Original Article

Distribution of service reception and defense in men's beach volleyball component tournaments of the Swatch FIVB World Tour

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Abstract

This study attempts to assess the distribution of service reception and defense, which are understood as intentional directing of the ball into specific areas of the court. The authors determined the size, location, and shape of the optimal area to which the ball should be set after the team's first touch during service reception and defense. The basis of analysis was the men's beach volleyball matches of the Swatch FIVB World Tour 2012. The authors assume that there is a common optimal area for various beach volleyball teams to which the ball is directed during service reception and defense. The study sample consisted of 64 professional beach volleyball players from the top-level teams ranked by the International Volleyball Federation (FIVB). The players' actions were observed during 32 matches from three component tournaments of the Swatch FIVB World Tour 2012. Data were collected with a KINOVEA 0.8.15 motion tracking system. Visualizations of players' actions in different areas of the court were made. The observation and statistical analysis revealed that during service reception, the ball was most often directed into a 2 m × 4 m area (OA2) close to the net, near the center of the court. Thus, the court area OA2 is the optimal area to which the balls are most often set after service reception during top-level beach volleyball matches. In defensive play, the players also directed the ball close to the net and near the center of the court; however the optimal area for defense, unlike for service reception, cannot be delineated.

KeyWords: team sport games, match analysis, Kinovea, players actions.

Introduction

Match analysis research in sport games has yielded numerous interesting studies in terms of their cognitive value and practical applications. However, there has been a tendency to carry out match analysis studies in team sports played on large fields, in which players cover relatively long distances during match play. Motion analysis studies have been conducted on soccer (Andrzejewski, Chmura, Pluta, & Kasprzak, 2012; Andrzejewski, Chmura, Pluta, Strzelczyk, & Kasprzak, 2013), basketball (Ben Abdelkrim et al., 2010; Hoffman et al., 2009; Scanlan, Dascombe, Reaburn, & Dalbo, 2012), ice hockey, and handball players (Chelly et al., 2011; Povoas et al., 2012; Šibila, Bon, Uroš, & Pori, 2011). The obtained players' activity profiles have provided the necessary data, which are the basis of the current knowledge about the playing intensity and volume in different team games.

There have been a number of studies involving match analysis systems in volleyball games. Some analyses of players' movements and playing time statistics have provided useful data on the duration and types of particular game parts and the number of types of performed actions during match play. An interesting tendency in research on players' performance in team games is the studies on the distribution of actions, which is the analysis of directions of movement of players and the ball and types of contacts with the ball (Clemente, Couceiro, & Martins, 2013; Fewell, Armbruster, Ingraham, Petersen, & Waters, 2012; Mroczek, Januszkiewicz, Kawczynski, Borysiuk, & Chmura, 2014).

There has been also a growing number of studies concerned with various aspects of beach volleyball such as the impact of different scoring systems and changes in court dimensions (Giatsis, Tili, & Zetou, 2011; Ronglan & Grydeland, 2006), physiological requirements of beach volleyball players (Magalhães, Inácio, Oliveira, Ribeiro, & Ascensão, 2011), or biomechanical aspects of volleyball-specific skills on a sand court (Tilp, Wagner, & Muller, 2008).

The methodology used by these authors is based on the analysis of particular game parts, especially using tracking of players' direction, type and speed of movement but without considering the court areas, ways, and efficiency of players' contact with the ball, which are essential in beach volleyball. Thus far, there have not been

studies examining the effectiveness of performance of non-scoring actions that are crucial for further actions determining the match outcome in beach volleyball.

Materials and methods

The distribution of service reception and defense were analyzed using authors' own method. The analysis accounted for the distribution of service reception and defense, which are understood as intentional directing of the ball into specific areas of the court. The study aims to determine the size, location, and shape of the court area into which the ball is set after service reception and during defense.

The authors focus on the court area of player's contact with the ball after receiving a serve and during a defense. It is assumed that there is an optimal area (OA) on the playing court, which is common for different beach volleyball teams, to which the ball is directed during service reception and defense.

