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Латентна структура прецизности младих одбојкашица процијењена у условима теренског тестирања

Latent structure of precision of young female volleyball players assessed in field testing conditions

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Abstract

On a sample of 73 young female volleyball players, 14 to 18 years of age, 11 motor tests were used to establish the latent structure of precision in volleyball. Specific tasks (tests) consisted of basic elements in volleyball: playing the ball with the fingers and 'bump', spike and specific moves on the volleyball court. Precision of playing the ball in the horizontal and in the vertical plane, agility, dexterity, and the level of coordination while taking part in situational tasks on the volleyball court have been assessed. By using the factor analysis (the model of the key components), five latent dimensions were chosen, which were structured as follows: (F1) the factor of the precision of shooting a target in horizontal and vertical planes, with fingers, with the values of coefficients 0.71 and 0.77, (F2) factors of precision of shooting at a target with a 'bump', with the values of coefficients 0.82, -0.42 and 0.71, (F3) the factor of changing velocity and direction, -0.71 and -0.59, (F4) the factor of motor manipulation with arms and legs 0.84 and -0.81 and (F5) the factor of coordination in the volleyball court, with the values of coefficients 0.71 and 0.80. It has been established that there is a link between the selected motoric tests and the precision of female volleyball players, within the given terms.

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Кључне речи:
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На узорку од 73 младе одбојкашице узраста од 14 до 18 година примијењено је 11 моторичких тестова, са циљем да се утврди латентна структура одбојкашке прецизности. Специфични задаци кретања (тестови) садржали су основне елементе одбојкашке игре: одигравање лопте прстима и „чекићем", смечирање лопте и специфичне кретње на одбојкашком терену. Процјењене су хоризонтална и вертикална прецизност одигравања лопте, агилност, спретност и ниво координације при извођењу ситуационих задатака на одбојкашком терену. Примјеном факторске анализе (модел главних компоненти) издвојено је пет латентних димензија које су сатуриране на сљедећи начин: (Ф1) фактори прецизности погађања циљева у хоризонталној и вертикалној равни прстима са вриједностима коефицијената 0,71 и 0,77, (Ф2) „чекићем", са вриједностима коефицијената 0,82, -0,42 и 0,71, (Ф3) фактор промјене и брзине и смјера креатања -0,71 и -0,59, (Ф4) фактор манипулације рукама и ногама 0,84 и -0,81, те (Ф5) фактор координације у простору одбојкашког терена, са вриједностима коефицијената 0,71 и 0,80. Утврђено је да постоји повезаност одабраних моторичких тестова и прецизности одбојкашица у задатим условима.

Introduction

Precision is considered a relevant factor of success in many sports. Experts agree that in the context of competitive sports precision manifests itself in two ways: precision of aiming and precision of shooting, but it is defined in different ways. Metikoš, Prot, Hofman, Pintar & Oreb [1] describe precision as the most controversial motor characteristic. According to them, in a sports competition precision is 'visible' to any observer, and according to the researches of anthropological dimensions it is completely elusive. The illusion of '(in) visibility' of precision is noticeable in results of well-designed and carefully carried out studies. This is a reason and a basis for the assumption that precision does not exist as stand-alone factor, but rather that the results in aiming and hitting targets are the consequence of interaction of a number of different factors, as stated by many authors.

Taking into account these views, research in the area of precision in volleyball is quite limited [2, 3, 4, 5, 6, 7, 8, 9]. This study is aiming at exploring and examining precision in volleyball at 14 to 18 years old female players. By using adequate instruments for measuring specific motorics, we aim to examine any manifestation and level of precision in young volleyball players within technical-tactical structure of volleyball. The aim of this research is exploration of the latent, respectively, factorial structure of test for assessing precision in young female volleyball players in field testing conditions.

Research method

The sample

The sample consisted of 73 young female volleyball players, members of volleyball teams from the borough of Banja Luka. They were 14 to 18 years of age, with a minimum of three years of playing volleyball. It is about sample with an average body height BH = 176 cm, body weight BW = 61.2 kg and BMI = 21.7 kg/m². Young volleyball players actively participate in the realization of training, for all respondents plan envisages a load of 5 training sessions per week, with a total length of a training lasting in average 90–120 minutes. All of them underwent medical examination and they are healthy.

Motor tests sample

Eleven motor tests were used to assess the following potential factors: precision of shooting targets in the horizontal and vertical plane, body coordination on the volleyball court, precision of spike techniques, muscular and nervous reactions.

