

## SECTION – SPORT SCIENCES

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## THE LEVEL OF ENDURANCE AND ACCURACY OF FEMALE HANDBALL PLAYERS' THROWS

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### Authors' contribution:

- A. Study design/planning
- B. Data collection/entry
- C. Data analysis/statistics
- D. Data interpretation
- E. Preparation of manuscript
- F. Literature analysis/search
- G. Funds collection

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**Keywords:** handball, woman, aerobic strength, accuracy of throws.

### Abstract:

**Aim.** The main aim of the research was to evaluate and compare changes in accuracy of throws performed by KS Cracovia 1906 handball players, before and after endurance effort.

**Basic procedures.** The study was carried out among 14 players who played in the second women's handball division in the 2016/2017 season. The study took place during final preparations for the season, at the beginning of September 2016. The level of durability of the tested players was assessed using the Beep Test and the accuracy of throws, both before and after the endurance effort (after the Beep Test), was analysed, considering the training and endurance experience of the tested handball players. Basic methods of descriptive statistics, the Student's *t*-test and Spearman's rank correlation coefficient were used in the preparation of the results, and to assess the size of differences between the individual players, normalised indicators were calculated.

**Results main findings.** Analysis of the research results presented in the study showed that after a long-term effort of endurance nature, the accuracy of throws among the tested handball players decreased. It seems that they suffered from nervous system fatigue leading to less accurate and less precise performance of motor tasks.

**Conclusions.** On the basis of the analysis performed in the study, the following conclusions were drawn: that the accuracy of throws among KS Cracovia 1906 handball players after a long endurance effort, significantly decreased, and the accuracy of throws, both before and after the endurance effort, does not depend on the training period. Furthermore, more time should be devoted to the formation of aerobic strength in training the tested team.

### Introduction

Handball is one of the most spectacular and exciting team sports with a variable pace of action. From the point of view of physiology, mixed efforts - aerobic and anaerobic - dominate in handball. About 30-35% of the game time is spent in the anaerobic exercise zone [1-5]. However, the fairly long duration of a game and the occurring short periods during which the player is not involved in playing, as well as fairly frequent intervals in the game,

allow the activation of oxygen metabolism. This places great demands on handball players in terms of physical efficiency, because the loss of energy reserves created during the muscle work at the time of exercise of varied structure and specificity of movement, must be covered by the involvement of both anaerobic and aerobic energy conversion processes [1,6-8].

Each and every effort leads to fatigue of the competitor's body. This is the condition in which the ability to work decreases, thus, the athlete performs tasks with

reduced efficiency and makes mistakes in their performance [9]. To avoid this, the competitor must be physically properly prepared for the competition. In addition, proper nutrition, drinking sufficient amounts water during the day and training should be considered [11].

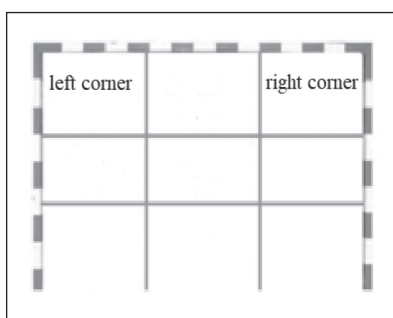
The main **objective** of the study was to assess and compare changes in throw accuracy performed by female handball players before and after endurance exercise.

## Materials and methods

The study involved 14 players of the KS Cracovia 1906 team who participated in the second women's handball league. The team comprised two goalkeepers, three pivots, seven backcourts and four wingers. Eight players were still juniors and took part in youth competitions. The research was conducted in September 2016, at the end of the preparatory period for the 2016/2017 season. The first measurements of throw accuracy were taken on the first day of the microcycle or immediately after the warm-up, comprising general development exercises which lasted 10 minutes. On the other hand, the second measurements of throw accuracy were performed after one week (on the first day of the following microcycle), immediately after the completion of the Beep Test, which was preceded by the same warm-up as in the case of the first measurement.

In the work, the following parameters were evaluated:

1. Goal throw accuracy. The players had to perform 10 throws towards the top corners of the goal. The throws were made from the position of the centre backcourt, after a jump and from a distance of not less than 7 metres from the goal. The result was the number of throws towards the designated sector of the goal - the upper left or right corner (a square measuring 40 x 40 cm).



2. Aerobic endurance using the Beep Test. The test was carried out on the handball court, in accordance with the instructions [9]. After the completion of the test, the results were recorded onto a card, then the distance covered and  $VO_{2\max}$  data were calculated from the test evaluation tables [9, 11, 12].