The optimal area is assumed to feature a particularly high number of ball settings for an attack after service reception and defense. In addition, the proposed optimal area is assumed to be different in terms of the statistical number of ball settings from any adjacent areas on the court. The aim of the study was to analyze the distribution of service reception and defense in beach volleyball matches of the Swatch FIVB World Tour 2012.

The study sample comprised 64 professional beach volleyball players ranked among the world's top teams by the International Volleyball Federation (FIVB). The players' mean body height was 195.02 ± 7.31 cm, and the mean body mass was 87.13 ± 8.55 kg. A total of 32 matches from three different high-level component tournaments (Mysłowice, Prague, Stare Jablonki) of the Swatch FIVB World Tour 2012 were analyzed.

The players were informed about the videotaping of the games in which they took part. The consent to videotape and analyze the matches was also obtained from the Polish Volleyball Association (PZPS) and the tournament organizer. All personal player and club data were anonymous. The study was approved by the Ethical Committee of the University School of Physical Education in Wrocław and was conducted in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki).

The matches were video-recorded with a full HD camcorder (Samsung HMX-H300P) positioned at the back of the court. The data were collected using the KINOVEA 0.8.15 software package (Organization, 2015), which allows the versatile analysis of all sport actions in various training or competitive conditions. The KINOVEA software makes it possible to freeze the footage frames at any given time and impose a reference grid on a court image to evaluate players' touching the ball in any areas of the court. The software has been previously used by Hilenó and Buscà (Hilenó & Busca, 2012) and Seweryniak and Szuliński (Seweryniak & Szuliński, 2013). Its accuracy and reliability were verified with an intraclass correlation coefficient (ICC) amounting to 0.86.

The use of KINOVEA and the mentioned frame of coordinates enabled us to divide each half-court in particular matches into 64 $1\text{m} \times 1\text{m}$ squares. The squares were marked from A to H along the Y-axis, and numbered from 1 to 8 along the X-axis. The observed spots of players' contact with the ball after receiving a serve or during a defense were marked from A1 to A8 (closest to the net) and from H1 to H8 (furthest from the net) (Figure 1). In each half-court, the A1 square was located on the left side of the court, under the net. The number of players' actions was recorded in terms of the square of setting the ball for an attack. If the serve receive was set on the boundary of two squares, the square in which the ball was hit was taken into account.

Figure 1. KINOVEA reference grid (squares) on a beach volleyball court

On the basis of the collected data on the number of observed actions during service reception and defense, visualizations of players' activities were made for particular court areas.

For the statistical analysis of service reception and defense in each model (M1, M2, and M3), each featuring a different position of the Optimal Area (OA1, OA2, and OA3, respectively), ANOVA with repeated measures was used. The Bonferroni correction was used as a post-hoc test. In all tests, $p \leq 0.05$ was considered to be significant.

Results

The obtained results show that after serve reception, the ball was directed to an area close to the net, near the center of the court. A high number of ball settings for an attack was performed in court squares A5, B3, B4, B5, B6, C3, C4, C5, C6, and D4.

The analysis of service reception results pointed to a certain area of the court into which the ball was directed more often by the receiving players than into other areas (Figure 2). This area consisted of squares B3, B4, B5, B6, C3, C4, C5, and C6. In the specified area, the ball was set 581 times after passing the serve, i.e., 65% of all actions within the front court.

	1	2	3	4	5	6	7	8
A	6	4	21	36	45	11	5	4
B	2	9	50	106	95	53	20	3
C	1	7	50	102	82	43	17	4
D	3	6	12	40	32	21	3	4
E	3	2	5	7	8	5	4	1
F	1	2	1	7	1	0	1	1
G	2	0	0	0	1	0	0	2
H	0	0	1	0	1	3	0	1

Figure 2 Distribution of service reception in the examined matches

In terms of the defense, it was more difficult to indicate squares with a particularly high number of actions. However, it was possible to mark out the area to which the ball was directed after the serve reception (Figure 3).