1. Shooting the horizontal target with fingers (PRHOR)

The aim: To measure a shooting with fingers at a target that is horizontally placed.

Task: A volleyball player stands in volleyball stance upright in relation to the target at a distance of 3 m, takes the ball, tosses it and with fingers tries to shoot the middle of the ring.

Final score: Sum of the total number of points in 10 attempts.

2. Shooting the horizontal target with 'bump' (ČEHOR)

The aim: To measure a shooting with 'bump' at a target that is horizontally placed.

Task: A volleyball player stands in volleyball stance upright in relation to the target at a distance of 3 m, takes the ball, tosses it and with 'bump' tries to shoot the middle of the ring.

Final score: Sum of the total number of points in 10 attempts.

3. Shooting the vertical target with fingers (PRVER)

The aim: To measure a shooting with fingers at a target that is vertically placed.

Task: A volleyball player stands in volleyball stance upright in relation to the target at a distance of 3 m, takes the ball, tosses it and with fingers tries to shoot the middle of the ring.

Final score: Sum of the total number of points in 10 attempts.

4. Shooting the vertical target with 'bump' (ČEVER)

The aim: To measure a shooting with 'bump' of a target that is vertically placed. *Task:* A volleyball player stands in volleyball stance upright in relation to the target at a distance of 3 m, takes the ball, tosses it and with 'bump' tries to shoot the middle of the ring.

Final score: Sum of the total number of points in 10 attempts.

5. Shooting the target in the horizontal plane from position 2 (ČEPOZ2)

The aim: To measure a shooting with 'bump' at a target that is horizontally placed in position 2.

Task: A volleyball player stands in volleyball stance in position 6, 1 m behind the line of attack. A horizontal target is set in the middle of position 2 (1.5 m from the net and the right side of the lateral line). The feeder is in the middle of position 1 (3 m behind the line of attack, and the right side of the lateral the line). The feeder throws the ball in the direction of the receiver who tries to shoot with 'bump' at the target in position 2.

Final score: Sum of the total number of points in 10 attempts.

6. Shooting the horizontal target with spike technique (SMEČ)

The aim: To measure a shooting with a spike from the jump at a target that is horizontally placed.

Task: A volleyball player stops behind the line of attack in the middle position 4. The target is in the second part of the field of the size of 3 x 3 m and is marked in the middle of the court. In the middle of the target is drawn a square (size 1 x 1 m). A volleyball player takes the ball out of the basket, tosses it and shoots at target with spike from the jump.

Final score: Sum of the total number of points in 10 attempts.

7. One-hand juggling a ball through a hoop (ŽONG)

The aim: To measure a skill of shooting at a target.

Task: A volleyball player stands in volleyball stance below the target, tosses the ball with one hand, strikes with the fist (or with a taut palm) and tries to shoot the frame of the hoop. When the ball passes through the hoop or around the hoop, the player tries with the other hand to shoot the frame. Time for test performance is 20 seconds. If the subject accidentally drops a ball, she takes another ball and continues the task.

Final score: Sum of the total number of hits.

8. Coordination by the volleyball net test (KOOMRE)

The aim: To measure a coordination ability of a volleyball player.

Task: A volleyball player stands in volleyball stance in front of the net. She jumps and raises her hands to block (in jump the fists are raised above the upper edge of the net), lands and does a collet to the back, on the line of attack, she lays on her stomach, with the technique of rolling turned to 360° back to stomach, then turns to the net, and jumps to spike to hit the ball with the fist that the assistant keeps over the net. The stopwatch is turned off when the volleyball player hits the ball that the assistant keeps over the net.

Final score: To the achieved time one second is added for each mistake made (touch of net in the block, spike, awkward coasting and rolling).

9. Coordination in space test (KOOPRO)

The aim: To measure a coordination ability of a volleyball player.

Task: A volleyball player is in volleyball stance position in front the left line of the square. She jumps three times by this line to come to the next line, with three jumps with right and left foot, runs across the line so that with the right foot she reflects to the right and with the left foot to the left side of the line. With the coming to the end of the second line, she turns back and with 6 jumps back comes to the third line, and then, with 3 cross steps she passes over the fourth line.

Final score: To the achieved time one second is added for each mistake made (bigger or smaller number of jumps, rough distortion of direction in relation to the line).

10. Hexagon test (HEKS)

The aim: To measure a coordination ability and agility of a volleyball player.

