Original Article

Selected somatic and motor parameters as factors of the efficiency of attack by players in women's top volleyball

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Abstract:

The aim of our study was to determine somatic and motor differences between the most efficient and the least efficient players in an attack in outside players positions (outside spiker and opposite) and middle players (blockers) at Volleyball Women's European Championship 2019. We obtained the researched data from the available CEV database. When determining the most efficient and least efficient players we used the order of the best, resp. the weakest ten players in a given player position. Specifically, we compared their body height, weight, jump reach from approach and in standing jump reach. To find the differences we used the nonparametric Mann-Whitney U-test and for the Effect size r according to Mangiafico (2016). We set the level of statistical significance at $p < 0,05$. When comparing the effectiveness of the most successful and least successful outside players, we found a significant difference in body height ($z = 2,721$; $p = 0,007$), body weight ($z = 2,419$; $p = 0,016$) and reach in the jump from approach ($z = 2,306$; $p = 0,021$). In the group of middle players in terms of the effectiveness of their attack we found a significant difference in body height ($z = 2,117$; $p = 0,034$) and standing jump reach ($z = 2,948$; $p = 0,003$). The body height of the players shows as a common parameter of higher effectiveness of the attack in both studied player positions. Based on effect size ($r = 0,16 - 0,29$) we can indirectly infer a small effect of the given parameters on a success of an attack. We can use the results when selecting players for individual player positions in women's top volleyball and in the search for the causes of the players' success in the implementation of the attack.

Key words: volleyball, performance analysis, skills, body height, weight, reach in the jump

Introduction

The most basic definition of an attack can be found in the rules, which define this game activity as any rebound of the ball on the opponent's side, except for the service and the block. Research observations consider attack to be the skills through which teams score the most points in a match (Ran, 2000; Lozano, 2005) and are also the most common predictor of a team success in a match (Přidal, 2001; Häyrinen et al., 2004; Monteiro et al., 2009; Marcelino et al., 2010; Patsiaouras et al., 2010; Rodríguez-Ruiz et al., 2011; Hančák & Přidal, 2012; Přidal & Bílik, 2016; Přidal & Bílik, 2015; Přidal & Kopůň, 2015; de Alcaraz & Marcelino, 2017; Valladares et al., 2017; Klaričič et al., 2018; Yu et al., 2018). Of the indicators for evaluating the quality of an attack, the most frequently used are those that express the relative proportion of attacks after which the team gained a point, resp. points were scored by an opponent (mistakes) or various indices, the most common of which is efficiency, which expresses the difference between successful and erroneous attacks in a relation to all attacks in percentages (for example statistical software Data Volley).

The attack itself is influenced by a number of factors, including the rational technique and tactics of carrying out the attack. The offensive performance of players is also limited by somatic, biomechanical and motor parameters. From the point of view of examining somatic parameters, the focus is on data related to body height, body weight, body composition (BMI etc.) (Malý et al., 2011; Čopić et al., 2014; Nikolaidis et al., 2014; Sieroň & Bidzinska, 2017). Most related to our issue are the findings of Nikolaidis et al. (2014), who found higher body height and a lower percentage of body fat in more efficient female teams than weaker ones. Similarly, a study by Wnorowski & Ciemiński (2016) showed that the body height and the spike reach significantly differentiate the best and the weakest ranked teams participating in the top men's volleyball tournament. Lidor & Ziv (2010) concluded that anthropometric data were correlated with volleyball skills' proficiency and game performance, especially in female players. Gabbett & Georgiev (2007) highlighted the importance of anthropometric characteristics in junior volleyball players, by showing that as the playing level increased, junior volleyball players were taller and leaner. Based on these results, it seems that volleyball performance is multidimensional (Rikberg & Raudsepp, 2011) and successful players are leaner and taller with greater motor

