

EFFECT OF STRENGTH ON SERVING EFFECTIVENESS IN VOLLEYBALL

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- strength,
- volleyball,
- effectiveness.

Abstract:

The aim of the study was to evaluate the effect of force generated by the muscles of the forearm on playing effectiveness for selected elements of the volleyball game (serve). The analysis was based on evaluation of the results obtained by 8 athletes from a university team. Measurements of force were performed in the forearm using a dynamometer. The Spearman's rank correlation coefficient was used in the analysis. A strong relationship was found between strength and the effectiveness index in attack during the game. Level of strength is not always correlated with the improved service effectiveness. In volleyball, the relationships between forearm strength and playing effectiveness are quite complex since playing effectiveness is affected by a number of technical and tactical characteristics, developed simultaneously throughout the training process. The information obtained is undoubtedly useful for coaching practice. The results obtained in the study are important from the standpoint of selection, prognosis and diagnosis in the sport and they represent the basis for conceptualization of training programs.

INTRODUCTION

The sport that is commonly known today as volleyball was initially invented in 1885 by William Morgan. It was supposed to be a team game dedicated to middle-aged businessmen. However, it was soon popularized among other people and volleyball teams started to be formed very quickly (Grządziel, Szade 2009). Volleyball today necessitates high skills in terms of technical and tactical preparation. The game has become one of the most interesting and fast developing team games, played by many people (Wróblewski 2005). Zaciorski finds that human strength can be defined as ability for overcoming external resistance and counteracting at the expense of muscular effort (Zaciorski 1970). Heyward defines strength as an ability of a muscle group to release maximum contraction force during single counteracting the resistance (Heyward 1997). Furthermore, Fidelus argued that strength, as a physical characteristic, is understood to mean a maximum force (moment of force) in individual groups or a sum of maximum forces (moments of forces) in the major human joints under static conditions (Fidelus et al. 1972). Precise measurement of strength under dynamic conditions is possible only using dedicated measurement platforms or isokinetic dynamometers (Osiński 2003). Z. Ważny classified in his book the conditions for manifestation of the muscular strength in the following manner (Ważny 1977):

- A. Strength developed under dynamic conditions:
 - Explosive strength
 - Speed strength

- Slow strength (Orzech 2002).
- B. Strength developed under static conditions:
 - Active strength: the primary aim of the activity is to counteract the external resistance through active muscle contraction
 - Passive strength: external forces act so that the muscle can only counteract the progressing stretch (Osiński 2003).

One of the fundamental factors that determine good playing in volleyball are motor abilities. Skilfully developed, these abilities are reflected during the game in improved, more efficient and effective playing. With reference to the paper published by Tomasz Laferi on speed and accuracy of perception of the effectiveness of the actions performed during the game, one can conclude that the indices that relate to the speed and accuracy of perception are significantly correlated with game effectiveness. This correlation occurs at the extraordinarily high level of significance (0.001 and 0.002) and is close to 0.7. Analysis of correlations between the indices of visual perception and individual indices of effectiveness of actions performed during the game revealed statistical significance only in passing and attacking, with the higher level found in attack. Serves and attacks turned out to be poorly correlated with the speed and accuracy of perception. The examination was carried out among 23-persons group of volleyball players who were members of two teams: Gwardia Wrocław (15 players) and Oławia Oława (8 players) who participated in Silesian regional championships for U-20 juniors. Mean index of playing effectiveness in the volleyball players studied reached the value of 0.37 and ranged from 0.25 to 0.60 (Laferi 2004). Another paper ("Effectiveness and efficiency of attack in volleyball") by Maciej Kosmol, Agnieszka Kosmol, Anna Kuder and Michał Kosmol analysed 20 video recordings from the games played by the Polish National Team in 2005 within the World League (15 games) and the European Championships (5 games). Eighty three sets were analysed in total, with 2001 actions performed in attack. The study used analysis of the recordings on video cassettes, statistical analysis of the data, and test for dependent samples for evaluation of statistical differences. In 20 games analysed (played by the Polish National Team in 2005), mean effectiveness of offensive actions was 52%, with the efficiency of 36%. In the World League, 1591 actions were recorded for the attack, with mean effectiveness in 15 games being 52% and efficiency of 26%. In the European Championships, 170 attacks were performed, with effectiveness of 58% and efficiency of 39% (Kosmol et al. 2007). Krzysztof Wnorowski and Jerzy Skrobecki in their paper "Criteria for evaluation of strength and speed components of human motor abilities in female and male volleyball players aged 14 to 15" presented the tests carried out in a group of boys and girls born in 1984 and 1985 who played volleyball. The players represented 8 macro-regions in the tournament Nadzieje Olimpijskie (Olympic Expectations) played in Cetniewo, Poland. The study evaluated 92 boys and 97 girls from Poland. Comparison of classification of macro-regions in the tournaments with the ranking of attempts suggests high relationship between each other. Correlation among the male teams was ca. 0.405, whereas in female teams it was 0.262. Mean results of rank correlations in female teams are presented as following: body height: 0.163; body mass 0.062; standing reach: 0.179; spiking reach: 0.348; vertical jump: 0.196; jumping time: 0.077; mat jump: 0.241; work: 0.234; 3kg ball throw: 0.380; 153-metre endurance run: 0.305. Mean results in male teams were: body height: 0.017; body mass 0.173; standing reach: 0.020; spiking reach: 0.440, vertical jump 0.343; jumping time: 0.077; mat jump: 0.268; work: 0.333; 3kg ball throw: 0.397; 153-metre endurance run: 0.194 (Wnorowski, Skrobecki 1998).

