

Skills Importance across Ages for Men's Volleyball

S. Drikos and I. Ntzoufras

Faculty of Physical Education and Sport Sciences, National and Kapodistrian University of Athens
sdrikos@gmail.com

Abstract

Volleyball is a competitive team sport whose main objective is to score the most points by grounding the ball to the opponents side of the court. The numbers of points a team scores is primarily based on the execution of the skills of the game. Due to the hierarchical structure of the game events follow stable patterns: serve outcome, pass-set-attack (complex 1) outcome, Serve-block-dig-set-counter attack (complex 2) outcome. The outcome consists of four possibilities: To win or to lose a point, continuation of the action with the ball on the team's side or with the ball on the opponent's side. In this paper we provide a method to calculate the importance of every skill on the outcome of the Volleyball game for youth, juniors and men teams. We base our analysis on Fellingham's model for importance scores. We use data from the performance analysis of the winning team from the most recent world championships in all ages for male volleyball. In order to arrive at posterior distributions we use a Markov chain transition matrix. To estimate the Markovian transition matrix, we assume a multinomial likelihood with a Dirichlet prior on the transition probabilities. The prior distribution of skills is formed by expert coaches' opinion. Our main purpose is to examine if key skills are consistent across ages in male volleyball.

1 Introduction

Volleyball is a competitive team sport in which the aim of each team to score first a required number of points by grounding the ball to the opponent's side of the court. Volleyball belongs to the same team sports category with Tennis, Badminton and Table Tennis. All of them are described as *Net and Wall games* [6].

In international tournaments, a volleyball match consists of at least three and a maximum of five sets with the winning team reaching first three earned sets. Each set is played until one team reaches a score of 25 points with at least two points difference from its opponent. The number of points a team scores is primarily based on the efficiency of the team skills of the game. Volleyball has three scoring skills (serve, attack, block) and three non scoring skills (pass, set, dig). For each team a maximum of three contacts of the ball is allowed before the ball crosses the net to the opponent's court. Each team in its effort to pass the ball to the other court exhausts all the contacts most of the times. A rally begins when a member of one team serves the ball across the net to the opposite team. Thus there are two complexes of the game. Complex 1 consists of pass, set and attack (or attack 1) and complex 2 consists of serve, block, defense and counterattack (or attack 2).

Quantitative analysis is not something new in the area of Volleyball but most of the times it is restricted to characterizing players' or teams' performance per season, per match or in more detail per set. Thus there are elements for the importance of each skill for seasons, tournaments, matches, sets, even for ambivalent sets [2], but there are very little data for the importance of skills and the level of their execution on the ending of a single rally.

In this work we implement a method to calculate the importance of every skill on the outcome of the Volleyball game for youth, juniors and men teams. We base our analysis on

Fellingham’s model [4] for estimating the importance scores. Our main purpose is to examine whether the key skills are consistent across tournaments for different ages in male volleyball.

Due to the hierarchical structure of the game, events follow consistent patterns: serve outcome, pass–set–attack 1 (complex 1) outcome, serve–block–dig–set–counter attack 2 (complex 2) outcome. All the attacks, except for those following a serve’s pass, are attack 2. The outcome consists of three possibilities: to win a point, to lose a point or to the continuation of the game on the opponent’s side. Due to the data collection method, the continuation of the game in the opponents side cannot be considered as a final try since the ball does not cross the net.

2 The data

All recorded data refer to the performance of the winning team from the most recent world championships of National teams in all age categories for male volleyball. National World Championships for three age categories (youth, juniors and men) currently take place every four years.

All data record the performance on selected matches of the latest World national team champions (Poland in Men, 2014; Russia in juniors and in youth, both for 2013).