abilities compared with lower level players (Milic et al., 2017). The study from Matillas et al. (2014) aimed to describe morphological characteristics of elite female volleyball players from the highest Spanish league, with special focus on differences by performance level and playing positions. Anthropometric, body composition and somatotype parameters according to performance and playing positions were analysed. Mean somatotype was 3.1 ± 0.7 ; 3.4 ± 0.9 ; 3.1 ± 0.9 characterised as central with a tendency to balanced mesomorph. Top level players were taller, had higher skeletal muscle mass and ectomorphy, and had a lower level of adiposity markers, compared with lower level players. Players selected for their respective National teams were taller, heavier, had higher muscle mass and lower endomorphy than non-selected players. Differences according to playing positions were found. Significant differences in somatotype and body structure between volleyball players and untrained students were found by Pastuszak et al (2016). Somatic features of the bodies of the volleyball players were dominated by the height of the body and the associated magnitude of the constituent characteristics. Giannopoulos et al (2017) examined the relationship between somatotype, level of competition and offensive performance in elite-level male volleyball players. The objective was to test the potential covariance of competition level (division A1 vs. A2) and player position (hitters vs. center vs. opposites) with respect to offensive performance. The results showed that A1 players were taller, heavier, more muscular and less endomorphic than A2 players. MANOVA and follow-up discriminant function analysis revealed somatotype differences among playing positions with centers and opposites being endomorph-ectomorph and hitters being central. Centers performed constantly better than hitters and opposites regardless of the division and somatotype. Multiple linear regression analysis showed that variables defining ectomorph and endomorph players, centers, and players of Division A1 significantly determined the relative performance superiority and were able to explain the variation in performance by almost 25%. Furthermore, Sheppard et al (2008) found a positive correlation between attack effectiveness and jumping ability, Drikos & Vagenas (2011) between attack effectiveness, typical set and final score.

Interesting results have been obtained by the studies examining the relationship between the spike reach and the height of the ball's impact during the attack (Vint et al., 2004; Li-Fang et al., 2008; Grgantov, Katic & Jankovic, 2006; Matušov et al., 2013). Studies have confirmed the relationship between the height of the spike reach and the height of the ball hit during the attack, when Matušov et al. (2013) say that the amount of ball hit during an attack in women and juniors does not show a clear relationship with the spike height jump. Currently, there are several studies that address the issue of the dependence of the flight speed of a ball after an attack on selected somatic and motor preconditions (Forthomme et al., 2005; Plawinski, 2008; Bermejo et al., 2013; Valades & Palao, 2015; Matušov & Přidal, 2016).

The authors deal less with the issue of examining game performance in relation to the reported somatic and motor parameters. The closest to this issue is the study of Stamm et al (2017). Among other correlations, the authors found that taller and heavier players were more effective in attacking. In the monitored group of top volleyball players, the body height and bodyweight of the players correlated with the effectiveness of the attack ($r = 0.534$; respectively $r = 0.518$; $p < 0.05$). Due to the fact that this issue is little researched, we decided to expand the knowledge in this area in our study.

The aim was to find out the somatic and motor differences between the most efficient and the least efficient outside and middle players in the attack in the final tournament of the Volleyball European Championship 2019. We assumed that there would be statistically significant differences and a large effect size between the monitored parameters.

Materials and Methods

The objects of our research were outside and middle players, for whom we obtained the data on the effectiveness of the attack from the available sources of CEV (<https://www.cev.eu/Competition-Area/Statistics.aspx?ID=1053>). We understand efficiency of the attack as the difference between successful and erroneous attacks in a relation to all attacks in percentages. Data were collected by professional scouts by using software Data Volley, which allowed access to total and detailed qualitative statistics by set and offered a wealth of various data. There were 117 players in category spiker ranking. Data are from all 67 matches of the final round. The chosen dividing criterion between the best and weakest players was their order in the first ten, resp. the last ten places in the presented statistics. The basic statistical characteristics of attack effectiveness in individual groups are given in the Table 1. We included outside spiker and opposite as the outside players, as these players attack from the edges of the net. Middle players – blockers are attackers in the middle of the net attacking from quick sets. We also obtained verification of the player's position of a specific player and their examined parameters on the provided page. For the needs of our research we recorded body height (cm), body weight (kg), reach in the jump from approach and the standing jump (cm).