3. Training and competition experience. It was assumed that training experience is the time of active participation in handball training in years. On the other hand, the experience is the period (in years) of participation in training and competitions of the senior team [11]. The following were applied in the analysis of results:
  - Basic measures of descriptive statistics: arithmetic mean ( $\bar{x}$ ) and standard deviation (SD).
  - In order to assess the size of the differences between individual players, indices were calculated according to the formula:

$$WU = \frac{X_{\text{tested player}} - \bar{X}_{\text{team}}}{SD_{\text{team}}}$$

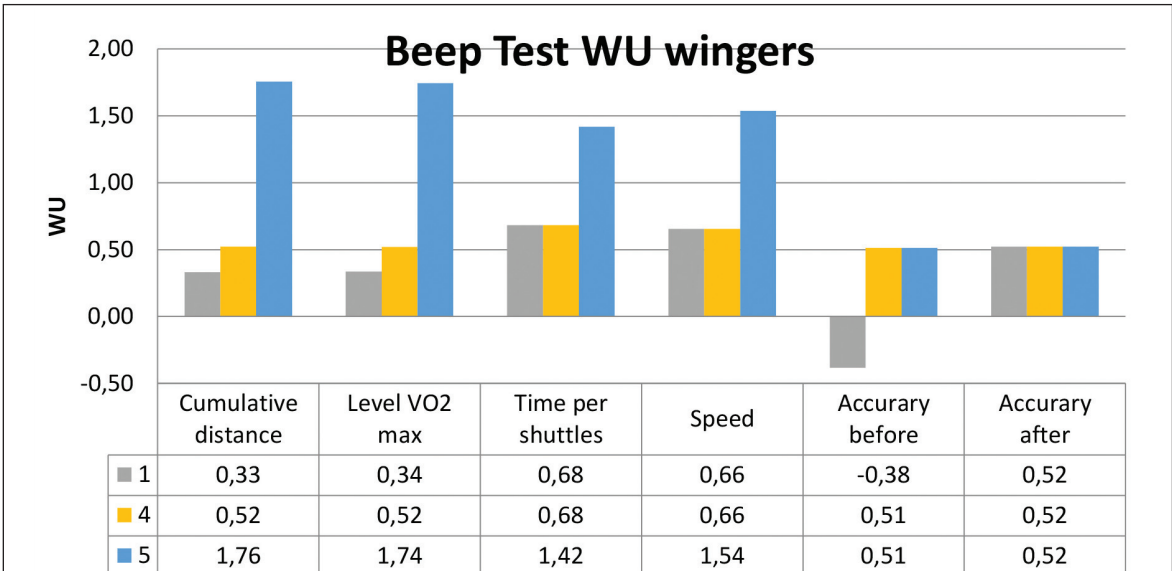
- The Student's *t*-test for dependent samples was carried out on the normalised results for the mean and standard deviation of the whole group. The significance of differences in the accuracy of throw tests after a standard warm-up and following the endurance effort (Beep Test) were assessed.
- Spearman's signed rank correlation coefficient was applied to assess the relationship between training and competitive experience, as well as the effectiveness of throws before and after the warm-up.

