

STRENGTH AS A FACTOR OF EFFECTIVENESS OFFENSIVE PLAYS IN VOLLEYBALL

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- volleyball
- strength
- effectiveness

Abstract:

The level of achievement in volleyball is affected by a plethora of factors, including physical fitness, motor coordination, technique of performing individual technical components or team members' ability to cooperate with each other. The knowledge of parameters that determine the level of achievement and their optimal values is essential for training activities to be effective. The authors of the study conducted the examinations in order to provide answers to the following research questions: Do changes in strength impact on the effectiveness of offensive plays in volleyball? The examinations were conducted in a group of teams that represented the AZS UR Rzeszów volleyball club.

INTRODUCTION

Modern volleyball requires that players demonstrate high level of abilities concerning technical and tactical preparation. The game has become one of the most interesting and fast-developing sports played by many people all over the world [Wróblewski 2005].

The level of achievement in volleyball is determined by physical fitness, motor coordination, technique of performing individual elements or ability to cooperate between players [Klocek, Szczepanik 2004, Klocek, Żak 1999, Naglak 1994].

Success in many sports often depends on abilities to generate maximum force, power and speed [Buśko 2006, Mastalerz 2008]. Evaluation of muscle strength of a player compared to the adopted standards reveals whether the levels achieved by a player are higher or lower than those obtained by other athletes with similar somatic parameters [Buśko 2006, Król 2007, Trzaskoma 2003].

Evaluation of strength and strength-speed abilities of players from various sports is based on measurements of maximal muscle torques generated by muscle groups of lower and upper limbs. Such measurements are conducted under conditions of isometric [Buśko 2006, Mastalerz 2008, Trzaskoma 2003] or isokinetic work [Bittencourt et al. 2005, Zabka 2011]. The results of such measurements may provide objective, quantitative information about sports skill level and effectiveness of training programs.

Strength level does not necessarily mean greater strength effectiveness. The effectiveness of play in volleyball is affected by many technical and tactical skills developed through training. 2011].

Zaciorski argued that strength can be considered as an ability to overcome the external resistance and to prevent its effect at the expense of the muscular effort [Zaciorski 1970].

Heyward defined strength as an ability of a muscle group to generate maximal contraction force during a single counteraction against the resistance [Heyward 1997]. According to Fidelus, strength, as a physical quality, should be regarded as a maximal force (muscle torque) of individual muscle groups or as a total of maximal forces (muscle torques) in principal human joints under unchanged conditions [Fidelus 1972].

The problems of the links between the effectiveness of performing individual technical components and motor abilities of individual players in volleyball have been discussed by different authors in scientific publications.

In his study on the effect of speed and accuracy of perception on the effectiveness of actions performed during the game, Tomasz Laferi demonstrated that the indices relating to the speed and accuracy of perception are correlated with playing effectiveness. This correlation showed the especially high level of significance (0.001 and 0.002) and was close to 0.7. Analysis of correlation between the indices of visual perception and individual indices of effectiveness of actions performed during a game revealed a statistical significance only for passing and attack, with higher level observed in attack. Serving and attack turned out to be poorly correlated with speed and accuracy of perception. The examination was conducted in the group of 23 volleyball players from two Polish teams: Gwardia Wrocław (15 players) and Oławia Oława (8 players). The examinations were scheduled for Silesian Regional U-20 Championships in Poland. The main index of playing effectiveness of volleyball players reached the level of 0.37 and ranged from 0.25 to 0.60 [Laferi 2004].

In a publication concerning the effectiveness and accuracy of attack, the authors analysed 20 video records from games played by the Polish national team in 2005 during the Volleyball World League (15 matches) and European Volleyball Championships (5 matches). Mean effectiveness of offensive actions during the 20 analyzed games was 52%, with the accuracy at the level of 36%. The total number of 1,591 actions in attack were recorded for the World League, with mean effectiveness during 15 matches at the level of 52% and accuracy of 26%. During the European Volleyball Championships, 170 attacks were performed at the effectiveness of 59% and accuracy of 39% [Kosmol M, Kosmol A et al. 2007].

In the study titled "Criteria for evaluation of strength and speed components of human motor abilities in male and female volleyball for players aged 14 to 15 years, Krzysztof Wnorowski and Jerzy Skrobecki presented a test conducted in a group of boys and girls born in 1984 and 1985 who played volleyball. These players represented 8 macroregions in the tournament "Nadzieje Olimpijskie" ("Olympic Hopes") played in Cetniewo, Poland. The examinations involved 92 boys and 97 girls from Poland. Comparison of classification of macroregions in the tournament with the ranking of samples suggests a high correlation between each other. Correlation in the male groups was around 0.405, whereas in the female groups, this level was 0.262 [Wnorowski, Skrobecki 1998].

The interest of the authors in the effect of strength on the effectiveness of offensive plays i.e. attack and serve in volleyball have led to examinations in this field. The examinations were conducted in a group of players from the AZS UR Rzeszów volleyball club.

The forearm muscle strength was measured in the dominant limb before and after a warm-up procedure, during and after the match, during technical breaks and during time-outs. The effectiveness of the attack and serving was also calculated for five players with the highest number of attacks and serves who were recruited for the study.

STUDY AIM

The aim of the study was to evaluate the effect of fatigue based on the measurement of the force generated by the forearm muscles on the effectiveness of offensive actions (serves and attack) in volleyball. Establishing correlations between the above parameters and conclusions drawn from these correlations should provide information that is useful for e.g. development of training programs.