Task: A volleyball player stands in volleyball stance in the middle of a hexagon and is turned with face toward to the line A during a skipping over all lines. Then she jumps out over B, and goes back to the middle. So she skips all lines in the order: C, D, E, F, A. The volleyball player must make three rounds, and then the stopwatch stops.

Final score: The best achieved time in three attempts is taken.

11. Falling rod test (REFL)

The aim: To measure a reaction time.

Task: A subject sits near the table so that she can put her elbow and forearm comfortably on the table. The rest of the arms should remain on the table so that only the fingers and thumbs are outside of the edge on the table. An assistant holds a measuring stick which is set vertically, and the 25th notch is set between his forefinger and a thumb. The assistant holds the beginning of the rod (length 1 cm). No part of fists should touch the measuring stick. Without warning, the assistant drops the stick, and the subject has to catch it with her forefinger and thumb. The result is the number of centimeters that is read out on the measuring stick, just above the thumb and forefinger after the capture.

Grade	Reaction time
excellent	over 22
very good	19–21
good	16–18
satisfactory	13–15
bad	under 12

The chosen tests were also used, with minor modifications made by Strahonja [10], Strahonja, Janković & Šnajder [11], Bartlett, Smith, Davis & Peel [12] and Marelić, Đurković & Rešetar [13].

Statistical analysis

Methods of descriptive statistics and factor analysis (Varimax method) were used to process the obtained data. The structure of motor precision was determined by using Hotelling's method of principal components. The number of main components was determined by using Gutman-Kraiser's criteria.

Results and discussion

Table 1 shows values of the characteristic roots (Eigenvalue). Based on these values, five main components were isolated, which explain **67.64%** of the common variance (total variance %) for the entire female volleyball players sample.

Table 1. Values of the characteristic roots and extraction of the main components

Eigenvalues Extraction: Principal components				
	Eigenvalue	% Total Variance	Cumulative	Cumulative %
F1	2.01	18.29	2.01	18.29
F2	1.60	14.63	3.62	32.92
F3	1.50	13.75	5.13	46.68
F4	1.22	11.11	6.35	57.80
F5	1.08	9.84	7.44	**67.64**

Table 2 shows the structure of the volleyball player's precision, so the correlation of the motor tasks used, with five main components that were defined as the factors within this research. By using the hierarchy of the isolated factors and the degree of Total Variance, and the Eigenvalue, the first factor (F1) is defined as shooting targets with the fingers. The second factor (F2) is defined as the precision of shooting targets with the 'bump'[1]. The third factor (F3) is defined as changing of speed and direction of movement. The fourth factor (F4) is defined as the factor of motor manipulation with arms and legs, and the fifth factor (F5), which explains the lowest part of total variability, is described as body coordination on the volleyball court. Factor values that have the highest influence within five defined factors have been marked.

According to the data collected, the precision factor in shooting target with fingers (F1) is most influenced and correlated with the motor tests of shooting the horizontal target with fingers (PRHOR), shooting vertical target with fingers (PRVER) and shooting horizontal target in position 2 (ČEPOZ2). The precision of shooting the horizontal target with fingers came up as the factor that describes a group of motor tests within which the precision of setting a ball in three different ways: with fingers, 'bump' and spike. In line with this, the components, which define the first factor, are statistical conditions to carry out the tests, the high level of concentration, adequate strength for carrying out a specific movement, and a good perception of movement form, distance of the aim, and timing.

Table 2. Factor structure of precision by female volleyball players – Varimax method

Factor Loadings (Varimax normalized) Extraction: Principal components					
	F1	F2	F3	F4	F5
PRHOR	**0.71**	0.00	-0.14	0.11	-0.37
ČEHOR	-0.16	**0.82**	0.08	-0.01	0.09
PRVER	**0.77**	0.11	0.10	0.07	0.01
ČEVER	0.22	**-0.42**	0.27	0.15	0.41
ČEPOZ2	**0.71**	0.41	0.00	0.01	0.07
SMEČ	0.09	-0.29	**-0.71**	-0.11	0.02
ŽONG	-0.09	-0.11	0.03	**0.84**	-0.06
KOOMRE	-0.16	0.27	0.16	0.05	**-0.80**
KOOPRO	-0.11	0.39	0.18	0.02	**0.71**
HEKS	0.13	0.24	**-0.59**	0.22	0.36
REFL	-0.12	0.15	-0.09	**-0.81**	0.07

The tests, which contribute to this, the first factor (F1), are highly correlated with it, and it can be concluded that the volleyball players found these tasks easier to carry out. Normally the technique of passing the ball with fingers is a technique in which the whole body is used, and the movement ends with 'arm/hand action'. Within these tests, the volleyball players have demonstrated excellent perception of the ball, taking into account that sight is of crucial importance to precision. They have also demonstrated high cognitive ability, concentration, emotional stability while carrying out the tasks, as well as a high level of ball control.