## Results

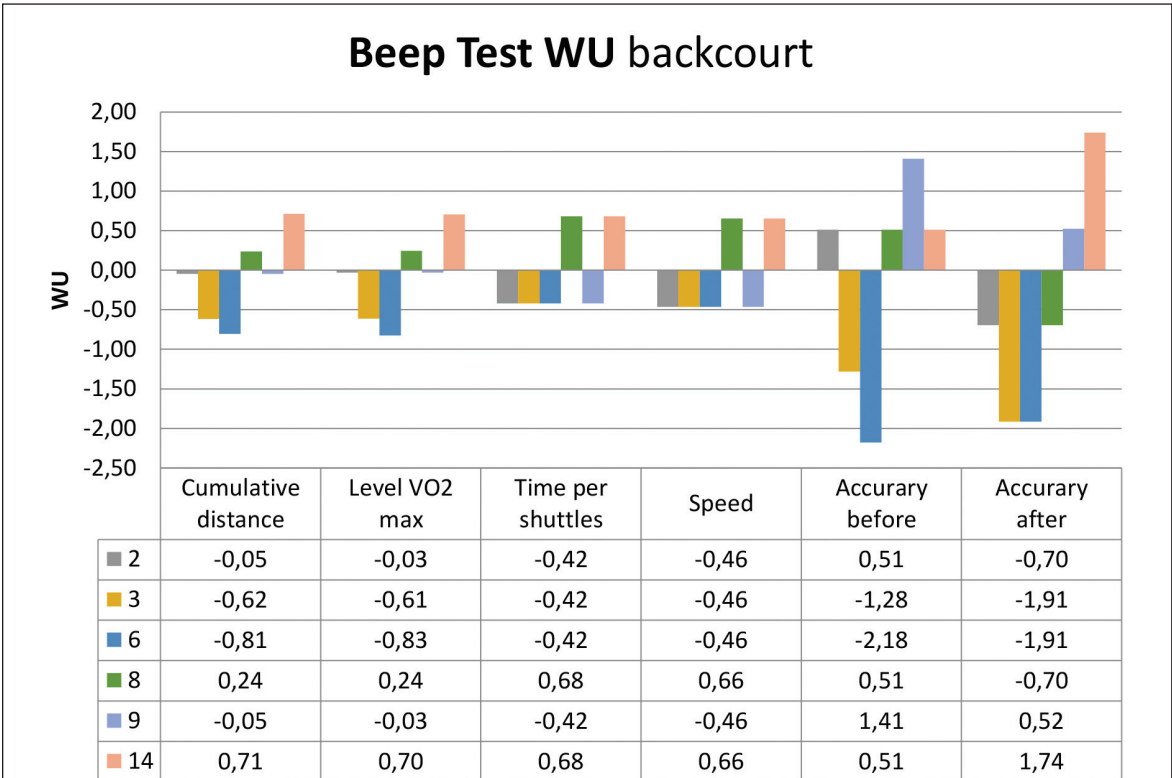
In order to assess the level of the analysed parameters for individual players, the measurement results of each handball player were normalised to the mean and standard deviation for all participants. This assessment was performed in groups distinguished according to game position (Fig. 1–4).

In Figure 1, the values of standardised indices calculated for players playing in the winger position are shown. We may notice a change in the accuracy of throws performed after aerobic exercise, approximate to the match conditions in player No. 1. Her throw accuracy improved significantly - before the exercise, it was clearly lower than the average accuracy of throws for the team ( $WU = -0.38$ ), and after the Beep Test, it exceeded the average values noted for the team by 0.52 SD. The accuracy of the throws did not change for the other two remaining players.

In Figure 2, graphically normalised indices calculated for backcourt handball players are shown. As it can be seen, the tested players were characterised by similar levels of aerobic endurance, although they had different body mass (between 55 kg and 64 kg), and body mass is known to determine the level of aerobic endurance to a large extent [10]. As noted, the accuracy of throws made after endurance effort significantly decreased in the majority of the analysed players. Only in player No. 14 was the accuracy of throws higher af-



**Fig. 1.** Values of normalised indices regarding analysed variables among wingers - normalisation to mean and standard deviation for entire team

