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Analyses of the efficiency of technique for improving the accuracy of performing power serve in jump by skilled volleyball players

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Purpose: *investigating the results of replicate experiment, in which the proposed technique for improving the accuracy of performing serve was used, and carrying out a comparative analysis the corresponding results of the current and initial experiments.*

Material & Methods: *the analysis of the video, pedagogic observations, statistical methods of processing the results.*

Results: *the replicate experiment has been carried out. The detailed analysis of the characteristics of moving ball has been performed. The approach for estimating the accuracy of the performing serve has been proposed. The estimation of statistical validity of differences between the results of the comparative analysis of the corresponding characteristics of both experiments has been performed using criteria Student and Fisher.*

Conclusions: *in the replicate experiment a reliable change of the characteristic, which is associated with the accuracy of performing power serve in jump, has been identified. Using techniques developed by the author in the practice of training process can be considered that it is effective.*

Keywords: *experiment, correlation, accuracy criterion, statistical validity, modeling characteristics.*

Introduction

Introductions of a power serve in jump and change of rules in calculation of points at its performance substantially changed the productivity and dynamic of games in modern volleyball. The analysis of statistical data of the games of the national championships of the countries of Europe, America and other greatest international competitions of volleyball showed that this serve plays the important role in the achievement of success in the competitive activity. It turned from the way of introduction of a ball in the game into the powerful mean of the attacking actions of contradictory teams that allows winning the point directly after its performance. However it should be noted also the large number of mistakes at its performance which in turn can lead to loss of scores and even to defeat of a team. Therefore one of the decisive factors of increase of the level of game of teams and achievement of success in competitions of different rank of modern volleyball is the technical -tactical improvement of a power serve in jump. In turn, the increase of efficiency of this serve in the competitive activity can be reached, paying close attention to the solution of this problem during the training process.

The technique of a power serve in jump is rather difficult and demands, first of all, knowledge of the main regularities of the movement of ball after its performance [6–8]. In our works [1; 7] the detailed analysis of different characteristics, which define the trajectory of flight of the ball is carried out, and their dependence on the corresponding kinematic variables, is studied. It was noted that studying of opportunities of improvement of accuracy of its performance is of great importance for the solution of the problem of increase of efficiency of a power serve in jump. We offered and made the corresponding experiment for this purpose (see works [2–4]).

The analysis of efficiency of the technique offered by us for the increase of accuracy of performance of a power serve in jump by the qualified volleyball players is carried out in this work. In works [2–4] the experiment was made with the group of volleyball players to whom certain tasks for the purpose of the solution of this problem were delivered. We developed practical recommendations for the increase of accuracy of this serve on the basis of results of the carried-out analysis of statistical data of the noted experiment and conclusions of the pedagogical supervision during its performance [4].

The important task is recognition of positive effect of introduction of the offered technique in practice of the training process. For this purpose, according to practice of sports researches, we offered the same group of volleyball players which consists of five people, during the certain time to use our recommendations during the corresponding trainings. Then, the repeated experiment, which scheme and details are described in works [1–4; 7], was made. 10 productive serves in performance by each volleyball player were considered unlike the noted works in the repeated experiment.

Communication of the research with scientific programs, plans, subjects. The research is executed according to the plan of the research work of the department of the Olympic and professional sport, the department of sports and outdoor games of Kharkiv state academy of physical culture. The direction of the research answers the subject of the Built plan of the research works in the sphere of physical culture and sport for 2011–2015 by the direction: “Improvement of the educational-training process in sports” (number of the

state registration No. 0111U003126) for 2016–2018 by the subject "Definitions of influence of different exercise stresses on the accuracy of performance of movements".

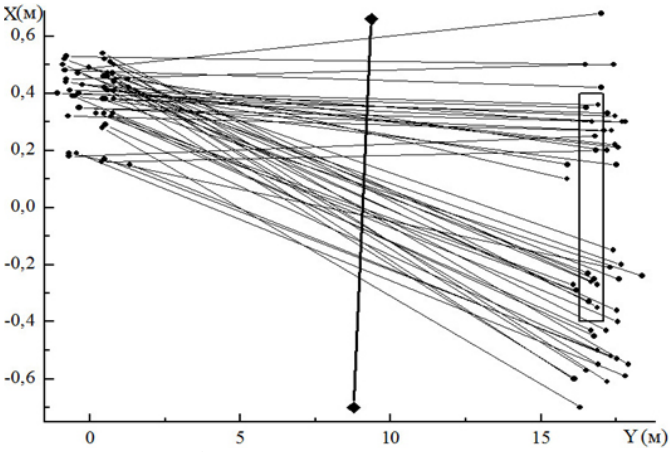
Purpose of the research: to carry out the comparative analysis of the corresponding results of the primary and repeated experiment in which the offered technique of increase of accuracy of performance of a power serve in jump was used.