The research problem was defined as: Do changes in the level of strength impact on the effectiveness of offensive plays in volleyball?

It was assumed that the decline in strength caused by fatigue induced by the match has an effect on the effectiveness of offensive play (serving, attack).

MATERIAL AND METHODS

The analysis was based on the results obtained for five athletes from an academic team. The measurement of forearm strength was measured using a dynamometer.

The group of players who participated in the study was the team from the AZS UR Rzeszów. The examinations were performed during the 2015/2016 season. The team played in the men's third league. The examinations were conducted during the match between AZS UR Rzeszów and SKS MOSIR Dukla teams in the Zelmer sports hall in Rzeszów, Poland.

The study used the observation method, which plays a very important role in the research while using it, unlike the experimental method, does not affect the local environment. The method represents the deliberate investigations of the facts, deliberate cognition based on the use of senses. In this study, the authors used the Pearson's r correlation coefficient.

The data on the effectiveness of attack and serving and strength of athletes who participated in the study were recorded in an Excel spreadsheet. Next, the Pearson's correlation coefficient was computed.

The Pearson's coefficient is given by:

$$r(x, y) = \frac{cov(x, y)}{\sigma(x) * \sigma(y)}$$

Furthermore,

$$cov(x, y) = E(x * y) - (E(x) * E(y))$$

where:

- $r(x, y)$ - Pearson's r between the variables x and y
- $cov(x, y)$ - covariance between the variables x and y
- σ - standard deviation from the population
- E - expected value

Dynamometric strength is measured as a maximal level of force produced by selected muscle groups. This measurement was used to evaluate the hand grip force in volleyball players. Constant testing conditions, identical physical body status and the same time of measurement are the prerequisite for ensuring comparable measurements during the test. In our study, the tests were performed before a match, immediately after the warm-up, during each technical break and after completion of the match. The study participants held the dynamometer in a convenient manner, with fingers and the whole palm of the hand in close contact with the device. Next, they positioned the arm along the body at a small distance so that the hand did not touch the hips and pressed the dynamometer using the maximal strength. The isometric contractions were performed during the match for the muscle group examined at the maximum level of force used against the resistance of the measurement device. The test was performed for the dominant limb. The method of purposive evaluation of the effectiveness of technical elements used in volleyball and the method of objective analysis of results obtained from observation of the tournaments were used to evaluate the effectiveness of selected actions (attacks). The first method was composed of the observation of the results of sports competition and recording the data in the observation spreadsheets.

The effectiveness of attack was evaluated based on a 3-level scale with the following marks:

- ‘+’ - performing the technical element which allowed for scoring a point or change the serve
- ‘0’ - performing the technical element that allowed for continuation of the action
- ‘-‘ - performing the technical element that ended in losing a point or a service change
- Furthermore, the effectiveness of the serve was also evaluated based on a 3-level scale with the following marks:
 - ‘AS’ - after the serve, the ball landed directly in the opponents' court or landed outside the court after the ball was touched by an opponent.
 - ‘+’ – after the serve, the ball is received by an opponent and action can be continued
 - ‘-‘ – performing the serve resulting in a loss of a point

This type of material provides information about many actions performed during the game and the percentage effectiveness of playing. The second method is composed of the individual evaluation of the effectiveness for an individual element of the game. After the evaluation, 5 players from the AZS UR team were qualified for the analysis, including two middle blockers, two receivers and one spiker.

RESULTS

The results of the examinations of the effectiveness of offensive plays (attack, serves) were analysed and compared with the strength of the upper (dominant) limb, which was measured using the dynamometer before and after the warm-up, during the match (technical breaks) and after completion of the match. The following results were obtained in the study:

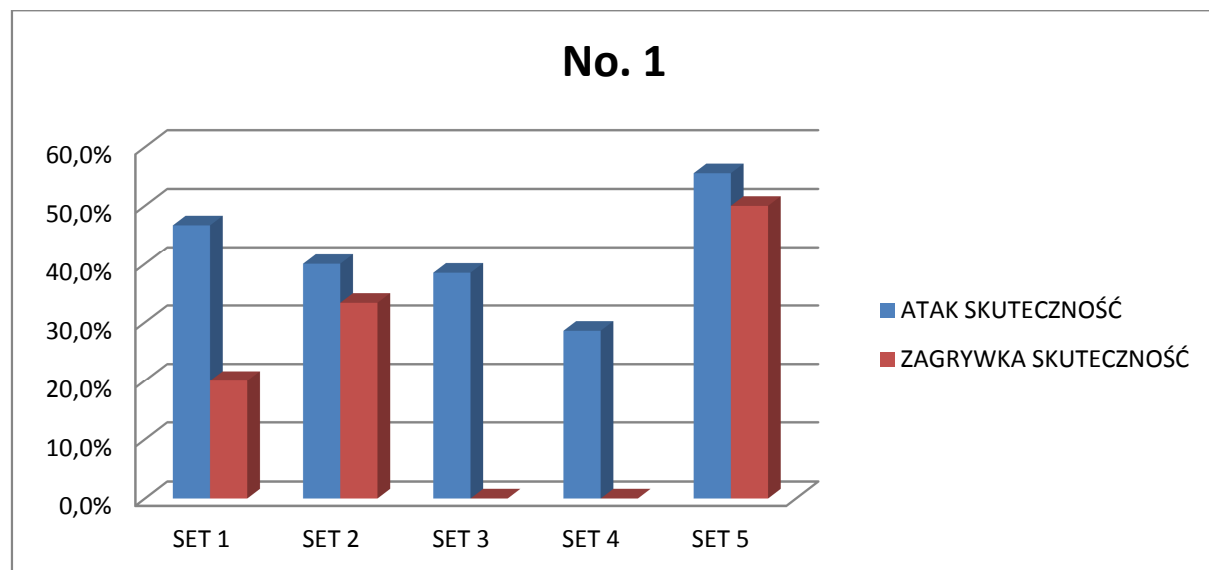


Diagram 1. Effectiveness of attack and serve of the player 1 in individual sets (ATAK SKUTECZNOŚĆ – ATTACK EFFECTIVENESS, ZAGRYWKA SKUTECZNOŚĆ – SERVE EFFECTIVENESS)

