THE INFLUENCE OF COORDINATION ABILITIES ON THE PRECISION OF FOREARM PASSING IN VOLLEYBALL

Original research article

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Abstract:

Scoring points in volleyball is possible if the plays are performed precisely, and in accordance with the characteristics of the set goals and tasks, which could be performed on all three planes. That is why volleyball precision is characterized as a very delicate feature, for which one needs to possess a good kinesthetic sense, a good evaluation of the parameters of the goal, movement control and coordination. Therein lies the subject matter of this paper, which refers to the evaluation of the influence of coordination on the precision of forearm passing in volleyball, as a significant factor of effectiveness in the game of volleyball. 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. The hypotheses in this research were confirmed, and the motor skill of precision can be isolated as a special phenomenon and interpreted as a factor of success in the technical-tactical structures of volleyball.

Keywords: *precision, coordination, volleyball.*

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INTRODUCTION

Precision is a motor skill, which requires that a certain target needs to be hit by a thrown or guided object. In sports practice there are three kinds of precision: precision of hitting the target, precision in aiming and precision in aiming-hitting the target (Nićin, 2000; Pržulj, 2000; Herodek, 2006). For volleyball practice, what is significant is the special volleyball precision of aiming-throwing, since volleyball players first solve the problems of hitting the ball, and as a consequence, hitting the volleyball targets. The way that the ball is hit in volleyball is specific, since the actions which are used on the ball differ, depending on the kind of action, whether the ball is being acted upon with one's fingers, palms, fists, upperarms, forearm or forearms (Stojanović et al., 2010). Scoring points in volleyball is possible if the actions are performed correctly (precisely) based on the characteristics of the set goals and tasks which could be performed on three planes: the horizontal, sagittal and vertical plane. As a result, volleyball precision is characterized as a very delicate characteristic for which one should have a good kinesthetic sense, a good evaluation of the parameter goals, movement control and coordination. Thus, there is an entire sequence of factors which function as a closed circle. It is enough for one disruptive factor to emerge for the results to change significantly (Stojanović et al., 2005). In relation to precision in volleyball, the issue of the special nature of volleyball precision arose. Precision was identified in manifest and latent anthropomotor space as a special volleyball ability (Janković, 1988; Stojanović et al., 2005). Within precision in volleyball the following elements stand out: precision of setting and passing using fingers, precision in setting and passing using forearms, precision in serving and precision in spiking (Bosnar and Šnajder, 1983; Drabik, 1996). Coordination as a motor skill is one of the least studied skills, and at the same time one of the most important skills on which the success in a certain sports discipline depends, along with the entire psychosomatic development of a child. In each sport it is directly related to technique and tactic. Accordingly, the higher the level of coordination, the better the athlete is adapted to training and competitive requirements. Sports games, which abound in technical and tactical elements, require a high level of this ability. It is very important to recognize the significance of this motor skill and to include exercises for its development from the very start, since that is how the development of young athletes can significantly be facilitated, and the basis for further improvement be established. Irrespective of the level of inherited coordination, we cannot expect constant progress if special attention is not paid to this ability (Karalić, 2010). Many studies have focused on coordination (Drabik, 1996; Hošek, 1976, 1981; Metikoš et al., 2003, Neljak and Višković, 2004) which show that coordination consists of the following components: rhythm, balance, reaction, kinesthetic differentiation, orientation in space, movement adequacy and synchronization of movement in time. A well-coordinated athlete always acquires a new skill quickly and is able to perform it properly. An athlete with better coordination than another athlete uses less energy for the performance of the same movement (Bompa, 2000). Coordination is affected by several factors: the intelligence of the athlete, systematic training, motor experience, as well as the level of development of other motor skills (Drabik, 1996). Compared to training and improvement in volleyball technique, the development of coordination skills is promoted as a fundamental part of the exercise of volleyball players (Tomić and Nemec, 2002). The basic aim of this transversal research is the study of the influence of the predictor system of specific

coordination skills on the precision of forearm passing in volleyball. In relation to the set goals, the basic assumption is that the specific coordination skills of the participants will significantly contribute to the prediction of the results of forearm passing in volleyball.