The second factor of precision of shooting the target with a 'bump' (F2) is most influenced by the motor test of shooting the horizontal target with a 'bump' technique (ČEHOR),

1 Professional term used for playing a ball with forearm in volleyball.

while the least influence on the second factor is exerted by the test of hitting the vertical target with the 'bump' technique (ČEVER). The high correlation value shows that while hitting the target by using a specific technique (the 'bump' technique), the volleyball players had high concentration, that they used the appropriate level of power for certain movements (forming the 'bump'), that they appropriately evaluated the differences in terms of the form and distance of the target, and that they appropriately judged the timing. The statistic conditions were also beneficial. A slightly lower level of correlation was found in the test of hitting the vertical target with a 'bump' (ČEVER), which can be explained either by the reduced level of concentration during the task, or by the fact that the target was placed vertically, as a circumstance that made the task more difficult.

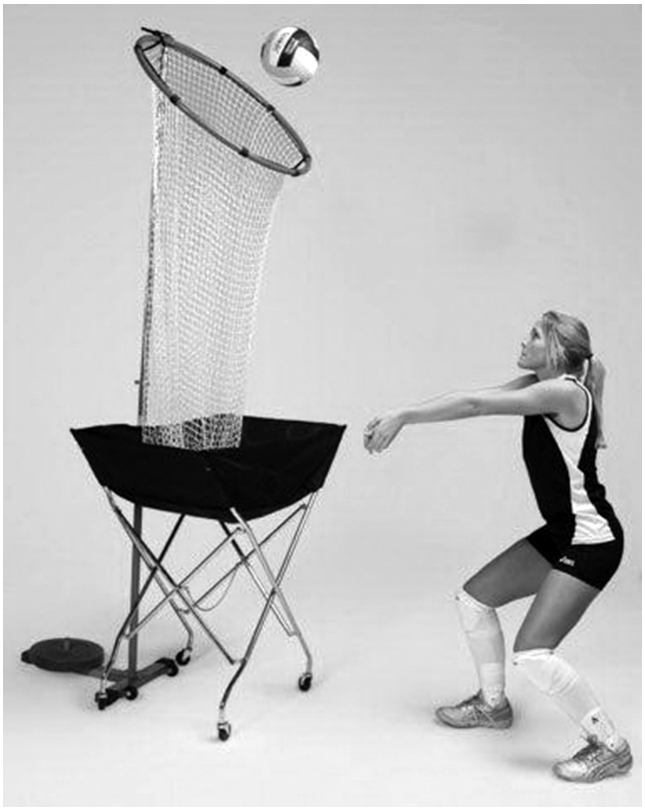

Figure 1. Precision of hitting the target with the 'bump' (source: www.pinterest.com)

The third factor (F3) is most influenced by motor tests of hitting the horizontal target by 'spike jump' (SMEČ) and the hexagon test (HEKS). These tests were marked by several factors. First of all, the coordination of upper and lower extremities, dynamic balance, strength, speed, endurance, stability of locomotor system, range of movement in joints, and optimal biometric movement structures [14]. Within these two tests, two forms of agility are present. The so-called horizontal-vertical agility dominates in the test that uses the 'spike' technique, while the hexagon test reflects the combination of frontal and lateral agility. Tests for factor 3 (F3) are specific in term of the conditions under which these tests were performed. The test of hitting the horizontal target by 'spike jump' was done in simulated competition conditions, incorporating body movement, with the main goal of fast movement through space, during the test. The test of hitting the horizontal target by 'spike jump' while jumping is characterized by explosive power and rapid singular movement. The second test, hexagon test that was done under typical training conditions, of moving the body with the aim of achieving the highest possible movement frequency. These facts partly explain the difference in the coefficients found, and their separate effect on factor 3 (F3). What links these three tasks within the second isolated factor is the movement coordination, especially of the arms, kinesthesia and timing.