Source: author's own study

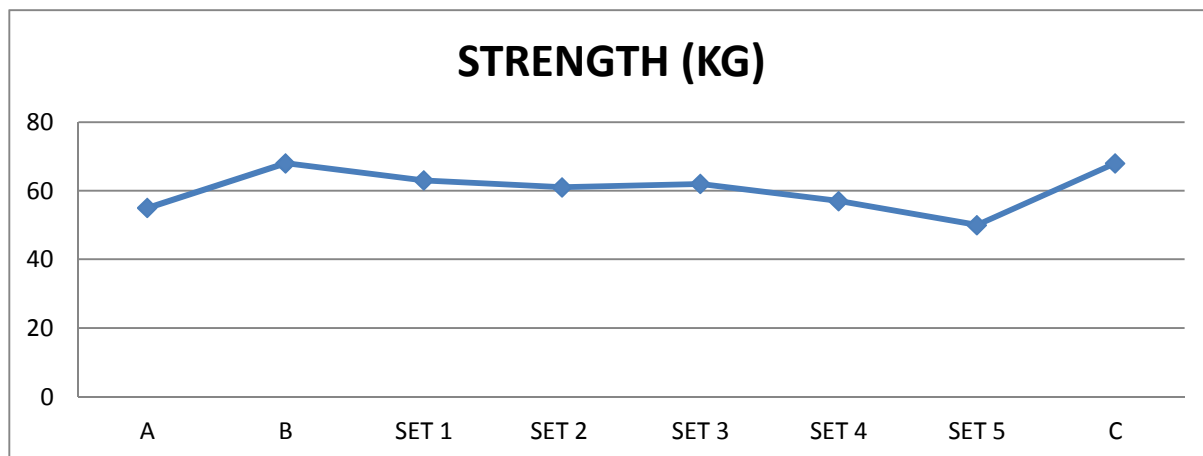


Diagram 2. Strength of the dominant limb of the player 1 during the match (SIŁA – STRENGTH)

Source: author's own study

Before the warm-up, the strength of the dominant limb was 55 kg, whereas after the game, this value rose to 68 kg. In the set 1, attack effectiveness was 46.7%, whereas the serve effectiveness was 20%, with mean strength of 62 kg. In the set 2, attack effectiveness was 40%, whereas the serve effectiveness was 33%, with mean strength of 61 kg. In the set 3, attack effectiveness was 38.5%, whereas the serve effectiveness was 0%, with mean strength of 62 kg. In the set 4, attack effectiveness was 28.6%, whereas the serve effectiveness was 0%, with mean strength of 57 kg. In the set 5, attack effectiveness was 55.6%, whereas the serve effectiveness was 50%, with mean strength of 50 kg. Strength of the player 1 after completion of the match was 68 kg.

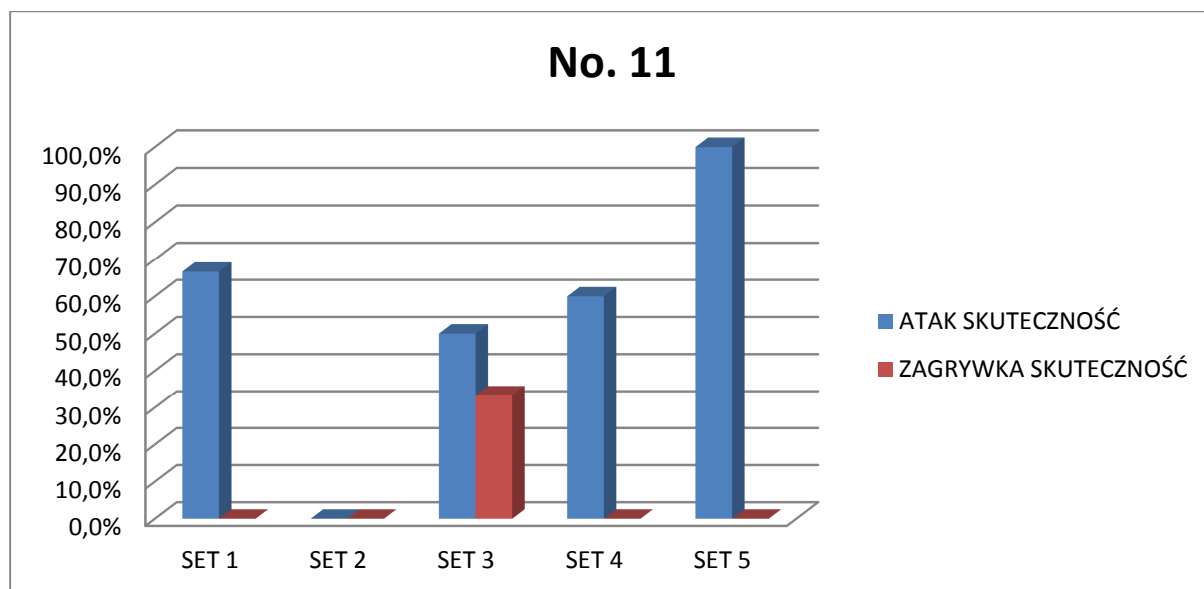


Diagram 3. Effectiveness of attack and serve of the player 11 in individual sets (ATAK SKUTECZNOŚĆ – ATTACK EFFECTIVENESS, ZAGRYWKA SKUTECZNOŚĆ – SERVE EFFECTIVENESS)