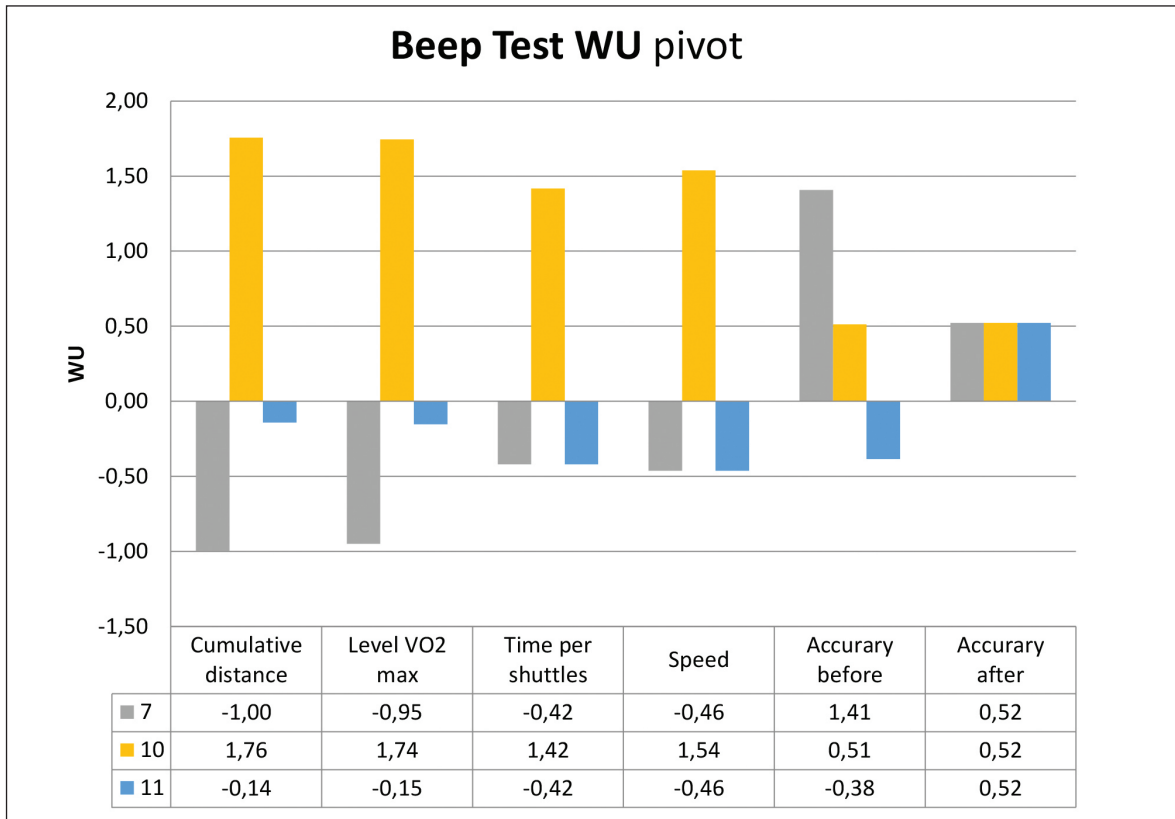


**Fig. 2.** Values of normalised indices regarding analysed variables in backcourt players - normalisation to mean and standard deviation for entire team

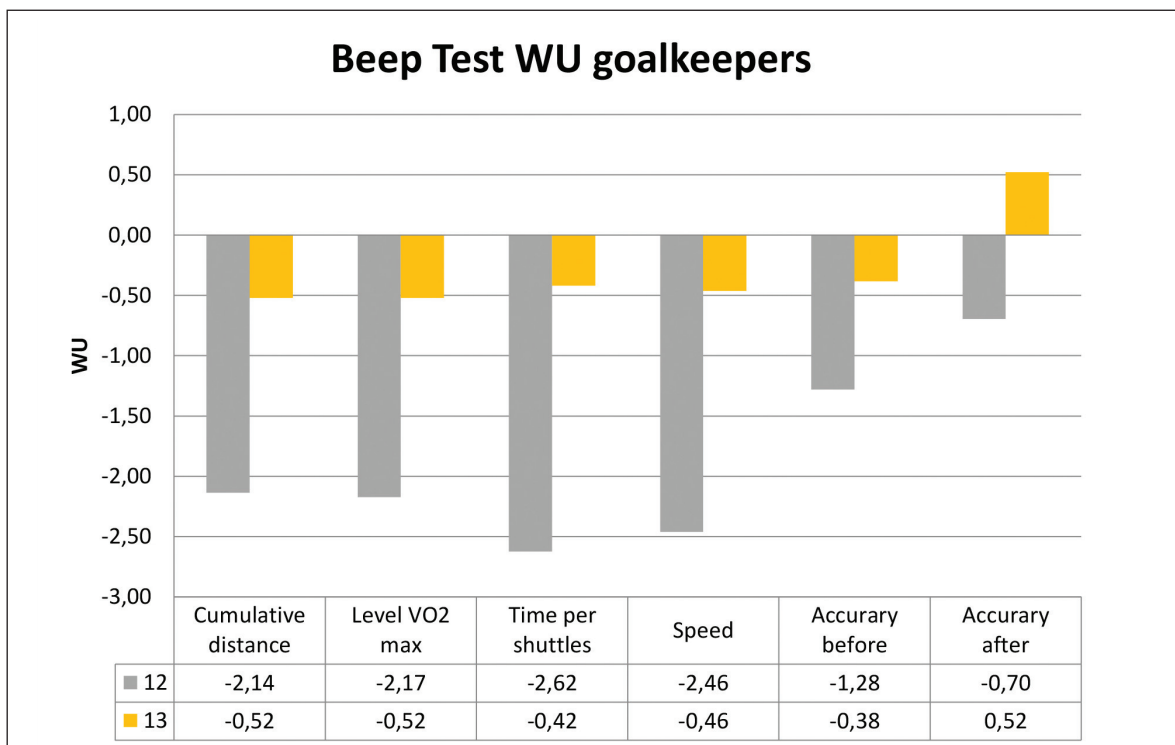
ter than before the effort, and it significantly exceeded the average accuracy of throws for the team - by as much as 1.74 SD.