We record and analyze only the actions of the selected team when the ball is in its court separately for both complexes. All skills were categorized in two complexes, except for the serve and serve’s pass. Thus we have set 1 and 2, block 1 and 2, defense 1 and defense 2, free ball 1 and free ball 2. For each skill we use a different ordinal grading system on tactical scale with one being a poorly performed skill and the maximum to be a skill performed in the optimal way. For serve, jump and float and for pass, against jump or against float serve we use a six-level ordinal tactical scale [1]. Sets, either after serve’s pass or after defense, are divided according to the position on the court and the tempo of the ball. We include five possible positions of attack of two tempos for each set. We have also added a variety of attack moves: attack as second contact from the setter, attack out of system and direct attack when the ball is driven directly from the opponent’s court. For block, either after serve or after attack, we use a three-level ordinal scale [5].

For defense, we use two states: free ball and dig, either after serve or after attack. Finally, the skill of *set error* records the case where the recorded team makes an unforced error during the second touch.

All recorded skills and their properties are summarized in Table 1. The data are recorded in a 60×62 matrix denoted by \mathbf{y} and each element y_{ij} recording the number of occurrences of each subsequent moves and skills (how many times skill S_j follows skill S_i). Column and row 60 refer to the continuation at the field of the opponent and the last two columns are terminal moves resulting to a point in favor or against the team under study.

Table 1. Performance ratings for all skills

3 Method of analysis

In this paper we use the methodology of Fellingham’s and Reese [3] to evaluate the importance of each skill. According to their approach, the coefficient of the skill importance for the i -th recorded skill is defined as the ratio of the posterior mean of P_i over its corresponding standard deviation, that is

$$I_i = \frac{E(P_i|y)}{\sqrt{V(P_i|y)}}$$

Skill (main)	Skill (sub)	Levels	Complexes	Tempos
<i>Serve</i> (<i>Jump & float</i>)	Serve ace	6		
	The ball drives directly to the serving team's court	5		
	The ball is on receiving team's court but with just one option for attack	4		
	The ball is on receiving team's court with two options for attack	3		
	The receiving team has all the options for attack	2		
	Serve error	1		
<i>Pass</i> (<i>vs Jump & vs Float serve</i>)	The receiving team has all the options for attack in optimum tempo	6		
	The receiving team has all the options for attack	5		
	The ball is on receiving team's court with two options for attack	4		
	The ball is on receiving team's court but with just one option for attack	3		
	The ball drives directly to the serving team's court	2		
	Pass error	1		
<i>Block</i>	Block kill	3	2	
	The ball remain to the blocking team's court	2	2	
	The ball remain to the attacking team's court	1	2	
<i>Setting location</i>	Left Front Side		2	2
	Right Front side		2	2
	Right Back side		2	2
	Middle Front side		2	2
	Middle Back side		2	2
	Out of system		2	
	Setter's Tip or attack in 2nd touch		2	
	Setting error		2	
	Direct attack		2	
<i>Defense</i>	Dig		2	
	Free ball		2	

2 complexes indicate that the skills are recorded for both complex 1 and 2 separately; 2 tempos indicate that the skills are recorded for quick and high tempos

where P_i is the probability that this skill will eventually end up in a point in favor of the team under study after two subsequent game moves and is calculated by

$$P_i = P(Y_{t+1} = \text{point}^+ | Y_t = S_i) + \sum_{k=1, k \neq i}^n P(Y_{t+2} = \text{point}^+ | Y_{t+1} = S_k) P(Y_{t+1} = S_k | Y_t = S_i) \quad (1)$$

with n being the number of skills, $P(Y_{t+1} = \text{point}^+ | Y_t = S_i)$ being the probability of scoring a point in favor of the team under study after a skill S_i and $P(Y_{t+1} = S_k | Y_t = S_i)$ is the transition probability from skill S_i to skill S_k . We further assume that the scoring for each skill is not influenced by the time point, hence

$$P_i = P(Y_{t+1} = \text{point}^+ | Y_t = S_i) = P(Y_{t+2} = \text{point}^+ | Y_{t+1} = S_k).$$

This ratio gives the opportunity to attach an importance score to every to every skill and its corresponding levels or categories. Every time the ball is on the side of the observed team a sequence of events takes place that follow specific schemes: serve–outcome, pass–set1–attack1–outcome and defense–set2–attack2–outcome. We assume that these schemes are of first order Markov chains. We record these sequences in a transition probabilities matrix where data of the matrix represent the probability to move from one state to another. Because we observed three teams, we created three transition matrices with dimensions 60×62 (two states related to point earned or lost by the team are terminal), containing the transitions for jump and float serves, passes against jump and float serves, sets after serve’s pass by location and tempo, sets after defense by location and tempo, block after serve, blocks after attack, free balls and digs and possible outcomes. Because of the hierarchical structure of the game, there are sequences that are not feasible, such as moving from an excellent pass to an ace serve. These cases are restricted to zero probability.