Source: author's own study

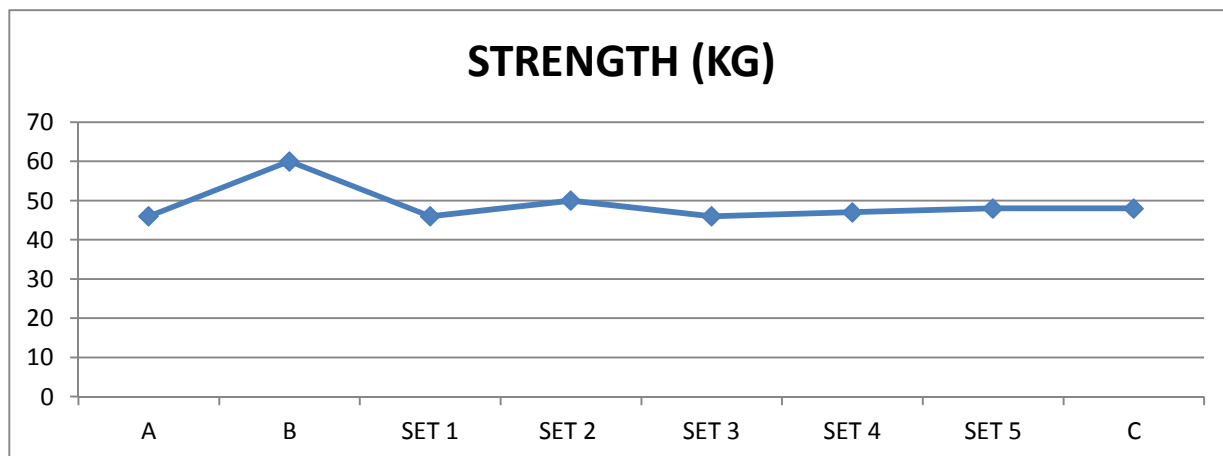


Diagram 4. Strength of the dominant limb of the player 11 during the match (SIŁA – STRENGTH)

Source: author's own study

Before the warm-up, the strength of the dominant limb was 46 kg, whereas after the game, this value rose to 60 kg. In the set 1, attack effectiveness was 66.7%, whereas the serve effectiveness was 0%, with mean strength of 46 kg. In the set 2, the player did not perform any attack, whereas the serve effectiveness was 0%, with mean strength of 50 kg. In the set 3, attack effectiveness was 50%, whereas the serve effectiveness was 33%, with mean strength of 46 kg. In the set 4, attack effectiveness was 60 %, whereas the serve effectiveness was 0%, with mean strength of 47 kg. In the set 5, attack effectiveness was 100%, whereas the serve effectiveness was 0%, with mean strength of 48 kg. Strength of the player 11 after completion of the match was 48 kg.

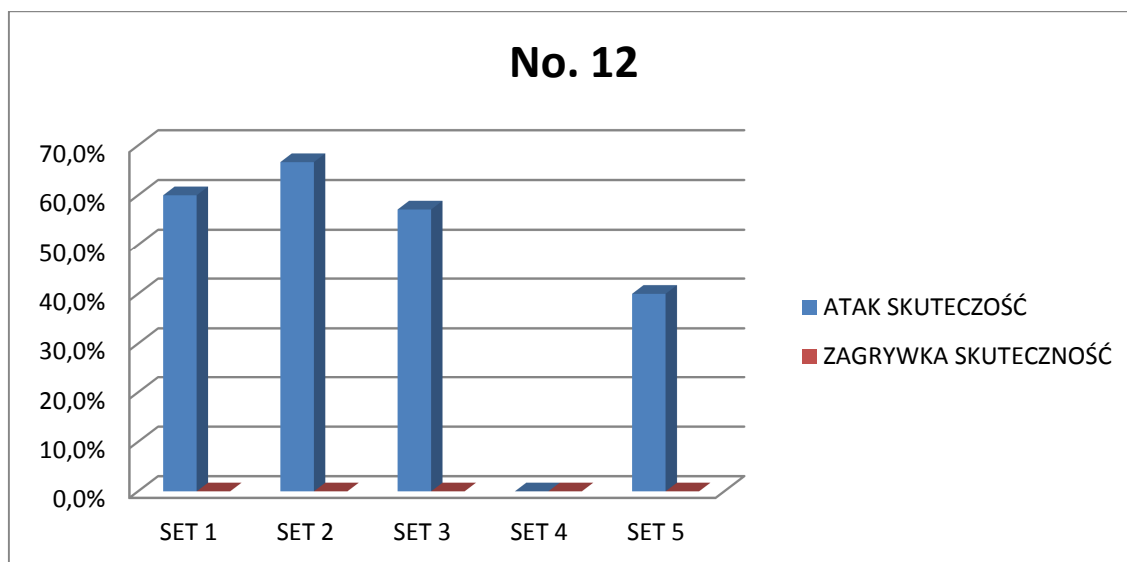


Diagram 5. Effectiveness of attack and serve of the player 12 in individual sets (ATAK SKUTECZNOŚĆ – ATTACK EFFECTIVENESS, ZAGRYWKA SKUTECZNOŚĆ – SERVE EFFECTIVENESS)