The strongest effect on factor 4 (F4) was shown in the tests of single-handed juggling of the ball through a hoop (ŽONG) and the test measuring reaction times the falling stick test (REFL). Considering that the values of the coefficient are showing a significant contribution of the tests to this factor, during the tests what stood out were psycho-motor skills, emotional stability, and also the interaction of speed and neuro-muscular reaction. Psycho-motor skills can be divided into general and specific skills. The general psycho-motor skills consist of performance of wider muscle groups and the whole body, while specific psycho-motor skills are defined as skills of manipulation, precision and speed - that all concentrate on extremities and smaller muscles. So undoubtedly, the success in these two tests was influenced by factors such as upper extremities coordination, the precision

of handling the props, orientation during reactions, speed of reactions, arm skills and speed, finger skills, and steadiness of the arms.

Figure 2. Precision of hitting the target with the fingers (source: www.pinterest.com)

The test of coordination at the net (KOOMRE) and space coordination (KOOPRO) stood out as tests which describe factor of body coordination on the volleyball field (F5). The coefficient values show very high correlation between the volleyball players' coordination skills and their performance in the given tasks. Related to this we can also talk about a direct connection with the effective usage of other motor skills of the volleyball players – systematic training, intelligence, motor skills experience, the level of development in other motor skills. Structure of this motoric skill has been extensively researched [15, 16, 17], based on which it has been concluded that coordination is also influenced by rhythmic abilities, balance, reactive skills, abilities in kinetic differentiation, orientation, adequacy of movements, synchronization and timing of movements. All this confirms the facts and findings of this research, and shows that coordination is multidimensional, as it requires complex activities.

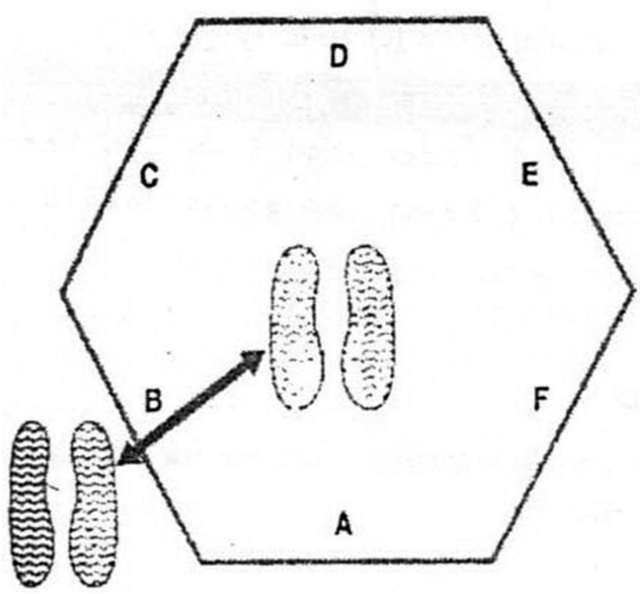

Figure 3. Change of direction and moving (source: completesoccertraining.blogspot.com)

Conclusion

The results confirm the following: there are certain manifestations within the examined area of precision. The structure of the motoric precision skill of 14 to 18 years old female volleyball players is influenced by factors of hitting the target with fingers and 'bump' in horizontal and vertical plane. Milić, Murić and Radenković came to the similar conclusion [18]; in their research, they stated that speed, coordination and flexibility affect volleyball precision. The factor of coordination within the volleyball court and the factor of neuro-muscular reactions are also important. The study [19], which also confirms the above, was conducted on a sample of female volleyball players. It was determined that there is a statistically significant influence of coordination skills on the precision of passing the ball with the 'bump', where the common variance of coordination and precision of forearm passing is moderately high.

Therefore, the motoric skill of precision can be viewed as an individual phenomenon, and can be considered a factor, which influences success, rates in given technical and tactical structures of volleyball, chosen for this research

[2, 3, 4, 6, 8, 9, 10, 11]. Namely, in the structure of technical and tactical elements operate particular types of precision volleyball players [2, 6, 8] who can be defined as factors of precision and these can be defined as the factors of precision in setting the ball with fingers, a 'bump' technique, and a spike technique.

Not much research has been done on factor structure of precision regarding carrying out technical and tactical elements of volleyball. If you take into account Metikoš et al.'s view [1] which describes precision as the most controversial motoric characteristic, 'invisible' in sports competitions and 'indecipherable' for the researches of anthropological dimensions, the lack of courage to examine this skill in different ways is easier to understand. It is believed that in time and by using the factor analysis approach within this research of anthropological area, more data will be collected which would confirm that there are a number of factors and their higher or lower effects on precision. This opens new questions related not just to the primary and secondary factors influencing precision, but also manifestations of other motor abilities, and especially a question of their mutual relations.

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