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Original Article

Impact of repeated short-term physical exercise on the level of selected technical skills in youth volleyball

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Abstract:
Problem statement: Volleyball is a sport where players are engaged in short-term high-intensity physical exercise. One of the determinants of higher sports skill level may be the ability to maintain the effectiveness of performing technical elements despite increasing fatigue due to physical exercise. *Purpose:* The aim of the present study was to evaluate the impact of repeated short-term physical exercise on the level of selected technical skills in youth volleyball. *Approach:* The study involved 20 volleyball players aged 13 to 18 years from the UKS "Błyskawica" Szczecin club. The study evaluated the impact of physical exercise on the basic techniques of volleyball: an overhand serve, reception using a forearm pass, setting the ball using an overhead pass, and a one-hand spike. Each form was examined by first performing a control test and then three research tests, each preceded by an exercise test that included elements of jumping to block and various forms of moving. Statistical analysis was performed by assessing the normality of distribution (Shapiro-Wilk test) and using Friedman ANOVA (with no normal distribution = $p < 0.05$) and ANOVA analysis of variance for repeated measures (normal distribution = $p > 0.05$). *Results:* The results did not show any significant statistical differences between the control test and the research tests in the measurements of the overhand serve, forearm pass, and one-hand spike. Analysis of the setting using an overhead pass revealed a statistically significant small increase in the results obtained between the control test and the third research test. *Conclusion:* The results of the study showed that repeated short-term physical exercise does not negatively affect the level of effectiveness of basic techniques performed by adolescent volleyball players. Further research on the impact of physical exercise in volleyball conducted in other research groups seems necessary.
Keywords: physical fitness, adolescent, sports ability, team sports

Introduction:

Athletes participating in professional sports are subjected to exercise associated with regular and properly planned sports training and competing during games and tournaments. High team performance can be ensured by adequate technical, tactical, and physical preparation of players. In team sports, players must be able to cope with the effects of heavy loads throughout the competitive season, which usually lasts several months. Changes in motor skills occurring over the course of the season have been studied in various team sports such as rugby (Hene & Bassett, 2013), Australian rules football (Bilsborough, Greenway, Livingston, Cordy, & Coutts, 2016), handball (Gorostiaga, Granados, Ibáñez, González-Badillo, & Izquierdo, 2006), soccer (Emmonds, Sawczuk, Scantlebury, Till, & Jones, 2020), and volleyball (Rousanoglou, Barzouka, & Boudolos, 2013). In other studies (Gjinovci, Idrizovic, Uljevic, & Sekulic, 2017; Gonzalez-Rave, Arija, & Clemente-Suarez, 2011; Jastrzebski, Wnorowski, Mikolajewski, Jaskulska, & Radziminski, 2014; Lipińska & Michalski, 2011; Malatesta, Cattaneo, Cattaneo, & Maffiuletti, 2003; Newton, Kraemer, & Häkkinen, 1999; Sánchez-Moreno, García-Asencio, González-Badillo, & Díaz-Cueli, 2018), authors have highlighted the development of motor skills following the introduction of training programs selected adequately to a macro-cycle or a period in the competitive season. In volleyball, where many techniques are used in the air by players at a high sports skill level, jump height and the ability to repeatedly perform jumps play an important role (Freitas-Junior, Gantois, Fortes, Correia, Paes, 2020). As shown in research conducted throughout the season, various programs based on strength training, (Gonzalez-Rave et al., 2011; Lipińska & Michalski, 2011; Newton et al., 1999; Sánchez-Moreno et al., 2018) plyometric training (Gjinovci et al., 2017; Jastrzebski et al., 2014), and electromyostimulation (EMS) (Malatesta et al., 2003) can improve the player's jumping ability. Appropriate use of selected training methods (Afrouzeh, Konukman, Lotfinejad, Afroozeh, 2020) and improvement of an athlete's physical fitness can also have a beneficial impact on their technical skills. As shown in a study of adolescent volleyball players, the level of selected motor skills can affect the quality and effectiveness of some technical elements, whereas the use of the results of physical fitness tests can allow for the identification of players' aptitudes for future specialization (Mroczek, Superlak, Kawczyński, & Chmura, 2017). With increasing training awareness and technological advances, modern technology is also increasingly used. It allows, among other things, to increase training efficiency and improve player selection (Piasecki, Florkiewicz, Krzepota, Steciuk, & Zwierko, 2015; Zwierko, Lubiński, Lesiakowski, Steciuk, Piasecki, & Krzepota, 2014).