Source: author's own study

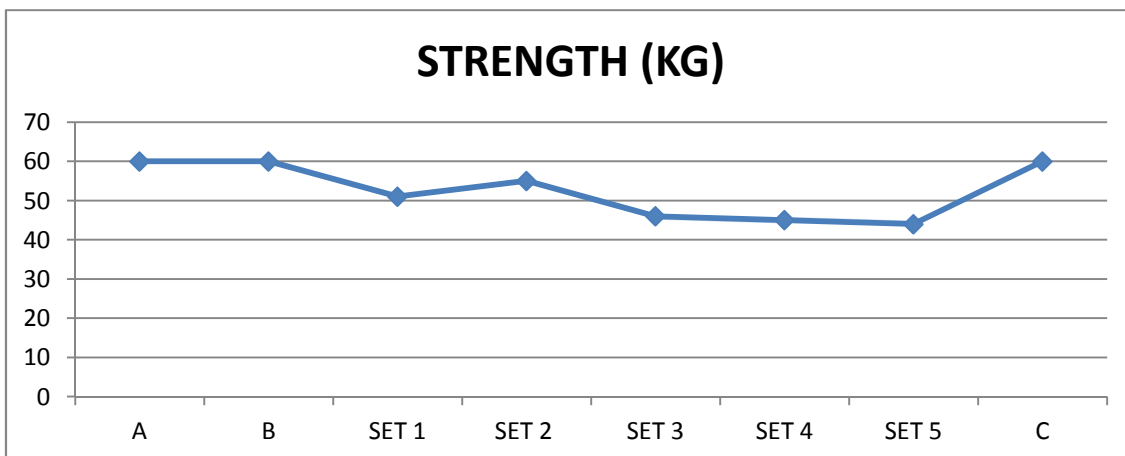


Diagram 6. Strength of the dominant limb of the player 12 during the match (SIŁA – STRENGTH)

Source: author's own study

Before and after the warm-up, the strength of the dominant limb was 60 kg. In the set 1, attack effectiveness was 60%, whereas the serve effectiveness was 0%, with mean strength of 51 kg. In the set 2, attack effectiveness was 66.7%, whereas the serve effectiveness was 0%, with mean strength of 55 kg. In the set 3, attack effectiveness was 57.1%, whereas the serve effectiveness was 0%, with mean strength of 46 kg. In the set 4, attack effectiveness was 0%, whereas the serve effectiveness was also 0%, with mean strength of 45 kg. In the set 5, attack effectiveness was 40%, whereas the serve effectiveness was 0%, with mean strength of 44 kg. Strength of the player 12 after completion of the match was 60 kg.

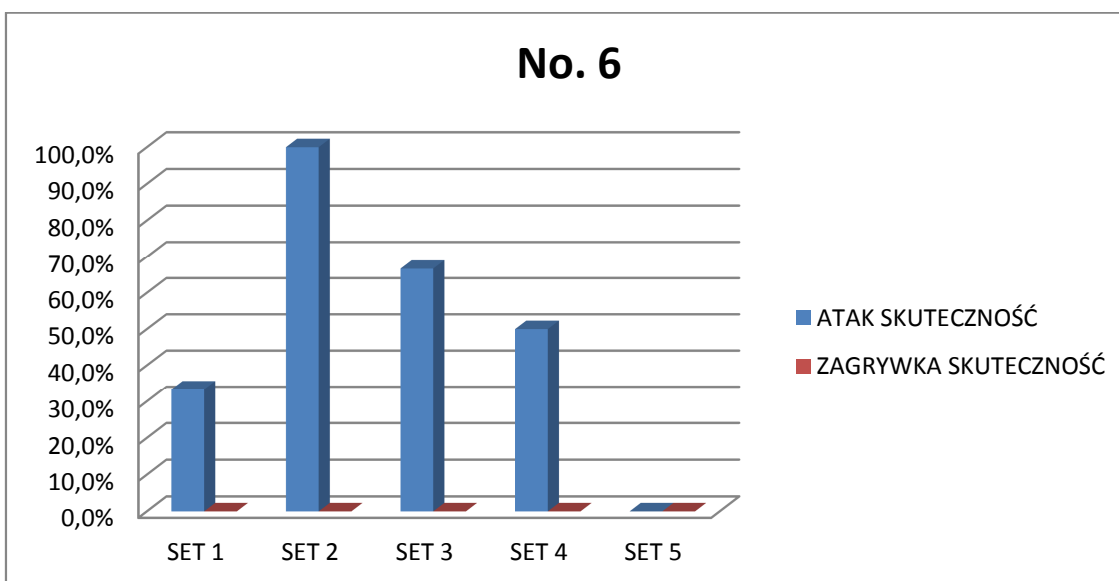


Diagram 7. Effectiveness of attack and serve of the player 6 in individual sets (ATAK SKUTECZNOŚĆ – ATTACK EFFECTIVENESS, ZAGRYWKA SKUTECZNOŚĆ – SERVE EFFECTIVENESS)