Basic statistical characteristics are given in Table 2 and 3 in the results. We used a nonparametric Mann-Whitney U-test to compare the differences in values in the examined variables of two independent groups (the most efficient and least efficient players in the attack). The level of statistical significance was set at $p < 0.05$ and the effect size r was computed according to Mangiafico (2016). According to the this author, when evaluating the size of the computed coefficient r the following categorization was used: $r \geq 0.10 - 0.30 \rightarrow$ small effect, $r \geq 0.30 - 0.50 \rightarrow$ medium effect, $r \geq 0.50 \rightarrow$ large effect.

Table 1 Efficiency of the attack the ten best and the ten weakest outside and middle players

Cohort	Median (%)	Minimum (%)	Maximum (%)	Vr (%)
The most efficient outside players	34,05	30,12	42,53	12,41
The least efficient outside players	0,59	-16,00	3,85	19,85
The most efficient middle players	44,42	30,19	57,81	27,62
The least efficient middle players	18,68	5,56	24,19	18,63

Results

When comparing body height between the most efficiency and least efficiency outside players in the attack, we found significant differences ($U = 13.5$; $z = 2.721$, $p = 0.007$). The average height of the most efficient 10 outside players at the Volleyball European Championships was 187.9 ± 5.95 cm. The body height of the outside players with the lowest attack efficiency was 180.9 ± 4.82 cm, which represents a difference of about 7 cm. Based on the results of the statistical analysis, we can say that the most efficient outside players in the attack were significantly higher than the least. These results, similarly to the results of the comparison of the outside players in other monitored parameters, are presented in Table 2.

We also found significant differences in the bodyweight of outside players ($U = 13.5$; $z = 2.419$, $p = 0.016$). More efficient outside players were on average heavier (75.6 ± 6.89 kg) than the least efficient ones (68.1 ± 6.74 kg), which is about 7.5 kg. The significance of the differences was also confirmed at the jump reach from approach ($U = 13.5$; $z = 2.306$, $p = 0.021$). The ten most efficient outside players had on average a higher jump reach after the approach by 5 cm (311.5 ± 9.16 cm) than the ten least efficient players (296.9 ± 14.12 cm).

We did not confirm the significance of the differences only in the standing jump reach ($U = 13.5$; $z = 1.739$; $p = 0.082$). However, the tendencies suggest that even in this case the values are higher for the most efficient outside players. On average, the ten most efficient outside players had a jump reach of 295.1 ± 12.74 cm and the least efficient 284.8 ± 9.12 cm, which represents a difference of more than 10 cm.

Regarding the effect size of the differences in the examined somatic and motor parameters of the group of the most successful and least successful outside players, the differences were small ($r = 0.17 - 0.27$), from which we can indirectly infer a small effect of the parameters on a efficiency of an attack (Table 2).

From the point of view of middle players (Table 3), we found significant differences only in body height ($U = 13.5$; $z = 2.117$, $p = 0.034$) and standing jump reach ($U = 13.5$; $z = 2.948$, $p = 0.003$). The middle blockers are the highest players in the current women's top volleyball, where the most efficient middle blockers in attack at Volleyball European Championship 2019 measured on average of 192.5 ± 3.50 cm and the least efficient, 188.3 ± 3.77 cm, which is a smaller difference than in outside players (about 4 cm vs. 7 cm).

We did not find significant differences in middle players in body weight ($U = 26.5$; $z = 1.739$, $p = 0.103$) and in a jump reach from approach ($U = 28$; $z = 2.117$, $p = 0.034$). However, the results indicate a tendency for higher body weight and a jump reach from approach in more efficiency attacking middle players.