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Depending on different tactical assumptions, volleyball uses a division of players specialized in playing in different positions (receiver, hitter, setter, middle blocker, and libero) (Ciemiński, 2017; Grządziel, Szade, & Nowak, 2012; Mroczek, Januszkiewicz, Kawczyński, Borysiuk, & Chmura, 2014; Zatyracz & Piasecki, 2000). However, the rules of the game and its dynamic nature mean that players are required to develop comprehensive technical skills (FIVB, Official Volleyball Rules 2021-2024). The basic elements that occur in a game include a serve, reception, setting, attack, defense, and block (Gabbett et al., 2006; Katić, Grgantov, & Jurko, 2006). The cyclic performance of successive technical elements depends on whether the team is in a situation of scoring points after the opponent's serve (reception, setting, attack, and attack coverage) or in a situation of scoring points after their own serve (serve, block, and counterattack) (Florence, Fellingham, Vehrs, & Mortensen, 2008; Świderek, 2012). A strong relationship can be observed between the technical elements successively occurring during the game. Accurate reception of a serve allows faster setting of the ball and a more effective attack. The opposing team's chances of defending the attack increase with lower reception accuracy and slower setting (Araújo, Tosini, Freire, Costa, & Meira Jr, 2020; Rocha, Ugrinowitsch, Freire, Castro, Praça, Evangelista, & Costa, 2019). Research (Barzouka, 2018; Bergeles, et al. Barzouka, Nikolaidou, 2009; González-Silva, Fernández-Echeverría, Claver, Conejero, & Moreno, 2017; Mazur, 2017; Palao & Ahrabi-Fard, 2011; Panfil & Superlak, 2011; Sotiropoulos, Barzouka, Tsavdaroglou, & Malousaris, 2019; Zetou, Moustakidis, Tsigilis, & Komninakidou, 2007) has confirmed that the key to success in volleyball is a well-chosen strategy of players' cooperation, both in individual technical elements (Mazur, 2017; Zetou et al., 2007) and in successive offensive and defensive actions (Barzouka, 2018; Bergeles et al., 2009; González-Silva et al., 2017; Palao & Ahrabi-Fard, 2011; Panfil & Superlak, 2011; Sotiropoulos et al., 2019).

Maintaining an appropriate sports skill level over the competitive season that lasts several months seems to be a key component to a player's success. The sports skill level is also evaluated during a single game. Multiple repetitions of the same movements require a high level of physical preparation, whereas maintaining the effectiveness of performed actions throughout the game seems to be one of the most important tasks during competitions. Previous findings have indicated that there are no negative effects of increased physical exercise on the level of coincidence anticipation (Niechwiej-Szwedo et. al., 2012) and that there are no differences in the accuracy of young players' serves after physical exercise (Lidor, Arnon, Hershko, Maayan, & Falk, 2007). As emphasized by previous authors, trained players of team sports, including volleyball, do not exceed the threshold of psychomotor fatigue, which may make it easier for them to maintain an adequate performance level throughout the game (Chmura, Nazar, & Kaciuba-Uściłko, 2007; Mroczek, Kawczyński, & Chmura, 2011). In the case of physical exercise undertaken during volleyball games, the specific nature of the game, with the time of breaks exceeding the time of the actual competition, is of great importance. Research results have shown that the overwhelming number of actions end after only a few seconds, and there are less frequent instances in which the time of actual play extends to tens of seconds (Grządziel et al., 2012; J. Sánchez-Moreno et al., 2016). At the highest level of sports performance in women's volleyball, most actions, excluding aces and service faults, end after one ball passing over the net from the moment of serve reception. For the course of the match, this emphasizes the importance of the quality of the serve performed and all the technical elements occurring in the reception phase (Pridal, Toporova, Priklerova, 2021). Previous authors have also stressed that the skills used during the game may be due not only to the appropriate strength and conditioning and technical skills of the player but also to his or her personality traits (Boichuk, Iermakov, Kovtsun, Levkiv, Karatnyk, Kovtsun, 2019). Mental toughness, nervous system strength, or volitional qualities can play a key role in making the right decisions and accurately performing motor tasks in stressful situations and during physical exercise. Developing an awareness of the impact of specific short-term physical exercise on players' performance is essential for continuous improvement at each stage of training. The aim of the present study was to evaluate the impact of repeated short-term physical exercise on the level of selected technical skills in youth volleyball.