Source: author's own study

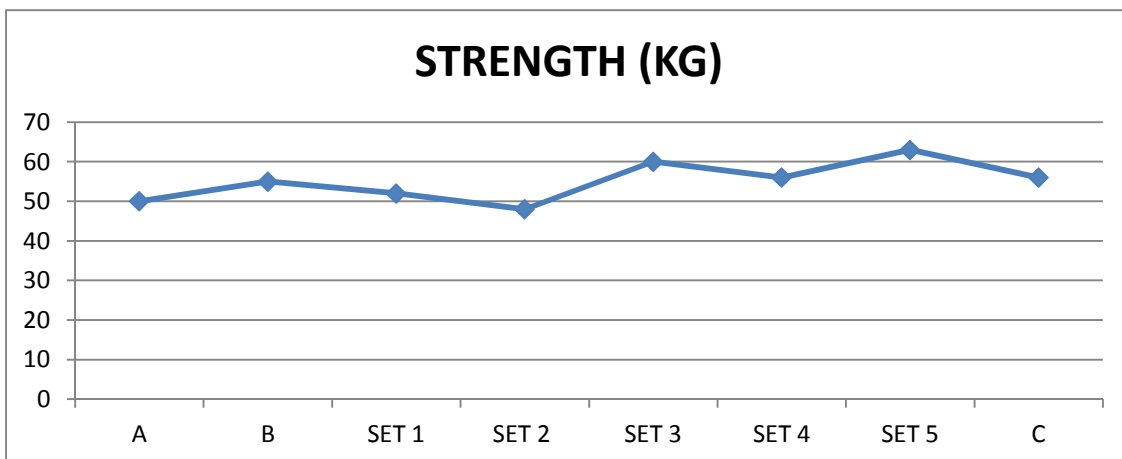


Diagram 8. Strength of the dominant limb of the player 6 during the match (SIŁA – STRENGTH)

Source: author's own study

Before the warm-up, the strength of the dominant limb was 50 kg, whereas after the game, this value was to 56 kg. In the set 1, attack effectiveness was 33.3%, whereas the serve effectiveness was 0%, with mean strength of 52 kg. In the set 2, attack effectiveness was 100%, whereas the serve effectiveness was 0%, with mean strength of 48 kg. In the set 3, attack effectiveness was 66.7%, whereas the serve effectiveness was 0%, with mean strength of 60 kg. In the set 4, attack effectiveness was 50%, whereas the serve effectiveness was 0%, with mean strength of 56 kg. In the set 5, attack effectiveness was 0%, whereas the serve effectiveness was 0%, with mean strength of 63 kg. Strength of the player 6 after completion of the match was 56 kg.

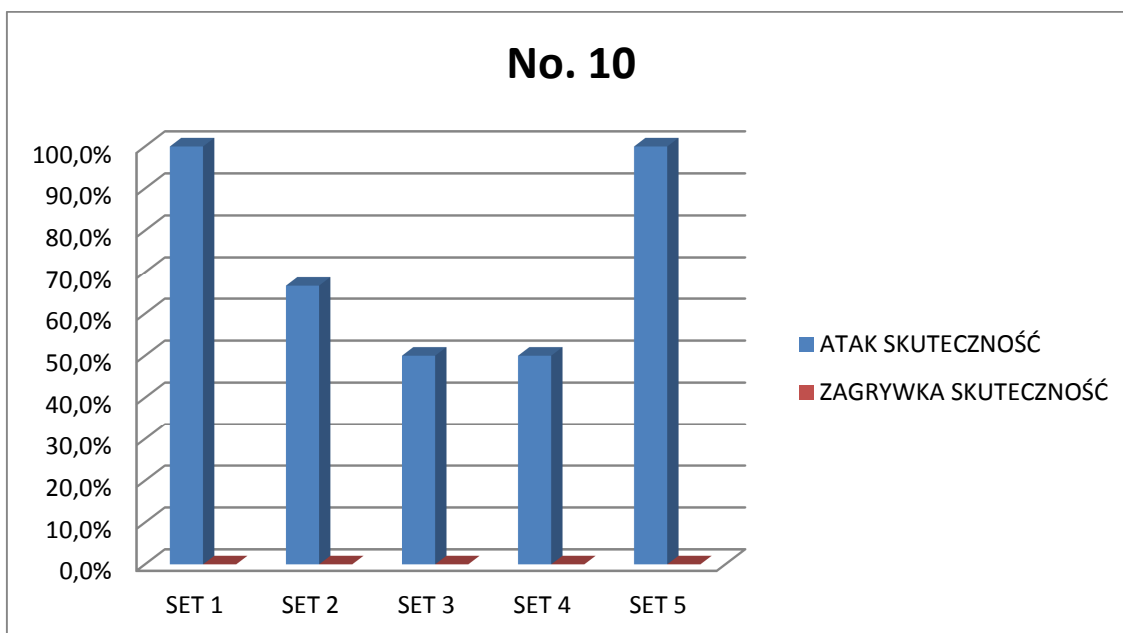


Diagram 9. Effectiveness of attack and serve of the player 10 in individual sets (ATAK SKUTECZNOŚĆ – ATTACK EFFECTIVENESS, ZAGRYWKA SKUTECZNOŚĆ – SERVE EFFECTIVENESS)