Table 2 Comparison of the values of the best and the weakest outside players in the efficiency of the attack

Parameters	The most efficient players			The least efficient players			U-test		Effect size r
	Average $\pm$ sd	Median (min-max)	Vr	Average $\pm$ sd	Median (min - max)	Vr	z	p	
Body height [cm]	187,9 5,95	185,5 182-202	20	180,9 4,82	181,5 172-190	18	2,721	0,007*	0,27
Body weight [kg]	75,6 6,89	75,5 63-88	25	68,1 4,48	67 63-75	12	2,419	0,02*	0,24
Jump reach from approach [cm]	311,5 9,16	313,5 295-322	27	296,9 14,12	296 275-311	28	2,306	0,021	0,23
Standing jump reach [cm]	296,1 12,74	296,5 275-315	40	284,8 9,13	287,5 270-298	28	1,739	0,082	0,17

* $p < 0.05$

Table 3 Comparison of the values of the best and weakest middle players in the efficiency of the attack

Parameters	The most efficient players			The least efficient players			U-test		Effect size r
	Average $\pm$ sd	Median (min-max)	Vr	Average $\pm$ sd	Median (min - max)	Vr	z	p	
Body height [cm]	192,5 3,50	191,5 188-197	9	188,3 3,77	189 182-193	11	2,117	0,034*	0,21
Body weight [kg]	78,3 6,29	78,5 70-88	17	72,0 6,74	71,5 61-82	21	1,739	0,082	0,17
Jump reach from approach [cm]	311 5,83	311,5 301-323	22	303,9 13,4	308,5 282-321	39	1,625	0,103	0,16
Standing jump reach [cm]	302,8 4,46	305 297-310	13	291,4 9,74	295 277-305	28	2,948	0,003*	0,29

* $p < 0.05$

In terms of effect size in the monitored somatic and motor parameters, we found small differences between the group of the most successful and the least successful middle players, similarly to the outside players ($r = 0.16 - 0.29$), based on which we indirectly infer also for this player function on the small effect of the given parameters on the efficiency of the attack (Table 3).

Discussion

In our study, we found differences in body height, body weight, jump reach from approach and from standing of the first ten most efficient and ten least efficient players in the attack, who played in the Volleyball European Championship 2019. From the point of view of the expected differences in the examined variables in the terms of player positions, we distinguished between outside and middle players. We included receiving spikers and opposite players among the outside players. In both player positions dominates the attack from the edges of the net, but the receiving players attack more often from zone 4 and opposite players from zone 2, resp. 1. For middle players, a typical attack of the middle players is completed in the middle of the net or after a quick pass to zone 2, in this case after a rebound from one leg.

Before proceeding to the analysis of the examined differences, it is important to remember that the outside players in both groups had a lower effectiveness of the attack than the middle players. The reason are the different game situations in which these two player positions attack. Outside players often have to attack against the opponent's organized defense after sets from the depth of the field, which is not possible for blockers. They attack almost exclusively after accurate reception and quick sets, which creates advantageous game situations for the successful completion of the attack. At the evaluated Volleyball European Championship 2019, only 2 outside spikers made it into the top ten most efficiency attackers. There was not a middle blocker among the last ten evaluated 117 players. The low effectiveness in the attack of the weakest outside players is evidenced by the negative values of their efficiency (Table 1). These show that these players made more mistakes in the attack than they gained points by attacking. From the point of view of solving the efficiency of the attack in relation to the differences in body height, we found significant differences between the group of the most efficient and the least efficient players in the attack for both player positions. Among outside players we found high variability in both the most efficient and the least efficient outside players. It points to that for outside players, lower players (the lowest one in the top ten measured 182 cm) with sufficient jump reach from approach but also extremely high (the highest one 202 cm) can prevail in the attack on one side (Table 2). This is also proved by the difference in the average body height of the most effective outside players compared to the weakest ones, which was up to 7 cm. This was not the case with the blockers. The difference was only 4.2 cm. Their offensive performance is logically limited by their technical-tactical skills and the frequency of typical game situations in which they complete the attack after a positive reception and a quick set. The group of higher blockers is more balanced in body height in both groups. From the point of view of choosing this player function for top volleyball, the minimal precondition is a height of over 189 cm. We can compare these data with the data on the average body height of the blockers at the OG 2016, which was 188.9 cm (source www.fivb.com). Our results correspond to the results of Stamm et al. (2017) in the men's category. In the monitored group of top volleyball players, body height correlated with attack efficiency ($r = 0.534$; $p < 0.05$) and body weight ($r = 0.518$; $p < 0.05$).