STUDY AIM

The aim of the study was to diagnose the effect of force generated by the muscles of the forearm on playing effectiveness in selected elements of the volleyball game. Evaluation of

the correlations between the above parameters and conclusions drawn from these correlations will provide information which might be useful for creation of training programs and plans.

MATERIAL AND METHODS

Dynamometric measurement of strength is determined by the maximum level of force generated by selected muscle groups. This measurement was used in order to evaluate the strength of the forearm in volleyball players. In order to obtain comparable results of measurements, it was necessary to ensure constant conditions during the test, identical physiological status of the body and the same time of the day for consecutive tests. In this case, the tests were performed before the match, directly after the warm-up. The subjects held a dynamometer conveniently, with fingers and the whole palm in close contact with the device. Then, they aligned the arm along the body at a small distance from the trunk so that the hand did not touch the hip and pressed the dynamometer at maximum strength. Two isometric contractions were performed during each match for the muscle group studied at maximum strength against the resistance of the measurement device. The study concerned the dominant limb of the athlete. The duration time between both tests was 10 seconds. In order to evaluate the effectiveness of selected activities (serves), we used an objective method of evaluation of the effectiveness of technical elements in volleyball and the method of objectivisation of the analysis of the results from observation of competitions. The first method consists in observation of the athletic competition and recording the data in an observation sheet. A three-grade scale was used, with the following denotations:

"+" - performance of the technical element which scores a point or a service change,

"0" - performance of the technical element with action being continued,

"-" - performance of the technical element with the team losing a point or a service change taking place.

This type of material provides information about the number of actions performed and percentage effectiveness in the game. The second method consists in individual evaluation of the effectiveness for individual elements of the game. After the examination, 8 male athletes from AZS UR club were qualified for the analysis. The study was carried out in a sports hall (Zelmer, at Hoffmanowa street in Rzeszów, Polska). It concerned 4 selected league matches in the season 2009/2010. All the subjects were students from universities, mostly from the Faculty of Physical Education and Physical Therapy in Rzeszów.

RESULTS

Mean age was 20.25 years, mean body height: 189.75 cm, body mass: 81.9 kg and competitive experience 4.9 years. Training sessions took 1.5 h, 5 times a week. The effectiveness of a selected element (serve) was evaluated.

Table 1. Characterization of measurement values in the group of volleyball players

Characterization of the group of athletes studied			
Age	Maximum	Mean	Minimum
	23	20.25	19
Body height	Maximum	Mean	Minimum
	200	189.75	178
Body mass	Maximum	Mean	Minimum
	91	81.9	68

Source: author's own elaboration

In order to analyse statistical data, we used the Spearman's rank correlation coefficient. Correlation coefficient might range from -1 to +1. A negative correlation represents the

reversed correlation i.e. when one of the variables is increasing, the other is decreasing (Lewicki et al. 1998).