We use a simple Bayesian model to estimate the transition probabilities and through them the success probabilities P_i as defined in (1). For simplicity, we denote by $\pi_{ik} = P(Y_{t+1} = S_k | Y_t = S_i)$. For each row (i.e. skill), we assume multinomial likelihood

$$f(y_{i1}, \dots, y_{i,n}, y_{i,n+1}, y_{i,n+2} | \pi_{i1}, \dots, \pi_{i,n}, \pi_{i,n+1}, \pi_{i,n+2}) \propto \prod_{k=1}^{n+2} \pi_{ik}^{y_{ik}}.$$

and $\sum_{k=1}^{n+2} \pi_{ik} = 1$, for each i . We use a conjugate Dirichlet prior distribution of the type

$$f(\pi_{i1}, \dots, \pi_{i,n}, \pi_{i,n+1}, \pi_{i,n+2} | a_{i1}, \dots, a_{i,n}, a_{i,n+1}, a_{i,n+2}) \propto \prod_{k=1}^{n+2} \pi_{ik}^{a_{ik}-1}$$

where in each row the prior parameters a_{ij} can be elicited by using the coaches as an expert’s opinion. Prior estimations were conducted by expert coaches in the three specific ages of men’s Volleyball. Due to the difficulty of passing the notions of transition probabilities prior elicitation was a tedious and difficult task. For this reason, we have decided to attach only a low weight to the experts/coaches opinion. Hence, the prior parameters were set equal to the elicited transition probabilities of experts multiplied by $0.1 \times N_i$ for each skill S_i and hence account for additional 10% of data points.

All skill scores were calculated using a simple Monte Carlo scheme of 10,000 iterations.

4 Results

With the use of importance scores we estimate the impact of performance in a specific skill and the uncertainty of it. Uncertainty connects directly to the number of executions of each skill. The skills which are performed more often receive higher importance scores. Comparing importance scores across teams or age categories, the ranking of importance scores should be compared. We summarize results by focusing on importance scores for each level of every skill for the three age categories (see Table 2). An analysis of the importance score for each skill (based on Table 2) follows.

Serve: Aces either from jump or from float serves are skills with high importance score in the three age categories. In Men's category all levels of float serves are more important compared to the similar level of jump serves. Also serves level 2 have higher importance score than serves levels 3 and 4 either if there are float or jump serves. This is due to the nature of importance scores as was explained above. An easy serve level 2 is executed more times than serves levels 3 and 4 during a match but the serving team maintains the right to fight for the point even if circumstances are against it because the ball was in its opponent with all attacking abilities.

Pass: A difference between youth or juniors and mens teams is the importance of pass accuracy. According to our scale with pass level 6 a team has all the possible choices to set the ball in optimum tempo and with pass level 5 has also all the possible choices but not in the fastest way. In men and junior teams passes level 6 (either against jump or float serves) and passes of level 5 have higher importance scores than all the other levels of pass. In youth teams this did not happen. Accurate pass is more important against float serve than against jump serve. Pass levels 5 and 6 against float serve are the most important scores for youth team.