Material and Methods

Participants: The study group consisted of 20 volleyball players aged 13 to 18 years from UKS Błyskawica Szczecin club. The study was conducted in August 2020 in the gymnasium of the School and Kindergarten Complex in Stepnica, Poland, and in the Sports Hall of the Szczecin Sports House. All study participants were informed about the experiment and gave verbal consent to participate. Written permission from the club president was also obtained for the purpose of conducting the research.

Procedure: The experiment was conducted using the tests for the evaluation of technical skills included in the Technical Skills Test Battery (Grządziel & Szade, 2012) and the agility and speed test included in the Systematic Methodology for Player Progress Assessment (Grządziel & Macura, n.d.). For the purpose of the study, the height of the net was adjusted for players' age categories as follows: U19 – 243 cm, U17 – 243 cm, and U15 – 235 cm. The method of performance and assessment of individual technical elements was also adjusted to the needs of the study. A 0 - 2 point scale was used to assess overhand serve and setting the ball using an overhead pass. Furthermore, a 0 - 3 point scale was used to evaluate the reception using a forearm pass and a one-hand spike.

A control test (C_K) was conducted for each technical element, followed by three consecutive research tests (R_T_1, R_T_2, R_T_3). An exercise test was performed before each research test. The activities were

performed in the following order: (1) jump into the block with a ringo ring passed from the left to right hand behind the antenna, (2) moving in the block using any method to the place where the second antenna is fixed, 3 m away from the first one, (3) block jump with a ringo ring passed from the right to left hand behind the antenna, (4) return using any kind of movement in the block to the level of the first antenna, (5) block jump with a ringo ring passed from the left to right hand behind the antenna, (6) volleyball dive under a hurdle, (7) side stepping, envelope shape with touching cones, (8) back flip with touching a cone (Fig. 1).

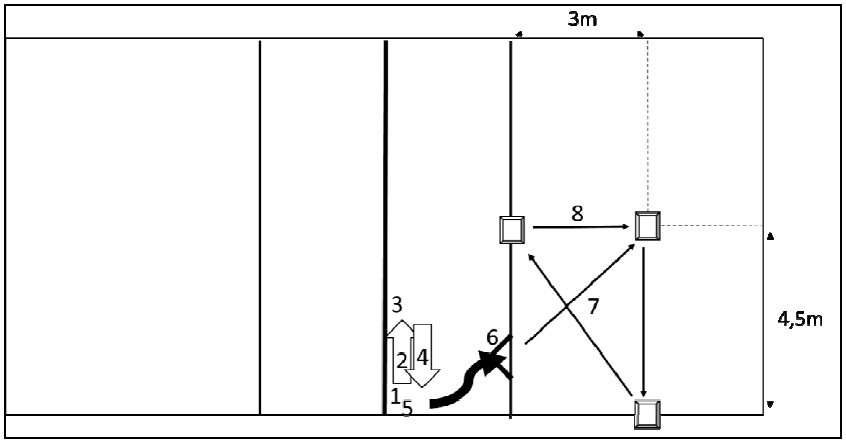

Fig. 1 The order of performing technical elements of the agility and speed test.

The following is a description and scoring system for each technical element.

Testing (T_1). Overhand serve.