	1	2	3	4	5	6	7	8
A	9	5	15	25	10	10	6	1
B	6	9	15	28	25	19	10	4
C	2	8	13	17	12	14	5	2
D	2	0	4	13	6	5	2	2
E	1	2	0	7	5	1	2	0
F	0	2	6	0	4	3	0	0
G	0	2	0	0	4	0	1	1
H	0	1	1	0	0	1	0	0

Figure 3. Distribution of court defense in the examined matches

During the defense, the players also directed the ball towards the net and the center of the court. However, the squares with the highest numbers of actions were not that explicit as during service reception. Of note, the squares from B3 to B6 and from C3 to C6 had a high number of ball settings: 143, i.e. 53% of all players' actions within the half-court.

Three models were assumed for statistical analysis (M1, M2, and M3), each featuring a different position of the Optimal Area (OA1, OA2, and OA3, respectively). Then, statistical calculations were made for service reception and defense using the number of recorded actions in particular court squares. In each model, the areas marked in red (OA1, OA2, and OA3), orange (O), green (G), and blue (B) had an equal surface of 8 m² (Figure 4). Thus, it was possible to check for significant differences in the number of performed actions during service reception and defense in the OA1, OA2, and OA3 areas and compare them with those in the adjacent areas. In the M1 model, the OA1 area was closest to the net (A3 to A6 and B3 to B6). In the M2 model, OA2 was 1 m from the net (B3 to B6 and C3 to C6). In the M3 model, OA3 was 2 m from the net (C3 to C6 and D3 to D6).

Figure 4. Optimal area models (in red) on a beach volleyball court

The analysis of the number of actions during service reception in the optimal areas OA1, OA2, and OA3 in the M1, M2, and M3 models revealed significant differences between the models (Figure 5).

Figure 5. Distribution of service reception for specific optimal area models

In the M2 model, the number of players' actions in OA2 significantly differed ($p < 0.005$) from the number of actions in all other model areas (O, B, and G) (Figure 5 M2). In models M1 and M3, a statistically significant difference ($p < 0.005$) between OA1 and OA3 and other areas was observed only for the O and B areas but not for G (Figure 5).

The statistical analysis of defensive actions revealed that in models M1, M2, and M3, the number of players' actions in OA1, OA2, and OA3 significantly differed ($p < 0.005$) from the number of defensive actions in the remaining areas (O, B, and G) (Figure 6).

Figure 6. Distribution of defense in particular models

Discussion

This study represents a novel approach to match analysis in top-level beach volleyball matches. The authors examined the movements of players on the court and the directions of ball movements aimed at scoring. The topography and distribution of ball movements are closely associated with players' specialization, which is commonly observed in beach volleyball and is reflected in players' physiological loads (Šibila et al., 2011).

Actions during match play and tactical tasks determine beach volleyball players' profiles of motor activity during matches (e.g., total covered distance, number of jumps, and number of contacts with the ball). According to Palao (Palao, Valadés, Manzanares, & Ortega, 2015), these profile components must be considered in the programming and execution of beach volleyball training loads. The results indicate that beach volleyball imposes considerably different demands, and features other work-rest characteristics compared to indoor volleyball. The work time in beach volleyball ranges between 3 s and 12 s, whereas the rest time is between 2 s and 31 s (Joao, Goncalves, Mota, Marcelino, & Medeiros, 2014; Palao et al., 2015); thus, in beach volleyball, the work-rest ratio was 1:4 compared to 1:2 in indoor volleyball. The beach volleyball player's time of remaining in different zones of energy metabolism amounted to 8 s/min at below 75% HR_{max} , 13 s/min at 75–85% HR_{max} , 25 s/min at 85–90% HR_{max} , and 14 s/min at above 90% HR_{max} . The mean covered distance in match play by beach volleyball players amounted to 1800 m, i.e., 850 m per set. The presented data are most definitely associated with the assumed model of beach volleyball activities, which are mainly determined by the skills and efficiency of actions of particular players, considering their individual tolerance of training and match loads.

Previous studies on the activities of beach volleyball players focused on the analysis of matches of top-level men's and women's teams (Giatsis & Zahariadis, 2008; Koch & Tilp, 2009a; Tilp, Koch, Stifter, & Rupert, 2006), differences between male and female players (Koch & Tilp, 2009b; Laios, 2008), and differences between winning and losing teams. Some studies (Busca, Moras, Pena, & Rodriguez-Jimenez, 2012; Lopez-Martinez & Palao, 2009) were concerned with the analysis of ball flight trajectory but primarily during offensive actions (e.g., service).