Table 2. Interpretation table for correlation coefficients (Lewicki et al. 1998)

Range of variability "C"	Determination of the strength of the relationship
C = 0	No correlation
0 = C ≤ 0.1	Insignificant correlation
0.11 = ≤ C ≤ 0.3	Poor correlation
0.3 ≤ C ≤ 0.5	Average correlation
0.5 ≤ C ≤ 0.7	High correlation
0.7 ≤ C ≤ 0.9	Very high correlation
C = 1	Full correlation

Source: Cz. Lewicki, E. Obodyńska, M. Obodyński, *Wybrane metody statystyczne w naukach o wychowaniu fizycznym i sporcie*, p. 117.

Table 3. Strength vs. serving effectiveness in the volleyball players studied during league matches

Study group	Serving effectiveness [%]				Dynamic strength			
	Match No. 1	Match No. 2	Match No. 3	Match No. 4	Match No. 1	Match No. 2	Match No. 3	Match No. 4
1	15	7	15	5	70	61	68	67
2	8	12	10	12	52	47	49	52
3	4	9	11	7	70	55	63	64
4	10	4	7	11	72	63	66	63
5	7	10	13	13	58	50	55	54
6	3	8	4	10	64	56	60	60
7	5	13	8	8	51	46	51	51
8	10	4	9	15	64	57	62	59

Source: author's own elaboration

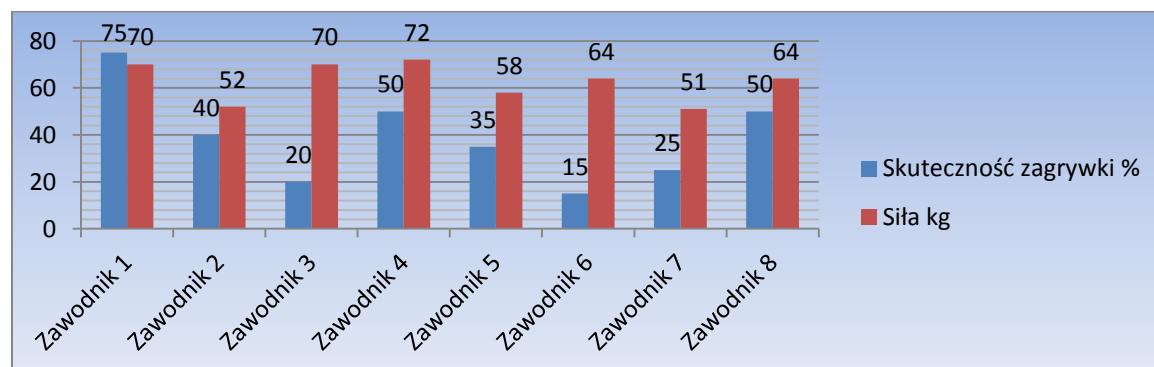


Diagram 5. Strength vs. serving effectiveness in the volleyball players studied (Match No. 1)

Source: author's own elaboration

The data presented in the diagram above shows the outstanding scores obtained for the athlete 1, with the level of serving effectiveness and strength at very high and relatively constant level. It is also noticeable that the level of serving effectiveness in this player exceeds the level of strength. Other athletes (particularly the athlete 6) have effectiveness indices lower than the strength index (at low level). Correlation coefficient between strength and serving effectiveness in the volleyball players studied during the match No. 1 was $r_s = 0.333$. The value of the Spearman's rank correlation coefficient shows that the strength of the relationship occurs at an average level.