MATERIALS AND METHODS

The sample of participants

The sample of participants consisted of a total of 37 female volleyball players, all members of the cadet team of the *As* volleyball club from Niš. The age of the participants in the sample ranged from 14 to 16, and they had all been involved in the training process between 4 and 6 years. The measuring was carried out in a volleyball camp in Vlasina in 2009.

The sample of measuring instruments

Considering the subject matter and the aim of the study, measuring instruments were used for the evaluation of the following hypothetical factors: precision in hitting the target on the horizontal plane, precision in hitting the target on the vertical plane, arm coordination, leg and body coordination on the volleyball court. The selected tests were also used by Metikoš et al. (1974), Strahonja, Janković and Šnajder (1982), Strahonja and Janković (1988), who confirmed their metric characteristics in their work. The description of the applied tests can be found in the work of Karalić (2010).

The criterion variable of precision of passing the ball in volleyball:
1. Hitting the horizontal target with forearm passing (ČEHOR)
2. Hitting the horizontal target with forearm passing in position 2 (ČEPO2)
3. Hitting the vertical target with forearm passing (ČEVER)

The predictor variables of specific coordination skills:
4. Arm coordination – Juggling the ball through a hoop with one arm (ŽONG)
5. Full body coordination – The coordination test along the net (KOMRE)
6. Leg coordination - The test of coordination in space (KOPRO)
7. Leg coordination - The hexagon test (HEKSA)

Statistical analyses

The basic aim of this study was to determine the influence of the predictor system of variables on the criterion variables, and it was thus necessary to determine the regression connection between these two systems. For that reason, the algorithm of the multiple linear regression analysis of the statistical package STATISTICA 8.0 for Windows was used. It consists of the following parameters: the vector of the correlation coefficient (R), the vector of the partial correlation coefficient (PART-R), the vector of the standardized partial regression coefficients (BETA), the extent of the regression t-test (t),

the significance of the partial regression coefficients (p-level), the multiple correlation coefficient between the criterion variable and the system of predictor variables (R^2), the determinant coefficient as the measure of the common variability between the criterion variable and the system of predictor variables, which influence the studied occurrence (DELTA), the size of the F-relation between the two systems of variables (F) and the level of significance of the F relation (p). The lower limit of significance of the correlation coefficient at the p< .05 level for the sample of the 37 female participants was .325.

RESULTS

The connection between the predictor system of specific coordination skills and precision in forearm passing on the horizontal plane (ČEHOR) (Table 1) as the criterion is statistically significant, with an explanation of the common variability between the system and the criterion variable of 26%. The remaining 73% of the explanation of the overall variability of precision of forearm passing on the horizontal plane can be ascribed to other characteristics and abilities of the participants, as well as the conditions during the testing time and so on. These results give a statistically significant explanation of the criterion variable using the system of specific coordination abilities (p<.041), so we could conclude that the entire predictor system has a statistically significant influence on the precision of forearm passing on the horizontal plane. A more detailed analysis of the numerical values of the partial regression coefficients of individual predictor variables clearly indicates that arm coordination is responsible for the prediction of the results for the precision of forearm passing on the horizontal plane (ŽONG), while the values of the partial regression coefficients of the other predictor variables are not significant for the prediction of the results of the criterion variable. The partialization of the correlation resulted in only one significant partial correlation between the criterion and the predictor system (arm coordination), while the other partial correlations are below the threshold of significance. The direct correlations are at the mid-level of significance, and the greatest direct correlation (R) was determined for arm coordination, while the other direct correlations were not significant. From the aforementioned we can determine that better results on the test for forearm passing on the horizontal plane can be determined for those participants who have better arm coordination.