	Men		U21		U19	
Block kill AS	948.1	(1)	315.5	(1)	165	(1)
SrvJump 6	281.2	(2)	139.1	(3)	57.2	(3)
Block kill	225.2	(3)	168.5	(2)	57.6	(2)
SrvFloat 6	114.4	(4)	57.6	(4)	15.7	(5)
Passin Float 6	27.9	(5)	18.3	(6)	14.3	(6)
Passin Jump 6	27.8	(6)	15.5	(9)	6.1	(22)
Passin Float 5	27.8	(7)	18.3	(5)	13.2	(7)
Passin Jump 4	24.9	(9)	14.1	(10)	8.2	(14)
Passin Float 4	22.8	(10)	14	(11)	11	(8)
Attack 1 MF quick	21.9	(11)	16.5	(8)	9.4	(10)
Passin Jump 5	27	(8)	16.9	(7)	3.3	(38)
SrvFloat 2	17.9	(12)	13.7	(12)	9.3	(11)

Table 2. Importance Scores for volleyball skills (the rankings of the skills are provided in brackets); the table is sorted according to the men's skill scores.

[Table continued on next page.]

	Men		U21		U19	
Dig 2	16.8	(14)	11.4	(15)	7.4	(18)
Dig	15.8	(15)	10.6	(17)	8.2	(13)
Free ball	15.6	(16)	10.7	(16)	7.5	(17)
Attack 1 LS quick	17.2	(13)	12.7	(13)	16	(4)
Attack 2 out of system	10.9	(24)	9.3	(20)	6.8	(21)
Attack 2 BRS quick	9.9	(27)	3.5	(45)	7.6	(16)
Free ball2	15.3	(17)	10	(18)	7.1	(19)
SrvJump 2	14.3	(18)	6.6	(26)	4.9	(27)
Attack 1BRS quick	11.5	(22)	5.8	(30)	3.3	(37)
Attack 1 FRS quick	14.1	(19)	12.7	(14)	10.7	(9)
Attack 1 MB quick	12.3	(20)	5.6	(34)	2.3	(45)
Attack 2 FRS quick	10.5	(25)	8.3	(23)	8.6	(12)
Attack 2 MB quick	7.7	(35)	6	(28)	3.5	(35)
Continue Block 3	7.7	(34)	4.6	(40)	3.4	(36)
Passin Jump 3	8.5	(30)	5.8	(31)	2.3	(44)
Passin Float 3	8.5	(29)	5.6	(33)	4.5	(30)
Attack 1 out of system	6.7	(37)	4.9	(39)	4.9	(28)
SrvJump 3	9.3	(28)	7.1	(25)	4.4	(32)
SrvJump 4	7.5	(36)	4.9	(38)	4.8	(29)
SrvFloat 3	12	(21)	8.7	(21)	7.9	(15)
Passin Float 2	5.7	(40)	2.5	(48)	4	(33)
Attack 1 LS high	8.4	(31)	5.8	(32)	5	(26)
SrvFloat 4	8.3	(32)	6.4	(27)	6	(23)
Attack 2 LS quick	11	(23)	9.4	(19)	5.9	(24)
Attack 2 MF quick	10.1	(26)	8.6	(22)	6.9	(20)
Attack 2 STR TIP	2.9	(49)	4.4	(41)	2.9	(40)
SrvJump 5	3.7	(47)	3.5	(44)	2.8	(41)
Attack 1 MB high	1.9	(51)	0.3	(53)	0.3	(51)
Attack 1 STR TIP	4.5	(44)	3.7	(43)	3.1	(39)
Attack 2 LS high	6.3	(38)	5.8	(29)	2.5	(43)
Attack 2 FRS high	5.4	(41)	1.4	(51)	2.7	(42)
Continue Block AS3	6.2	(39)	5.1	(37)	4.5	(31)
Attack 2 BRS high	3.5	(48)	3.3	(47)	1.3	(50)
Direct attack	8	(33)	8.2	(24)	5.9	(25)
Attack 1 FRS high	4.3	(45)	3.3	(46)	1.5	(48)
SrvFloat/	5.1	(42)	5.5	(35)	3.8	(34)
Continue Block AS2	0.6	(53)	0.3	(52)	NaN	(53)
Passin Jump/	5	(43)	5.2	(36)	2.2	(46)
Attack 1BRS high	4.1	(46)	3.8	(42)	2	(47)
Attack 2 MB high	2.1	(50)	1.6	(49)	1.4	(49)
Continue Block 2	1.2	(52)	1.5	(50)	0.3	(52)

Table 2 (continued). Importance Scores for volleyball skills (the rankings of the skills are provided in brackets); the table is sorted according to the men's skill scores.

