commonly used defensive systems

individuals. A few notable exceptions include the work of Szwarc [19], who analyzed both offensive and defensive actions although only those performed individually, and Alvarez et al. [20], who studied the effectiveness of defensive team play in basketball. Nonetheless, despite the usefulness of these studies, they focus on games of an entirely different character than volleyball, and in particular beach volleyball, and are of limited use when discussing the results of the present study. Other studies that may be valuable are those which collected data only from indoor and beach volleyball games. Research on the tactical patterns presented in volleyball by Jäger and Schöllhorn [6] could have provided an interesting comparison; however, this study does not address the effectiveness of team play. Of interest may be the conclusions reached by Koch and Tilp [4], who analyzed the effects of offensive team in beach volleyball action sequences. The present study may complement the above-mentioned studies by providing additional data on team play and how teammates work together not only in beach volleyball but in other sports. Hence, one of the first steps that need to be taken is for more in-depth analysis of the obtained results.

One of the reasons why defensive systems No. 2 and 3 may have been so commonly used could be due to the various opportunities these systems provide when one of the players is playing up by the net and blocking ('shadowing') part of the court. In system No. 2, the blocker covers half of the court along the sideline, creating a situation that not only makes it easier to block but also hinder the attacker. This effectively limits the opposing team's possibilities while allowing for a stronger defense. Whereas system No. 3 was used most often in situations where, after initially setting up the formation for system No. 2, the blocker by the net decides not to block. The blocker then withdraws to the back row by taking the shortest path along the sideline of the court. However, when taking into account the remaining defensive systems, of additional interest are systems No. 4, 9, 11, and 12, which were used 29, 32, 30, and 33 times, respectively, accounting for 4% of all defensive actions. Although these defensive systems were used quite rarely, they all presented a similar frequency during game play.

Analysis on the effectiveness of the remaining defensive systems also provided interesting results. One of the highest reliability ratios was found in system No. 11, where almost half of all the observed plays were effective (16 effective plays out of 30). The remaining three defensive systems all featured similar effectiveness: system No. 4 – 10 effective plays out of 29, No. 9 – 10 out of 32, and No. 12 – 11 out of 33. Interesting results were also found when the sum of both effective and ineffective plays were considered. The present authors believe that ineffective action should also be viewed positively as they keep the ball in play and could provide the team with a point-scoring situation later in the rally. When analyzing both effective and ineffective plays, it was found that sum of both plays in systems

No. 3, 4, and 11 accounted for more than half of the total. Moreover, in system No. 11, the sum of both effective and ineffective plays was more than 60% of the total.

Measuring the reliability of the analyzed defensive systems is a complex issue, as it is based not only on effectiveness but also how often each system was used. For example, the systems that were used the most often (systems No. 2 and 3) and also had the highest effectiveness did not present the highest values of reliability. Instead, systems No. 3, 6, 7, 11, and 14 were the most reliable (0.43, 0.47, 0.50, 0.53, 0.50, respectively, see Fig. 10), although systems No. 7 and 14 were very rarely used. This may indicate that results on the systems' reliability may be accidental.

This is why system No. 3 demands the most attention, as it was used quite often while still being relatively reliable (0.43), which must have been very difficult to obtain in such difficult tournaments. As for the remaining systems with the highest reliability, this could have been caused more by surprising opponents by the use of such rare strategies than their actual strategic value. Nonetheless, the fact that the observed teams were able to perform such rarely-used strategies flawlessly and still surprise their opponents points more to their technical expertise and mastery of beach volleyball.

Conclusions

1. The defensive systems employed by the analyzed teams showed wide variation. The most commonly used system was No. 2, which was used 334 times and accounted for 45% of all observed plays, followed by No. 3, which was used 93 times (12% of all observed plays). Among the remaining defensive systems employed by the teams, No. 2, 3, 5, and 8 were also used particularly often. Elite volleyball players and those aspiring to create a world-class beach volleyball team should focus on these strategies, as they accounted for almost 75% of all team play.

2. The effectiveness of the analyzed systems is largely dependent on how often they were used. The most effective plays were made with the most actively used systems, No. 2 and 3 (87 and 40 effective plays made, respectively, which accounted for 26% and 43% of the total). If comparing the systems in terms of what proportion of all plays were effective, system No. 3 would undoubtedly be in first place. Analysis on the amount of effective and ineffective plays found that system No. 3 also presented the highest values (51 plays, or 55% of the total sample).

3. Among the most commonly used systems, system No. 3 was also the one that presented the highest reliability (0.43). The fact that such a commonly used system had such a high level of effectiveness (and therefore reliability) points to the elite level of the studied teams. On this basis, this system could be used as an indicator of teams' technical proficiency during training Additionally, similar to the results on effectiveness, the most reliable systems were those which were rarely used. The unexpected use of these systems and their associated tactics may have been the cause of their effectiveness in match play. Beach volleyball training should consider placing more focus on these systems instead of more popularly used ones.

4. Analysis on the overall effectiveness of the most commonly used systems found that teams using system No. 3 attained the best results although system No. 11 also is of note when considering the less popularly used defensive strategies. Therefore, if systems No. 3 and No. 11 were used as a measure of effective team play, then teams mastering these systems could be assured sporting success. Nonetheless, a team should also focus on adopting non-standard systems in their strategies as to be able to take an opponent by surprise.

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