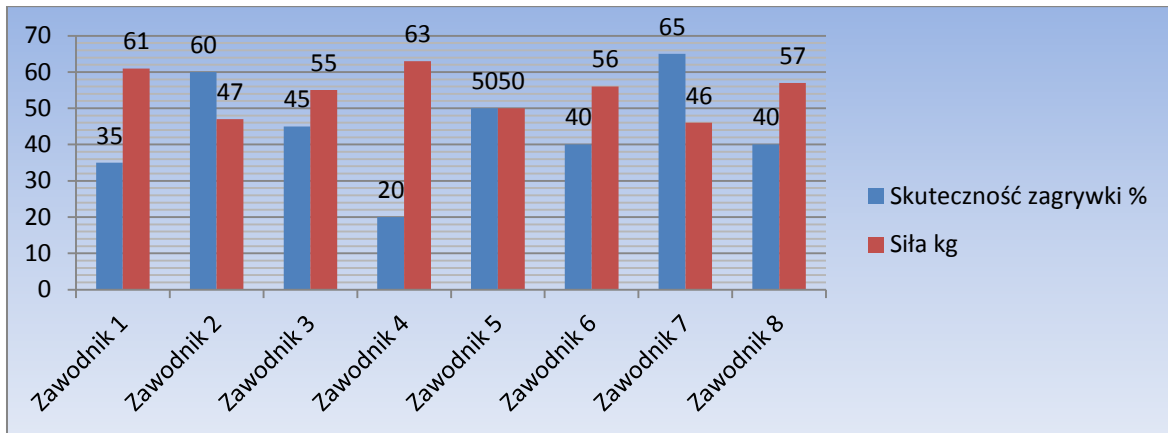


Diagram 6. Strength vs. serving effectiveness in the volleyball players studied (Match No. 2)
Source: author's own elaboration

In another match, only the athlete 5 showed the same level of serving effectiveness index compared to the level of strength index. Furthermore, a specific situation was observed in the athlete 4, with the level of the effectiveness index being very low compared to the level of strength.

Strength vs. serving effectiveness in the volleyball players studied during the match No. 2 is $r_s = 0.644$. The Spearman's rank correlation coefficients showed that the strength level correlate with serving effectiveness at a high level.

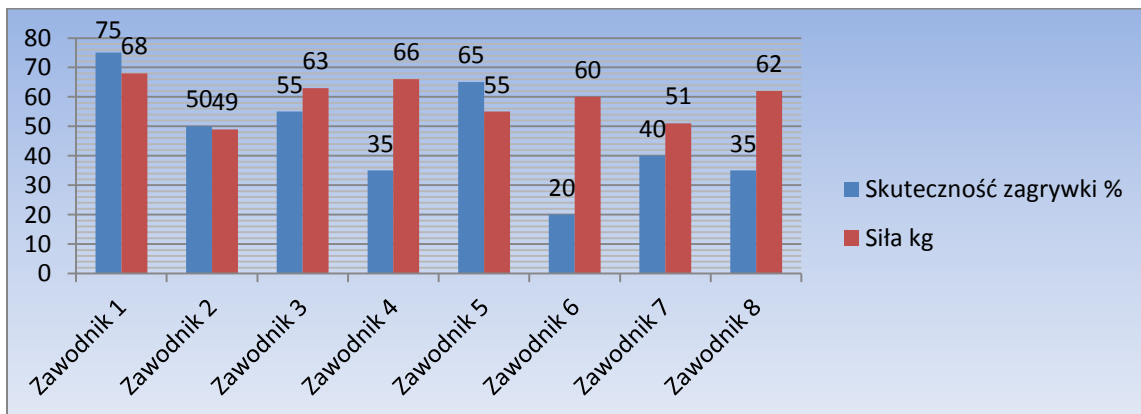


Diagram 7. Strength vs. serving effectiveness in the volleyball players studied (Match No. 3)
Source: author's own elaboration

During the Match No. 3, indices of strength level in all the people studied remain at a very equal level, reaching the values ranging from 49 to 68%. Furthermore, the athlete 6 showed very high discrepancies between the indices of strength and serving effectiveness (40%). Strength vs. serving effectiveness in the volleyball players studied during the match No. 3 is $r_s = 0.143$. The Spearman's rank correlation coefficients showed that the strength level correlated with serving effectiveness at a poor level.