Procedure: The participant stands behind the end line of the volleyball court. His task is to make six overhand serves (with or without a jump) into the court on the other side of the net. Before each serve, the supervisor blows the whistle to allow the serve to take place. From this point on, the participant has 8 seconds to complete the task. A scoring system adopted for the T_1 test was: 2 pt - a serve outside the 5 m x 4 m box in the court, serve to anywhere on the court up to 3 m from the net; 1 pt - a serve to a 5 m x 4 m box in the middle of the court; 0 pt – service error (Fig. 2).

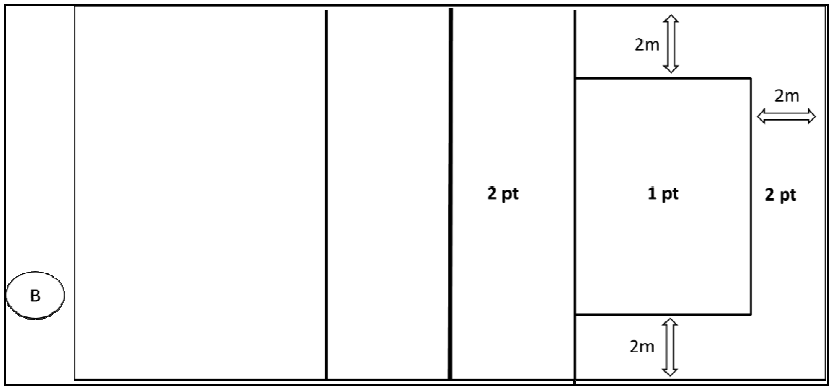

Fig. 2 Assessment of an overhand serve (T_1).

Testing (T_2). Reception of a serve using a forearm pass.

Procedure: The participant stands in zone 5 (left side of the court on defense) to receive a straight serve. On the other side of the court, 6 stationary overhand serves are performed to the area of the court where the receiver stands. Serves are performed in the following order: 1. topspin serve, 2. float serve, 3. float serve, 4. topspin serve, 5. topspin serve, 6. float serve. Any incorrect serve must be repeated. A scoring system adopted for the T_2 test was: 3 pt – reception of a serve into the zone 0 (2 m x 2 m square from the centre line and the axis of the court towards the right sideline) with ball trajectory above the highest point of the antenna; 2 pt – reception of a serve into zone 0 with ball trajectory below the highest point of the antenna with the possibility of setting using an overhead pass, reception of a serve into the attack zone outside zone 0 with ball trajectory above the highest point of the antenna; 1 pt – reception of a serve into the zone 0 with ball trajectory below the highest point of the antenna with the possibility of setting using a forearm pass, reception of a serve into any zone of the court with ball trajectory above the highest point of the antenna; 0 pt – reception of a serve outside the court, reception of a serve without the possibility of setting the ball (Fig. 3).

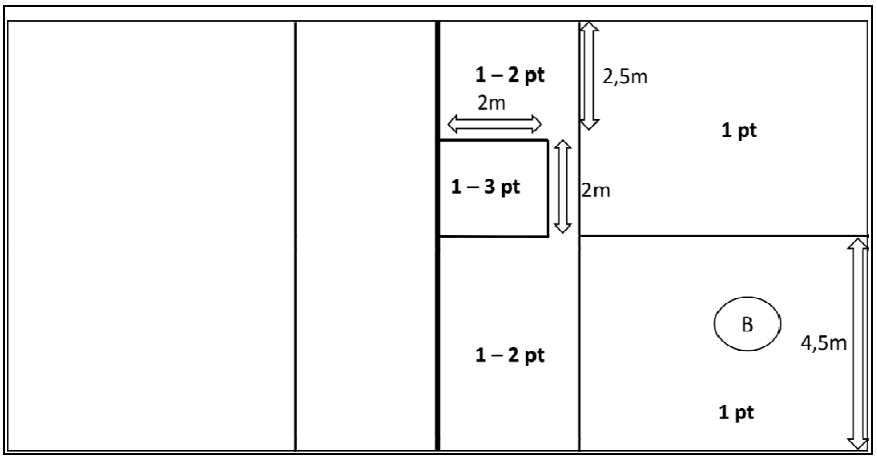

Fig. 3 Assessment of reception using a forearm pass (T_2).