When looking for differences in body weight between the most efficient and the least efficient attackers in the examined player positions we came to different findings. We found a significant difference ($p < 0.05$) in the outside players, in contrast to the middle blockers, where the difference was not significant, although the tendencies were similar. It turns out that more efficient outside attackers had significantly higher body weight than the least efficient ones, which may be related to body height. In 10 least efficient outside players, we can observe the highest homogeneity in body weight and the lowest variability ($sd = \pm 4.48$ cm and $Vr = 63 - 75$ kg). In these players their lower body weight can be reflected in the lower severity of the attack as one of the important factors of its efficiency. The study of Zapartidis et al (2009) who found in young handball players a significant relationship between the speed of the ball while shooting, among other indicators, also with body weight ($p < 0.05$) also led us to this consideration.

Testing the jump reach plays a key role in assessing the players' motor readiness. In particular, the evaluation of the jump reach from approach is one of the decisive criteria for the volleyball player's readiness to perform. This test is a very specific test, where the movement structure is essentially identical to the course of spike approach and jump, as opposed to the standing jump, which is a movement that players use minimally in the game. In our group of outside players, we found significant differences between the examined groups ($p < 0.05$). The difference in the average height of jump reach from approach of the most efficiency outside players and the least efficiency was up to 14.6 cm. However, a higher jump reach from approach does not automatically guarantee a higher success rate of the attack.

Logically we have to remember that the height of the ball impact in the attack is lower than the spike reach and different from the point of view of individual players as reported by Li-Fang et al., (2008), Matušov et al., (2013) and others. Of course, the technical and tactical skills of the players are also largely decisive. An interesting finding is, on average a similar jump reach after the approach of the most efficient outside players and the most efficient middle blockers. In this case, the median difference is 2 cm in favor of the outside players. It turns out that outside players will in most cases be more explosive types of players who have

on average lower body height than blockers, but have a comparable or higher jump reach from approach. We did not find significant differences in the blockers, and also the effect size was small. However, the tendencies suggest on average up to 7.1 cm higher reach after the approach of more efficient attacking blockers. In the case of results in standing jump reach, we found significant differences in the blockers. The reason may be a higher body height of the more efficient middle blockers, which creates the advantage of rebounding from the place without the approach.

In our study, in all significant differences in the examined parameters between the most efficiency and least efficiency players in the attack, we found a small effect size ($r > 0.2$). From a point of view, it turns out that even players with worse examined parameters (body height, body weight, jump reach) can be among the most efficient attackers. There are not differences in these parameters between the examined groups from the factual point of view. If the least efficiency attackers, who in most cases played in worse teams, would play in better teams, we can assume higher efficiency in the attack. The final efficiency of the attackers, in addition to their game, somatic, motor and psychological preconditions, is also influenced by the activity of teammates. First of all, in the case of an attack, it is a question of the game situation in which the attack was carried out (advantageous or disadvantageous situation for starting an attack), what was the accuracy of the set, what block the player had to attack, what was the situation in the game and so on.

Conclusion

In our study, we looked for selected somatic and motor parameters that limit the efficiency of the attack of outside players and middle players in women's top volleyball. By comparing two independent groups (the most effective vs the least effective players in the attack), we found statistically significant differences in several parameters. It turns out that the predictor of success is the effectiveness of the attack on the outside players is body height, body weight and jump reach from approach. For blockers, body height and standing jump reach. Overall, we can say that more efficient players in the attack are higher, heavier and have a higher jump reach than players who have shown lower efficiency in the attack as the most comprehensive indicator of the evaluation of its success. However, we cannot overestimate the results due to the small effect size of the identified differences in these parameters. Nevertheless, we can use them in the selection of players for individual player positions for women's top volleyball and in the search for the causes of the players' success in the attack. Verification of results for other age groups or men's volleyball requires special monitoring.

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