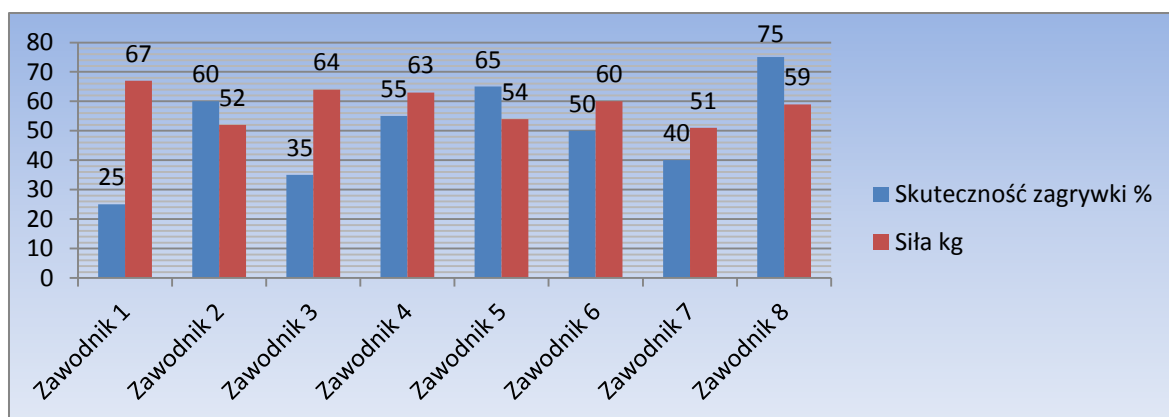


Diagram 8. Strength vs. serving effectiveness in the volleyball players studied (Match No. 4)
Source: author's own elaboration

In the Match 4, the most of the athletes, except for the athlete No. 2 and 5, showed higher level of strength compared to the level of serving effectiveness. This observation seems quite surprising since higher dynamic strength results in poorer effectiveness during the game. Strength vs. serving effectiveness in the volleyball players studied during the match No. 4 is $r_s = 0.523$. The Spearman's rank correlation coefficients showed that the dynamic strength level correlated with serving effectiveness at a high level. According to the interpretation table for the correlation coefficient, this correlation is high but negative. This also seems quite surprising because higher strength translates into lower performance. Therefore, some regularity can be observed, with higher strength resulting in poorer serving effectiveness (Lewicki et al. 1998).

CONCLUSION

Analysis of the athletic competition in volleyball is one of the major problems of the theory and practice present in various team games. In Poland, this problem has received insufficient scientific attention in the professional literature, while the methods used by coaches in their work have not been verified scientifically yet, which makes the evaluation of the results obtained even more difficult (Gaj 1981). Precise determination of the relative strength in a particular movement has become the most interesting problem, both from the standpoint of sport biomechanics and training practice (Eliasz et al. 1994). Professional sports make great demands on constant searching and developing the resources of information to further understanding of the phenomena that occur during the training process (Borysiuk 2001). After analysis of the results obtained in this study, we found that the relationships between forearm strength and playing effectiveness in volleyball are quite complex since playing effectiveness is affected by a number of technical and tactical characteristics, developed simultaneously throughout training process. With respect to the overview of the literature, a paper by Tomasz Laferi ("Speed and accuracy of perception of the effectiveness actions performed during a volleyball game") demonstrated that, apart from strength, playing effectiveness is also affected by technical and tactical components. This researcher found a strong correlation between the level of speed and accuracy of perception and the index of playing effectiveness. Both attack and serve show statistically significant relationships with speed and accuracy of perception (Laferi 2004). The tests were carried out under conditions of a sports hall, without using a specialized apparatus. Therefore, they are not as reliable as laboratory tests, although they are characterized by higher specificity. This concerns in particular those sports where comprehensive simulation of actual conditions is impossible.

The results obtained in such tests cannot be treated interchangeably with the results of the laboratory tests, but they should enhance and supplement them (Eliasz et al. 1994).

FINAL CONCLUSIONS

The above theoretical investigations and the results obtained in the study lead to the following conclusions:

- A strong relationship was found between strength and the effectiveness index in attack during the game.
- Level of strength is not always correlated with the improved service effectiveness.
- In volleyball, the relationships between forearm strength and playing effectiveness are quite complex since playing effectiveness is affected by a number of technical and tactical characteristics, developed simultaneously throughout the training process.

The information obtained is undoubtedly useful for coaching practice. The results obtained in the study are important from the standpoint of selection, prognosis and diagnosis in the sport and they represent the basis for conceptualization of training programs.

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