Testing (T_3). Setting using an overhead pass.

Procedure: The participant stands in zone 0 (in the attack zone, 3 m from the right sideline). The participant performs setting 6 times with balls thrown from zone 6 (the middle of the defense zone) on the same court. A scoring system adopted for the T_3 test was: 2 pt – setting the ball with ball trajectory above the highest point of the antenna to a 1 m x 1 m square inside the court; 1 pt – setting the ball with ball trajectory above the highest point of the antenna to a 2 m x 3 m rectangle; 0 pt - setting the ball with ball trajectory below the highest point of the antenna, setting the ball outside a 2 m x 3 m rectangle (Fig. 4).

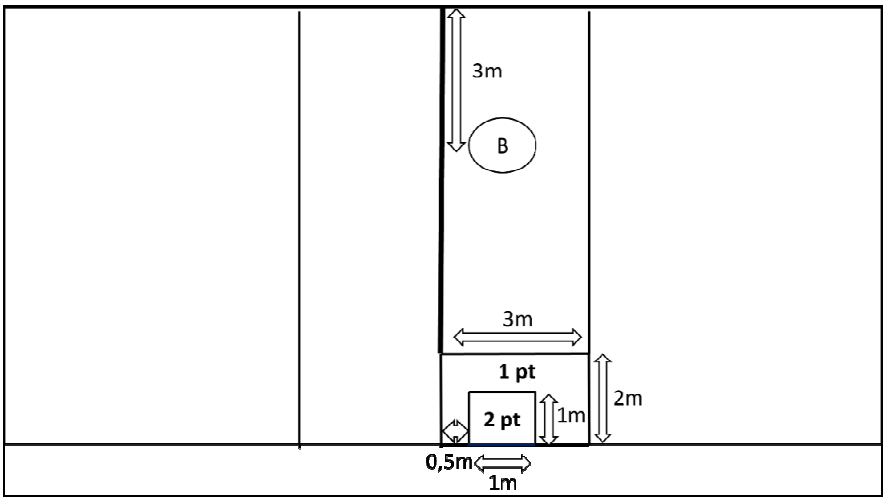

Fig. 4 Assessment of setting the ball using an overhead pass (T_3).

Testing (T_4). One-hand spike.

Procedure: The participant stands in the attack position on the left side of the court. The participant performs 6 successive one-hand spikes from the front row with the set ball. Allowed forms of attack are a regular dynamic spike or a dink. Each set ball must reach the flight trajectory over the highest point of the antenna and be no further than 1.5 m and no closer than 0.5 m from the net and no wider than the left sideline and no narrower than 1 m from the left sideline. If these conditions are not met, the test must be repeated. A scoring system adopted for the T_4 test was: 3 pt – straight attack to a 2 m x 2 m square inside the court, diagonal attack to a 2 m x 2 m square inside the court; 2 pt – straight attack to a 7 m x 2 m rectangle, diagonal attack to a 7 m x 2 m rectangle from the right sideline; 1 pt – attack to a 5 m x 9 m box in the middle of the court; 0 pt – attack out of bounds (Fig. 5).

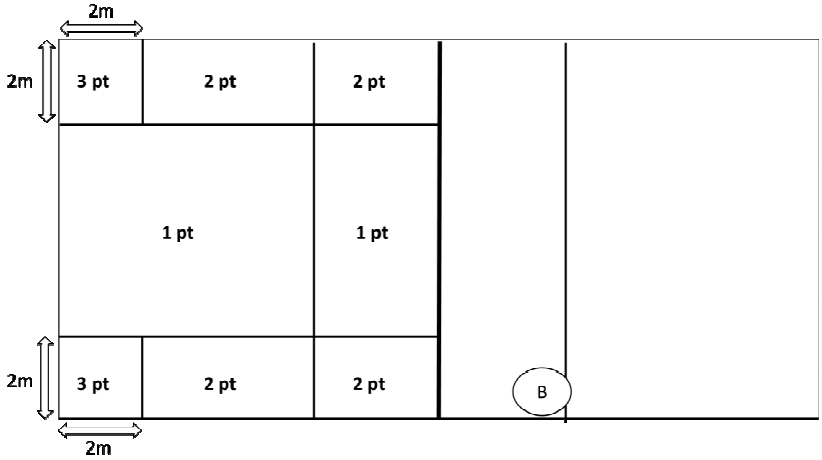

Fig. 5 Assessment of one-hand spike (T_4).