Source: author's own study

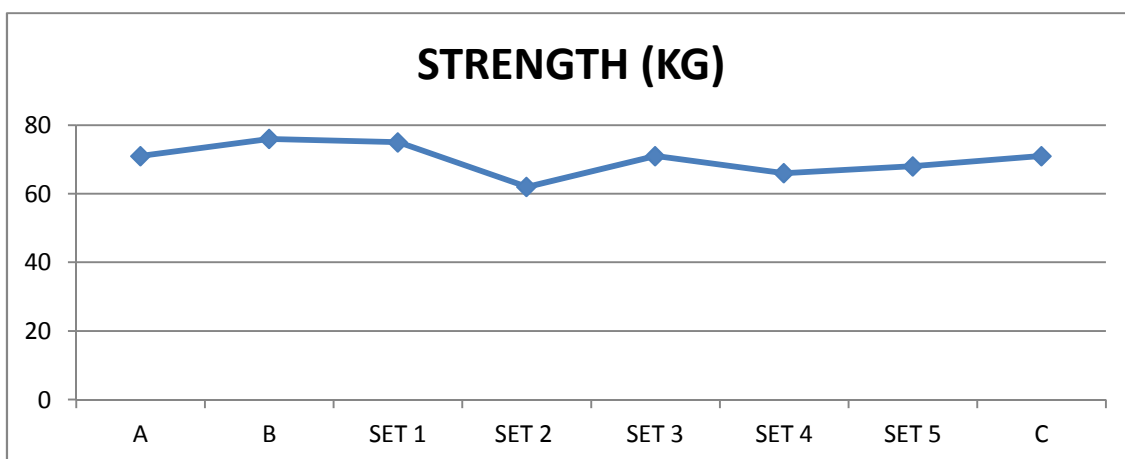


Diagram 10. Strength of the dominant limb of the player 10 during the match (SIŁA – STRENGTH)

Source: author's own study

Before the warm-up, the strength of the dominant limb was 71 kg, whereas after the game, this value rose to 76 kg. In the set 1, attack effectiveness was 100%, whereas the serve effectiveness was 0%, with mean strength of 75 kg. In the set 2, attack effectiveness was 66.7%, whereas the serve effectiveness was 0%, with mean strength of 62 kg. In the set 3, attack effectiveness was 50%, whereas the serve effectiveness was 0%, with mean strength of 71 kg. In the set 4, attack effectiveness was 50%, whereas the serve effectiveness was 0%, with mean strength of 66 kg. In the set 5, attack effectiveness was 100%, whereas the serve effectiveness was 0%, with mean strength of 68 kg. Strength of the player 10 after completion of the match was 71 kg.

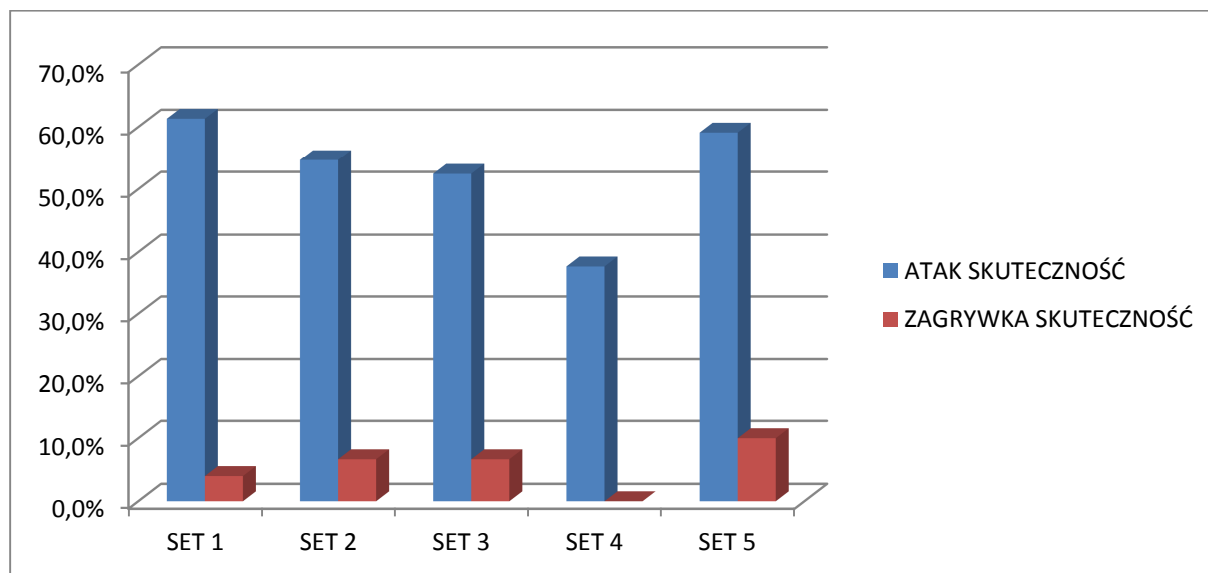


Diagram 11. Effectiveness of attack and serve for all players who were qualified for the analysis (ATAK SKUTECZNOŚĆ – ATTACK EFFECTIVENESS, ZAGRYWKA SKUTECZNOŚĆ – SERVE EFFECTIVENESS)

Source: Author's own study.