Table 1. *The regression of the criterion variable of hitting the horizontal target with forearm passing (ČEHOR)*

Variable	R	Part-R	Beta	Std. Err. of Beta	t (32)	p-level
ŽONG	**-.41**	**-.49**	-.500	.159	-3.14	**.004***
KOMRE	.02	.17	.168	.173	.97	.340
KOPRO	.09	.19	.187	.170	1.10	.279
HEKSA	.15	.27	.251	.157	1.60	.119
Delta= .511 **R^2=** .261 **F**(4,32)=2.83 **p< .041***						

Legend: **R=***correlation coefficient;* **Part-R=** *partial correlation coefficient;* **Beta**= *partial regression coefficient;* **St. Error of B**= *standard error of the partial regression coefficient;* **t**= *the value of the Beta test coefficient;* **P-level=***the significant of the Beta coef-*

ficient; **Delta =** *the coefficient of the multiple correlation between the criterion variable and the system of predictor variables;* **R^2=** *the determinant coefficient;* **F=** *the extent of the F test;* **p=** *the significance of the F test.*

The connection between the overall predictor system of specific coordination skills and the precision of forearm passing on the horizontal plane in position 2 (ČEPO2) (Table 2) as the criterion is statistically significant, with an explanation of the common variability between the system and the criterion variable of 31%. The remaining 69% in the explanation of the overall variability of precision in forearm passing on the horizontal plane in position 2 can be ascribed to other characteristics and abilities of the participants, as well as the conditions during testing time and so on. These results offer a statistically significant explanation of the criterion variable with the help of the system of specific coordination skills ($p<.016$), so we can conclude that the entire predictor system has a statistically significant influence on the precision of forearm passing on the horizontal plane in position 2. A more detailed analysis of the numerical values of the partial regression coefficients of certain predictor variables clearly indicates that, for the prediction of the results in the precision of forearm passing on the horizontal plane in position 2, arm coordination (ŽONG) and space coordination (KOPRO) are the most significant, while the values of the partial regression coefficients of the remaining predictor variables are not significant for the prediction of the results of the criterion variable, although they are on the verge of statistical significance. The partialization of the correlation helped determine three significant partial correlation criteria with the predictor system. The statistically significant coefficient of the partial correlation (Part-R) can be determined for arm coordination in space and leg coordination, while the partial correlation for whole body coordination was below the threshold of significance. All the direct correlations are below the level of significance. What stems from the aforementioned is that better results on the test of forearm passing on the horizontal plane in position 2 will be scored by those participants who have better arm coordination and spatial coordination.

Table 2. The regression of the criterion variable of hitting the horizontal target with forearm passing in position 2 (ČEPO2)

Variable	R	Part-R	Beta	Std. Err. of Beta	t (32)	p-level
ŽONG	-0.30	**-0.45**	-0.434	0.154	-2.82	**0.008***
KOMRE	0.12	0.32	0.323	0.167	1.93	0.063
KOPRO	0.20	**0.37**	0.370	0.164	2.26	**0.031***
HEKSA	0.23	**0.34**	0.306	0.151	2.02	0.052
Delta= .557 **R^2=** .312 **F**(4,32)=3.61 **p< .016***						

Legend: **R=***correlation coefficient;* **Part-R=** *partial correlation coefficient;* **Beta**= *partial regression coefficient;* **St. Error of B**= *standard error of the partial regression coefficient;* **t**= *the value of the Beta test coefficient;* **P-level=***the significant of the Beta coefficient;* **Delta =** *the coefficient of the multiple correlation between the criterion variable and the system of predictor variables;* **R^2=** *the determinant coefficient;* **F=** *the extent of the F test;* **p=** *the significance of the F test.*

The connection between the overall predictor system of specific coordination skills and the precision of forearm passing on the vertical plane (ČEVER) (Table 3) as the criterion is not statistically significant, since the common variability of the predictor system and the criterion variable is only 14%. These results do not offer a statistically significant explanation of the criterion variable with the help of the system of specific coordination skills (p<.276), so we can conclude that the entire predictor system does not have a statistically significant influence on the precision of forearm passing on the vertical plane. A more detailed analysis of the numerical values of the partial regression coefficients of individual predictor variables clearly indicates that none of the predictor variables have a statistically significant influence on the criterion variable. The partial and direct correlations also do not have a statistical significance. From the aforementioned, we can conclude that the system of predictor variables of specific coordination skills cannot be used to predict the results for the precision of forearm passing on the vertical plane.