Statistical analysis:

Statistical analysis was performed by means of Statistica 13.1 software. In measurements T_1, T_3, and T_4, a comparison of results for statistical significance was conducted using Friedman's ANOVA (no normal distribution = $p < 0.05$), and, in the measurement T_2, using ANOVA analysis of variance for repeated measures (normal distribution = $p > 0.05$).

Results:

Table 1 shows the results obtained by the participants in each measurement. The results of the analyses showed no statistically significant differences between the controls and subsequent technical skill tests in T_1 ($Chi^2 = 2.24$, $p = 0.524$), T_2 ($F_{(3, 57)} = 1.54$, $p = 0.215$), and T_4 ($Chi^2 = 3.05$, $p = 0.384$). Analysis of T_3 ($Chi^2 = 12.37$) showed a statistically significant difference ($p = 0.006$), whereas post-hoc analysis found a statistically significant difference between C_K and R_T_3 ($p \leq 0.05$).

Table 1 Means, standard deviations, medians, lower quartiles, and upper quartiles for the control test and subsequent research tests for each technical element.

		N	M	SD	Me	Q1	Q2
T_1	C_K [points]	20	7.70	2.32	7.50	6.50	9.00
	R_T_1 [points]	20	8.60	2.09	9.00	8.00	10.00
	R_T_2 [points]	20	8.05	1.88	8.00	7.00	9.00
	R_T_3 [points]	20	8.45	2.06	9.00	8.00	9.50
T_2	C_K [points]	20	9.10	2.88	9.00	7.50	11.00
	R_T_1 [points]	20	10.60	2.78	11.00	8.50	13.00
	R_T_2 [points]	20	9.70	3.60	9.50	7.50	12.00
	R_T_3 [points]	20	9.50	3.78	10.00	7.50	12.50
T_3	C_K [points]	20	7.45	2.48	8.00	6.00	9.00
	R_T_1 [points]	20	8.05	1.47	8.50	7.00	9.00
	R_T_2 [points]	20	8.50	2.37	9.50	7.00	10.00
	R_T_3 [points]	20	9.10*	1.89	9.00	7.50	10.50
T_4	C_K [points]	20	9.35	4.08	8.50	6.00	12.00
	R_T_1 [points]	20	8.80	3.37	8.00	6.00	11.50
	R_T_2 [points]	20	9.30	3.74	10.00	7.50	11.00
	R_T_3 [points]	20	10.00	2.75	9.00	8.00	11.50

* = statistically significant difference compared to the control test ($p \leq 0.05$).

Discussion:

The aim of the present study was to evaluate the impact of repeated short-term physical exercise on the level of selected technical skills in adolescent volleyball players. The study found no significant changes induced by physical exercise in the measurements of overhand serve, reception using a forearm pass, and one-hand spike. In the assessment of individual tests of setting the ball using an overhead pass, an improvement of the results was observed between the control test and the third test.

A review of the studies on the impact of physical exercises on motor tasks performed by the player reveals a varied approach to the parameters studied. Similar to our study, many publications on other sports presented analyses of the performance of individual elements (Ferraz, Van Den Tillaar, & Marques, 2012; Machnacz, Dudkowski, & Rokita, 2009, Rampinini et al, 2009, Rampinini, Impellizzeri, Castagna, Coutts, & Wisløff, 2009). Studies of soccer players found that sport-specific physical exercise can lead to a decrease in the efficiency of short passes (Rampini et al., 2009, 2008) and partially negatively affect the ball speed after kicking (Ferraz et. al. 2012). Furthermore, female handball players have been shown to increase their average number of passes and grabs after sport-specific short-term exercise (Machnacz et al., 2009). In other studies, the authors have extended the scope of the analysis by including the technique used to perform individual elements (Royal et al., 2006). A study of water polo players showed that increasing physical exercise does not alter the accuracy and speed of throws but it leads to poorer technical performance (Royal et al., 2006).