In Figure 3, graphically normalised indices calculated for pivot players are shown. It is not surprising that these players achieved worse Beep Test results than

their teammates, because they were characterised by large body mass. One of the subjects (No. 7) exhibited a decrease in the accuracy of throws towards the goal after the endurance effort similar to match conditions. On the other hand, player No. 11 demonstrated marked improvement in accuracy compared to the entire team.



**Fig. 3.** Values of normalised indices regarding analysed variables in pivot players - normalisation to mean and standard deviation for entire team



**Fig. 4.** Values of normalised indices regarding analysed variables in goalkeepers - normalisation to mean and standard deviation for whole team

**Table 1.** Spearman's rank correlation coefficients analysed between training and competition experience, as well as accuracy of throws before and after the Beep test.

	Accuracy of throws before	Accuracy of throws after Beep Test	Difference between throws
Training experience	0.277	0.178	-0.195
Competition experience	0.165	0.125	-0.098

As it can be seen in Figure 4, both goalkeepers gave way to the other players in terms of throw accuracy after a standard warm-up, while following the endurance effort similar to game conditions, player No. 13 clearly improved her throw efficiency compared to the whole team. It should be noted, however, that both goalkeepers had a low level of aerobic endurance compared to the team.

The analysis presented above may indicate that fatigue of the tested players caused by the endurance effort had impact on the decrease in throw effectiveness. This is confirmed by the results of the Student's *t*-test, in which it was shown that the differences in the results of the throw accuracy tests performed by the examined handball players after the standard warm-up and following the endurance exercise (Beep Test) were statistically significant (*p* = 0.01).

In the study group, no relationship was found between training and competitive experience, or the accuracy of handball players' throws (Tab. 1). This is certainly due to the number of tested players and the specificity of the group (the majority of young players), but it seems that this may be related to the effectiveness of players on the court. Because the players who have more experience and have trained longer are most often more effective during the game [3, 4, 14].

Discussion

Analysis of the test results presented in the paper allowed to deduce that after a long-term endurance effort, the accuracy of throws among the tested handball players decreased. It seems that they developed nervous system fatigue leading to less precise performance of motor tasks [4, 15, 10]. During the Beep Test, the upper body worked less intensively, mainly fulfilling the balance function [15-17], but nerve fibres throughout the body were involved in transmitting nerve impulses [10, 16]. Therefore, immediately after the test, it was difficult to control the whole body while performing throws towards designated corners of the goal [16]. Among all of the tested handball players, those playing the winger position had the best oxygen endurance. It should be noted, however, that the level of endurance among the tested players was not too high. The Beep test caused severe fatigue, which led

to a decrease in efficiency, reduced excitability and efficiency of organs [18]. As it is well-known, after exceeding the culmination of fatigue, human movement slows down, as does the reaction to external stimuli [19]. Then, the tired players make more mistakes [10, 20, 21]. For example, physical fatigue may be the main factor reducing the accuracy of throws in basketball [22], thus, resistance to fatigue must be developed during the training process. One of the reasons for fatigue among the studied players could be their poor physical preparation. The examined team, despite its sporting aspirations - the desire to be promoted to the first league - trains only 3 times a week, which is certainly not sufficient enough from the point of view of modern handball requirements [11, 14, 17].

In the work, training and competitive experience were also assessed. Experience helps players make correct decisions quickly and with fewer mistakes [14, 22], because they have already encountered similar situations on the court. Experience also helps to maintain stable mental state during a match [4, 12]. It should be borne in mind that the researched team consisted of very young female players, and the differences between them in terms of professional experience were small. Therefore, it seems that for this very reason, no correlations were noted between sports experience of the tested handball players and their accuracy of throws.

Conclusions

Based on the analysis carried out in the work, the following conclusions may be drawn:

- 1. The accuracy of throws among the tested handball players after a long endurance effort decreased significantly.
- 2. The accuracy of throws performed by the tested handball players before and after the endurance effort did not show a relationship with their training or competitive experience.
- 3. In handball training, an extremely important role is played by aerobic endurance, which is the basis for mixed efforts during the game. It is the fitness conditions that often determine a player's high performance in the final phase of the match.