Table 3. The regression of the criterion variable of hitting the vertical target with forearm passing (ČEVER)

Variable	R	Part-R	Beta	Std. Err. of Beta	t (32)	p-level
ŽONG	-0.16	-0.26	-0.267	0.172	-1.55	0.130
KOMRE	0.14	0.19	0.199	0.187	1.06	0.295
KOPRO	-0.00	0.10	0.105	0.183	0.57	0.571
HEKSA	0.25	0.29	0.294	0.169	1.74	0.091
Delta= .379 **R²**= .144 **F**(4,32)=1.34 **p**< .276						

Legend: **R=***correlation coefficient;* **Part-R=** *partial correlation coefficient;* **Beta**= *partial regression coefficient;* **St. Error of B**= *standard error of the partial regression coefficient;* **t**= *the value of the Beta test coefficient;* **P-level=***the significant of the Beta coefficient;* **Delta =** *the coefficient of the multiple correlation between the criterion variable and the system of predictor variables;* **R²=** *the determinant coefficient;* **F=** *the extent of the F test;* **p=** *the significance of the F test.*

DISCUSSION

We can conclude that in the field of motor space of the individual, the space of precision is the least studied segment. This occurrence is probably related to the characteristics of the motor tasks of precision, which, among other things, require the finest regulation of movement during the act of hitting the perceived target (Herodek, 2006). This is also a reason why tasks of this type create a significant amount of interference, and this makes a significant contribution to determining their position in the multivariate space of the psychosomatic status of volleyball players. The disruptive factors also include the amount of smoke in the room, stress, one's emotional state, poor concentration and so on. Even though the existence of the dimension of motor precision has experimentally not been confirmed and the concept of precision has not been verified at a satisfactory level, it appears relatively early on in the relevant literature as an aspect of coordination, and at the same time, as related to the neuromuscular control of movement and

motion (Herodek, 2006). The cause probably lies in the fact that there are very few constructed tests of precision, since their metric characteristics are not definitely manifested. In addition, these tests require a large number of repetitions. Because of that, they last for a long period of time, which is why they are avoided by researchers, especially if the aim of the study are dominant and subdominant extremities, since each test needs to be repeated twice. In addition, the phenomenon of the clash of extremities with the ball as the most important mechanical element in volleyball is not precisely and clearly defined. For these reasons, the classification of precision is divided into precision of hitting and precision of aiming. It cannot be considered complete in volleyball since it does not include all the aspects of precision. The characteristic of volleyball is that contact with the ball is made only for a very short period of time, that is there is a clash with the ball, irrespective of whether its direction changes or whether the ball is passed in the same or the opposite direction. In addition to the intensity of the impact and the speed of movement of the ball, the precision of passing the ball in volleyball also depends on the size of the exit angle during impact between the arm and the ball. Optimal precision in passing the ball is achieved when the exit angle is greater than 45^0, considering that such a position includes both a vertical and horizontal component to the movement of the ball, which facilitates the anticipation of the trajectory of the ball flight. Precision depends on other features of the target: size, distance and so on. The changes in precision depend on the length of the concentration, the complexity of the technical-tactical task, as well as the situation on the court (Stojanović et al., 2005). The realization of the tasks of precision of passing the ball in volleyball is very complex, since its success depends on the effectiveness of the cortex responsible for the analysis of motor skills. It depends on the ability of the center for the quick analysis of information which is obtained with the help of receptors. General motor precision, which is otherwise very difficult to define, does not have any effective transfer. Training influences only the typical precision up to a point, since there are limits. There are no individuals who achieve above-average precision in all sports motor tasks. The characteristic of performing the special act of movement ability and the appropriate physical quality of a man is referred to as precision. In order to determine precision it is important to be precise about which physical sizes are used to formulate the aim of motor tasks (Nemcev, 2003). After the analysis of obtained results we can conclude that the system of predictor variables which consists of four tests of coordination, defined by the latent space of arm coordination, full body coordination and leg coordination, has a high predictive capacity of precision of forearm passing on the horizontal plane in volleyball. The moderately high coefficients of the partial regression and the percentage of the common variance of all the criterion variables which define the precision of hitting the horizontal targets with the predictor system indicate the good choice of tests in the predictor system. If we were to view the individual responsibility of the tests of coordination for achieving results for the criterion variable, we can determine that in the space of the precision of forearm passing through arm coordination and leg coordination has a significant predictive result. In the analysis of the structure of movement and motion in the technique of forearm passing, a greater use of arms and legs in the realization of the technique is evident. The movement of the body on all the planes during the forearm passing technique is more pronounced, and thus it is understandable that the coordination requirements of forearm passing are greater. This can clearly be seen based on the values of the partial and direct coefficients of the correlation between the predictor variables and the