Sport-specific physical exercise and its impact on motor activities performed in volleyball is an issue that has so far received little attention in the available literature. When analyzing the results of the research presented in this paper, it is worth mentioning the study that examined the accuracy of the serves of young volleyball players both after rest and following a short-term sport-specific exercise (Lidor et. al., 2007). Our study not only confirmed the conclusions of that study about the lack of differences in the effectiveness of serves under varying conditions but also showed that this tendency can also be observed for other technical elements. Other studies on exercise which have not directly addressed technical elements but focused on factors that may affect their performance also seem to be important. Studies have shown that in players of team sports, the increase in exercise intensity does not adversely affect the level of coincidence anticipation, which may make it easier for them to maintain the quality of motor activities for longer periods of time. (Niechwiej-Szwedo et al., 2012). It seems worth emphasizing that in this case, the authors employed a universal exercise test performed on a cycle ergometer. In our study, in order to more accurately reflect the exercise performed during a volleyball game, we decided to use a test containing elements of targeted and special fitness (Grządziel & Macura n.d.). Similar components of fitness were also included in a test developed by previous authors to assess the ability of professional volleyball players to perform repeated physical exercise (Sheppard et al., 2007).

As shown in the reviewed studies, different authors have chosen to use different research methods in their analyses. However, it seems that in order to accurately analyze the impact of repeated short-term physical exercise on the effectiveness of technical elements in volleyball, it is necessary to ensure the conditions in which the impact of other factors not considered in the analysis is limited. Although the research conducted during the game allows for relating the results to the actions performed in real sports competition settings, the athlete may also be exposed to other factors such as stress (Moreira et. al., 2013) or mental fatigue (Coimbra, 2021), which may affect his or her performance. Furthermore, it is also important to keep in mind the tactical actions of the player or a team and countermeasures used by the opponents, which, if not taken into consideration, can distort the results and interfere with a reliable assessment (Mazur, 2017).

Conclusions:

No negative impact of repeated short-term physical exercise on the effectiveness of basic technical elements was observed in the present study in adolescent volleyball players. During the measurement of the setting the ball using an overhead pass, there was even a statistically significant increase in the number of points scored between the control test and the last research test. This indicates that in adolescent volleyball players, repeated short-term physical exercise does not negatively affect the effectiveness of technical elements. The research presented here was intended to fill a gap in the available literature and draw attention to the need to study various phenomena that may affect the sports performance of volleyball players. Certainly, the results cannot guarantee similar trends in other study participants and the use of modified research methods. As the sports skill level in the group studied increased, more advanced parameters could be included in the technical elements, such as the interaction of two or three players in the reception, the use of specialized radars to assess setting in different directions, the inclusion of the pace of the setting the ball in the analysis of the attack, and, depending on the type of serve, using speedometers to determine the expected speed ranges for the ball. Perhaps a larger group of participants could allow for a comparison of results for the elements studied between players specialized in playing in different positions. It would also be worthwhile to examine a female group or to compare results in groups with different training experience. This would help draw further interesting conclusions and provide information on how much the performance of technical elements following sport-specific physical exercise is affected by the player's fitness and on the importance of the characteristics of the volleyball itself.

Practical applications:

The results of the study demonstrated that the sport-specific physical exercise undertaken during the volleyball game is not a factor in decreased effectiveness of individual technical elements in volleyball. The research presented here can be replicated under almost any training conditions without the use of special equipment, which may allow coaches to conduct tests on their groups of players. Coaches, based on the knowledge that short-term physical exercise is not a factor in decreasing the effectiveness of technical elements,

should focus more on other elements of the game that may interfere with the ability to maintain the player's performance throughout the game. The right approach may be to include the choice of more difficult and challenging forms of performing technical elements, such as more risky directions of attack and serve, both in conditions after rest and following physical exercise.

Conflicts of interest. Author declares no conflict of interest.

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