**Institutional Review Board Statement:** The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Ethics Committee

## References:

- [1] Czerwiński J: *Charakterystyka gry w piłkę ręczną na podstawie najnowszych badań*. Człowiek i Ruch. 2001;1:99-105.
- [2] Norkowski H: *The intensity of handball competition in relation in the field*. Physical Education and Sport. 2002;46(2): 203-208.
- [3] Thorlund JB, Michalsik LB, Madsen K, Aagaard P: *Acute fatigue-induced changes in muscle mechanical properties and neuromuscular activity in elite handball players following a handball match*. Scandinavian Journal of Medicine and Science in Sports. 2008;18(4): 462-472.
- [4] Michalsik LB, Aagaard P, Klavs M: *Match performance and physiological capacity of male elite team handball players*. EHF Periodical. 2011;1:168-173.
- [5] Bompa T, Zajac A, Waśkiewicz Z, Chmura J: *Przygotowanie sprawnościowe w zespołowych grach sportowych*. Katowice: AWF; 2013.
- [6] Miyagi O, Yamamura C, Tsukanaka A, Koiso H, Shimasazaki T, Ishiko T, Kitagawa K: *Effects of the anaerobic and aerobic training on blood lactic acid and the form of locomotion activity during the game in soccer players*. Japanese Journal of Biomechanics in Sports and Exercise. 1997;1(1): 15-23.
- [7] Rannou F, Prioux J, Zouhal H, Gratas-Delamarche A, Delamarche P: *Physiological profile of handball players*. J Sport Med Physiol Fitness. 2001; 41(3): 349-353.
- [8] Bangsbo J, Iaia FM, Krstrup P: *Metabolic response and fatigue in soccer*. International Journal of Sport Physiology and Performance. 2007; 2(2): 111-127.
- [9] Norkowski H, Noszczak J: *Piłka ręczna – zbiór testów*. Warszawa: ZPRP; 2010.
- [10] Górski J: *Fizjologiczne podstawy wysiłku fizycznego*. Warszawa: Wydawnictwo lekarskie PZWL; 2014.
- [11] Gorostiaga EM, Granados C, Ibañez J, González – Badillo JJ, Izquierdo M: *Effects of an entire season on physical fitness changes in elite male handball players*. Medicine & Science in Sports & Exercise. 2006; 38(2):357-366.
- [12] Tomkinson GR, Léger LA, Olds TS, Cazorla G: *Secular trends in the performance of children and adolescents (1980–2000): An analysis of 55 studies of the 20 m shuttle run in 11 countries*. Sports Medicine. 2003; 33: 285–300.
- [13] Léger LA and Lambert J: *A maximal multistage 20m shuttle run test to predict  $VO_{2max}$* . European Journal of Applied Physiology. 1982; 49:1-5.
- [14] Czerwiński J: *Piłka ręczna. Wybrane elementy teorii i treningu*. Warszawa: ZPRP; 2014.
- [15] Chelly MS, Hermassi S, Shephard RJ: *Relationships between power and strength of the upper and lower limb muscles and throwing velocity in male handball players*. Journal of Strength and Conditioning Research. 2010; 24(6):1480-1487.
- [16] Marques MC, Van Den Tillaar R, Vescovi JD, González-Badillo JJ: *Relationship between throwing velocity, muscle power, and bar velocity during bench press in elite handball players*. International Journal of Sports Physiology and Performance. 2007; 2(4):414-422.
- [17] Chmura J, Zajac A: *Współczesny system szkolenia w zespołowych grach sportowych*. Katowice: AWF Katowice; 2016.
- [18] Urbańska J: *Zmęczenie życiem codziennym*. Poznań: Instytut Psychologii UAM; 2010.
- [19] Sozański H, Czerwiński J, Sadowski J: *Podstawy teorii i technologii treningu sportowego*. Tom 1. Warszawa – Biała Podlaska: AWF Warszawa Zamiejscowy Wydział Wychowania Fizycznego w Białej Podlaskiej; 2013.
- [20] Sozański H, Witczak T, Starzyński T: *Podstawy treningu szybkości*. Warszawa: COS Biblioteka Trenera; 1999.
- [21] Lyons M, Al-Nakeeb Y, Nevill A: *The impact of moderate and high intensity total body fatigue on passing accuracy in expert and novice basketball players*. J. Sports Sci. Med. 2006;5(2): 215-227.

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