Attack 1: For all ages quick tempo attack after serves pass is more important than attack with high tempo. A differentiation is that for youth team, attacks from back row are not as important as front row attacks. The importance of back row attack (middle and right side) is getting higher as the age category increased. As attack out of system we have described the

attack independently of location and tempo when setting comes from any member of the team except the setter. In this type of attack the youth team has higher position in the importance scores ranking than in Men and Juniors teams respectively. According to these and in connection to the limited importance of passing accuracy against jump serve we can think that a difference between men or juniors teams is the rhythm of the offensive game. Youth teams must prepare better for a slower offensive tempo than older and more experienced players. Middle front side attack and left side's attack both in quick tempo are the most efficient attack types for men and juniors. All levels of well organized attack 1 have higher importance scores than attacks 2. This is a clear message about the importance of complex 1 in male volleyball.

Attack 2: Attack out of system is for all ages in the top two positions for attack 2. It is one of the most important attack skills during complex 2. Volleyball coaches have to work more on details concerning unpredictable situations such as when the setter is not able to set the ball according to the teams offensive plan and another player is getting to set it in a safe manner. For all ages setting quick tempo is more efficient than high tempo attacks.

Direct attack: Importance of direct attack when the ball comes directly from the other court is getting lower as age category increases. Direct attack is more important for youth and junior teams than for men.

Block: From all blocking situations the most important is Kill Block after serve. Kill block and serve ace are the two direct methods to break the point of the opponent. In Male Volleyball contrary to Male tennis the serving team has a disadvantage and if they win the point we call it a break point. Thus kill block when serve is the previous action is the most important option of defending abilities.

As for the defending skills Free ball and Dig, it is important to define that dig or free ball can take place in two occasions: either when responding to opponents action or from a technical spike to opponents block when circumstances are not ideal for a powerful attack especially because attack is out of system or because previous actions (pass and set) are not so successful. Free ball and dig in both complexes are in the second ten in ranking of importance scores for male teams across ages. Either after serve or after attack defending abilities gives the teams the opportunity to claim a point.

5 Conclusions

It is important to recognize that this analysis applies only for these specific teams. But these teams being the winners of the respective age category in world championships reflect the highest level of volleyball game for each category. Because of the class of the teams it is reasonable to extend our conclusions to teams in world level for these ages. According to our results importance of Volleyball skills across ages did not vary too much. High class teams as world champions use almost same ways to win points during a game. It would be a great challenge to use data of performance analysis as prior information for a specific team. The more detailed the data, the more standardized a team's profile is, and the more weighty the prior information.

Our target was to propose a performance analysis system more extended and more applicable to men's teams, with the ability to rank the importance not only for every volleyball skill but for every level of the scale we use to describe skills. This method could help volleyball coaches to highlight important skills per age category and to allocate training time more efficiently.

References

- [1] Rocha. C. and Barbanti. V. An analysis of the confrontations in the first sequence of game action in brazilian volleyball. *Journal of Human and movement studies*, 50(4):259–272, 2006.
- [2] S. Drikos and G. Vagenas. Multivariate assessment of selected performance indicators in relation to the type and result of a typical set in mens elite volleyball. *International Journal of Performance Analysis of Sports*, 11:85–95, 2011.
- [3] G. Fellingham and C. Reese. Rating Skills in International Men’s Volleyball. Unpublished report to the USA National Men’s Volleyball Team, 2004.
- [4] M. Miskin, G.W. Fellingham, and L.W. Florence. Skill importance in womens volleyball. *Journal of Quantitative Analysis in Sports*, 6(2), 2010.
- [5] J.M. Palao, J.A. Santos, and A. Urena. Effect of team level on skill performance in volleyball. *International Journal of Performance Analysis of Sports*, 4(2):50–60, 2004.
- [6] B. Reed and P. Edwards. *Teaching Children to Play Games*. White Line Publishing, Leeds, 1992.