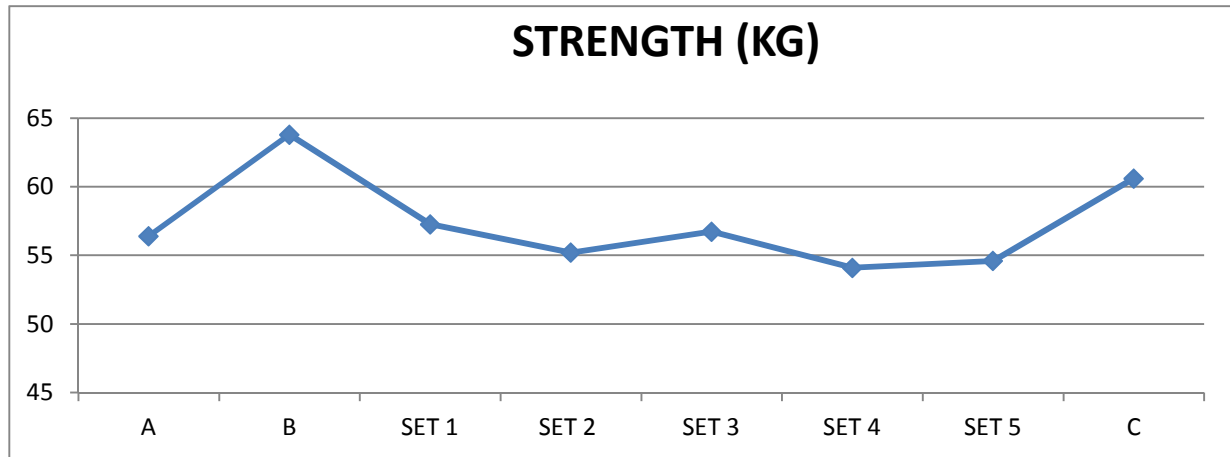


Diagram 12. Strength of the dominant limb for all the players qualified for the analysis (SILA – STRENGTH)

Source: author's own study

Before the warm-up, mean strength of the dominant limb of all the players was 56 kg, whereas after the game, this value rose to 64 kg. In the set 1, mean attack effectiveness for all qualified players was 61.3%, whereas the serve effectiveness was 4 %, with mean strength of 57 kg. In the set 2, attack effectiveness was 54.7%, whereas the serve effectiveness was 7%, with mean strength of 55 kg. In the set 3, attack effectiveness was 52.5%, whereas the serve effectiveness was 7%, with mean strength of 57 kg. In the set 4, attack effectiveness was 37.7%, whereas the serve effectiveness was 0%, with mean strength of 54 kg. In the set 5, attack effectiveness was 59.1%, whereas the serve effectiveness was 10%, with mean strength of 55 kg. Mean strength of all qualified players after completion of the match was 61 kg.

Analysis of the results obtained in the study leads to the conclusion that the attack effectiveness for all the athletes analysed in the whole match was around 53%. The highest attack effectiveness was observed during the set 1 (63%), whereas the lowest effectiveness was found for the set 4 (38%). The highest level of serve effectiveness was recorded for the set 5 (10%), whereas its lowest value was observed in the set 4, with none of the athletes performing the point-scoring serves (consequently, the effectiveness was 0%). This poor effectiveness in the set 4 did not translate into the strength in this set since it was at the level similar to the set 5, where serve effectiveness was 10% and attack effectiveness was 59%.

Table 1. Correlation coefficient for the players studied

Correlation coefficient	Player 1	Player 11	Player 12	Player 6	Player 10
Attack/Strength	0.29	-0.77	0.17	-0.68	-0.81
Serve/Strength	-0.15	-0.47	-0.5	-0.72	-0.27

Source: Author's own study, 2016.

In the most of the cases of individual players, the correlation coefficient (Attack/Strength, Serve/Strength) was below 0 and ranged from -0.1 to 0.0, i.e. the correlation was negative poor or negative strong. Only in the case of the player 1 and player 12, the Attack/Strength correlation was 0.29 and 0.17, respectively, which means a positive poor correlation. This rejects the previously proposed hypothesis that the decline in the level of strength caused by match-induced fatigue has an effect on the effectiveness of offensive play (serving, attack).

CONCLUSION

Analysis of sports competition in volleyball is one of the major concerns connected with the theory and practice present in different team games. The accurate determination of the relative force in a specific motion has become a very interesting problem, both from the standpoint of sports biomechanics and training practice. Professional sports require continuous searching and development of information resources in order to better understand the phenomena that occur over the training process. Analysis of the results of the study revealed that the correlation between hand grip strength and effectiveness of volleyball plays is relatively complex since during the game, the effectiveness of a player's actions depends on a number of technical and tactical parameters, developed over the whole training process.

The analysis of the tests, comparison of the results and confrontation with the previously acquired knowledge and auxiliary materials lead to the conclusion that the changes in the hand grip strength during the match do not substantially affect the effectiveness of offensive plays in volleyball. However, this does not mean that strength training should be neglected in volleyball since it can be useful in such elements of the game as e.g. fighting at the net.

Our findings are not consistent with the previous reports on the effect of strength on effectiveness of offensive plays (attack and serve) in volleyball. Forearm strength is not always connected with the effectiveness of offensive playing. One of the basic factors that determine a good level of achievement in volleyball are motor abilities. If skilfully developed, these abilities are reflected during the game by a correct, more effective and efficient play.

The tests performed in the study provided answers to the research questions and showed that the hypothesis proposed in the study should be rejected. Analysis of the results reveals that the force generated by forearm muscles has an insignificant or no effect on the effectiveness of attack and serve in volleyball. Much more important factors that affect the offensive actions are e.g. technique of performing a specific element and team tactics prepared with respect to the player's skills.

The following conclusions were drawn based on the observations and analysis of the tests performed in the present study:

1. No correlation was found between the decline in strength and effectiveness of attack and serve.
2. Strength is not always correlated with effectiveness.
3. In volleyball, relations between forearm strength and playing effectiveness are relatively complex, since effective playing depends on technical and tactical skills developed over the whole training process.

Undoubtedly, the information collected based on the tests can be useful for improved organization of training plans. The results are important from the standpoint of the choice, prognosis and diagnosis in volleyball and represent the basis for coaches who develop training programs.

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