This study involved an analysis of players' actions, match parts, and tracking of player's activity regardless of the place, ways, and effectiveness of players' contact with the ball, all of which are of particular importance in beach volleyball. Häyrinen and Tampouratzis (Häyrinen & Tampouratzis, 2012) in their assessment of service reception efficiency applied the commonly used indoor volleyball criteria from the Data Volley software, which did not account for the specificity of beach volleyball and assumed that only hand setting was perfect. In situations where many beach volleyball players do not use hand settings at all (e.g., world and Olympic champions E. Rego and R. Santos from Brazil), this criterion seems – in the authors' opinion – erroneous. A more valid criterion for assessing the quality of service reception and defense can be the court area the ball is directed to and the time a player has to move into this area (Seweryniak & Szuliński, 2013).

The determination of an optimal area for service reception and defense is the starting point for any analysis of efficiency of players' actions in beach volleyball. Research on the most elite beach volleyball teams sets a frame of reference for the evaluation of efficiency of actions. An important contribution to this research could be the determination of the OA2 optimal area for service reception in model M2 of this study, which considerably differed in terms of the number of actions from the other model and OAs.

The results of this study show that despite the common "pedigree", beach volleyball and indoor volleyball significantly differ from each other. These conclusions should change the prevailing attitudes to beach volleyball training in terms of match conditions and tactical assumptions of service reception, which is a key action for constructing all subsequent offensive actions on the court.

The analysis of distribution of defensive actions does not strongly imply that there are court areas of exceptionally high numbers of serve reception locations. At the same time the statistical analysis indicated that one may not decidedly delineate an optimal area for defensive actions. A likely reason for this is that directing the ball in defense is less accurate owing to the receiving player's more "unbalanced" position while moving during defense than during serve reception. In addition, the defending player acts under the conditions of greater time deficit because the duration of the ball flight is considerably shorter during defense than during a serve; thus, the defending player has less time to make a correct decision and undertake an effective action.

The models in this study assumed identical optimal areas for service reception and defense. Therefore the results and conclusions constitute the basis for further research on the validity and reliability of these models, especially during defense. It is possible that the models assumed too small or too large optimal areas or that the shape of OAs could be somehow modified.

The research prospects indicated by this study generate a number of questions related to the range and method of analysis of optimal areas of action. Future studies may concentrate on the analysis of individual players' actions involving the distribution of serve reception court side (left or right) or the distribution of defense actions between the blocking and backcourt players.

Conclusions

A 4m × 2m area, which contains an especially high number of ball settings for attack during service reception, is delineated on a beach volleyball court. Similar areas are also observed for defensive actions, and the analysis of distribution points to a 4m × 3m area directly by the net. However, the differences from other areas on the court are not significant as during service reception.

In the optimal area OA2 for service reception (model M2), the number of players' actions was significantly different from the number of players' actions in the adjacent areas (O, G, and B). Such differences were not observed in models M1 and M3. OA2 is the optimal area used by top-level beach volleyball teams. Owing to the significant differences in the number of ball settings in the optimal areas in models M1, M2, and M3 from other areas (O, G, and B), an optimal area for defense, unlike for service reception, cannot be delineated.

The results of this study indicate that after receiving a serve, the ball should be directed towards an optimal area, which is based on the model developed by analyzing top-level beach volleyball teams. Regarding the defense, the imperative is to maintain the ball in play. For easy attacks, the ball can be directed towards the optimal area, just like during service reception. The application of the KINOVEA virtual reference grid can considerably facilitate the coach's analysis of match play of beach volleyball teams.

In conclusion, beach volleyball players should be trained to pass the served ball into the optimal area for service reception and face the net as often as possible. This corresponds to the specifics of match play by the world's top-level beach volleyball teams.

Conflicts of interest

The authors hereby declare that there is no conflict of interest.

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