criteria. This confirms the fact that coordination plays a part in the realization of each movement structure, from the simplest to the most complex. The influence and significance of this ability increases with the complexity of the motor activity, and is most pronounced in situations which require quick solutions to problems at the motor level. That is why this ability is called 'motor intelligence' (Herodek, 2006). This can be the basis for the conclusion that coordination is always strongly bound to the technique involved in a particular sport, in this case, the technique and precision of forearm passing. That is why special attention should be paid to the creation of a great variety of various structures of movement which can contribute to a more complete formation of the ability of coordination, which improves the ability of precision.

CONCLUSION

In the regression analysis of the precision of forearm passing in volleyball, the statistically significant multiple correlations of all the criterion variables, which define the precision of hitting the horizontal target, and the applied system of predictor variables, were dominant. The predictor system consists of four variables for the evaluation of arm coordination, full body coordination, and leg coordination of the female volleyball players. This has confirmed that the applied system of predictor variables is connected to the results the female participants achieved in the tests of precision of forearm passing toward horizontal targets in a statistically significant manner, tests which are performed in the form of certain situational motor models. The applied system, based on the obtained results, is suitable for the prediction of all the results for the precision of forearm passing on the horizontal plane in volleyball. The results of the individual regression coefficients have indicated that the applied tests of coordination of the arms and legs in this study significantly predict the results of the tested criterion variables of precision in forearm passing, while the extent of the correlation between the criterion and whole body coordination as the predictor variable is insufficient for the more precise prediction of the criterion. Based on the obtained results, we can conclude that the female volleyball players who have better arm and leg coordination achieve better results on the tests of precision by forearm passing on the horizontal plane. Generally speaking, we can conclude that coordination as a skill has a significant influence on the manifestation of precision in forearm passing in volleyball, and the higher the extent of the acquisition of coordinated and proper movements and motion at the cadet age, the greater the precision of hitting certain targets in volleyball.

PRACTICAL APPLICATION

Knowledge of the predictive value of specific coordination skills on the achievement of results on tests of precise forearm passing in volleyball will enable coaches and teachers in volleyball clubs and volleyball sections in elementary and high schools to implement a more effective training process, especially in training specific volleyball coordination and precision in forearm passing. This will enable finding out the most optimum solutions for a more correct and effective diagnosis, prognosis, programming and

immediate realization and control of training in volleyball clubs and volleyball sections in elementary and high schools in the future. In addition, the results of this research will help researchers, who are dealing with the problems of result prediction in sports games, by serving as a basis for further studying and finding solutions to the questions that this study did not take into account. This primarily refers to the choice of predictor variables which are used to influence results in sports games, as well as the right age of the participants and the right time for their selection in sports games.

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