Material and Methods of the research

Methods: analysis of video filming, pedagogical supervision, mathematical methods of processing of results.

Results of the research and their discussion

The relevant statistical data of the repeated experiment are submitted in pic. 1. Let's remind that the target in the form of square of 0,8 x 0,8 m in size served as the purpose in both experiments that was represented on the platform plane between 1 and 6 zones. The fragment of the central line of the platform is shown for the descriptive reasons in pic. 1. Axis Y of the Cartesian reference system, which was elected by us, crosses this line at an angle which equals about 67°.



Pic. 1. Results of the repeated experiment *(points answer the ball projection coordinates to the platform plane at the initial moment of its flight and the place of its landing)*

It is visible from the comparison of coordinates of touch-down of the ball that given on pic. 1and the corresponding drawing in the work [4], that the accuracy of performance of serves in the repeated experiment considerably improved. Lines, in pic.1, characterize the direction of flight of the ball as along these lines, its rectilinear movement to the corresponding speed happens. It should be noted that 28% of all executed serves have got precisely to the target. The direction of flight of the ball was elected by players correctly approximately in 40% of cases; however reached range of its flight didn't allow getting to target precisely. That is in this case, in the target only those serves, which direction answers with value of the angle α, had probability of hit of the ball, in the interval $0.23^{\circ} \geq \alpha \geq 3.1^{\circ}$. α – is the angle between the direction of the movement of the ball and the axis Y [4] which is defined by the corresponding coordinates of the ball in initial and final phase of its flight.

On the basis of the analysis of this experiment we defined different characteristics of flight of the ball and kinematic variables which describe trajectories of its movement. The following designations are used for them: d та R – deviation of initial coordinates of the movement of ball from reference mark of the elected system of coordinates and coordinates of the place of its landing from the target coordinate, L – range of the movement of ball, v_0 – the initial speed of its movement, θ – ball outing angle concerning the platform plane. In tab. 1 the provided data of the average analysis of these sizes which details are in details described in the work [4].

The correlation analysis of these sizes similar carried out in [4], showed that the greatest values have coefficients of linear correlation r_{La} and r_{Lv_0} which equal 0,5 and 0,59 respectively. It specifies on the average communication with the positive direction between characteristics which define these coefficients. Let's note that the correlation coefficient between kinematic variables θ та v_0 r_{qv_0}=–0,69, the average communication with the negative direction answers. The weak interrelation is observed between other characteristics of trajectory of flight of the ball.

From the practical point of view, the most convenient way of assessment of accuracy of performance of serve in these experiments, in our opinion, there is measurement of R, which is considered by us in the work of [4] characteristics which defines ball touch-down point deviation from the target. The simplest assessment of efficiency of the technique, which was offered by us, can be carried out within the popular method of average sizes, using the comparative analysis of results for the characteristic of R that received in both experiments. In this method the key parameters of the primary quantitative information on sizes R are: arithmetic average value $\bar{X}_R$ and average square deviation σ_R. Let's note that values of size R in the corresponding variation row submit to the normal law of distribution.

The comparison of the noted parameters determined in this work ($\bar{X}_R$=0.70 m і σ_R=0.31 m) і в [4] ($\bar{X}_R$=1.16 m, σ_R=0.53 m), shows that the improvement of the corresponding parameters of variation ranks which are considered, is observed in the repeated experiment. Thus, it is possible to draw conclusion that the high-quality improvement of the characteristic of R took place in the repeated experiment what is connected with the accuracy of performance of a power serve in jump.

Further, we will use formalism of the selective method (see, for example [5]) for more reliable assessment of efficiency of the developed by us technique, which is traditionally used in the solution of certain tasks of physical culture and sport, when determining various characteristics of sports activity on the basis of the analysis of results of the corresponding researches or these made experiments. Many problems of selective method can be classified as class of comparative tasks. It is possible to include any parameters and characteristics of the training process in basis of the comparative analysis of two or more samples.

Actually, conclusions from the comparative analysis of results which were received when processing statistical these both experiments, will answer only the group of volleyball players, which is marked out above, who were tested by us. However, as often becomes in practice of sports researches, we will assume that this group of volleyball players is selection of population which is rather part large number of volleyball players of the same qualification and sports experience, as this group is. The same reasoning is fair also for results of the average

Table 1

Results average statistical analysis of data of experiment

$\bar{X}_{v_0}$ m·s^{-1}	σ_{v_0} m·s^{-1}	$\bar{X}_{\alpha}$ degr.	σ_{v_0} degr.	$\bar{X}_L$ m	σ_L m	$\bar{X}_{\theta}$ degr.	σ_{θ} degr.	$\bar{X}_R$ m	σ_R m	$\bar{X}_d$ m	σ_d m
17,65	1,11	–1,73	1,35	16,91	0,89	5,28	1,32	0,70	0,31	0,76	0,23

analysis of the data connected with performance by these volleyball players of power serve in jump. Proceeding from it, the corresponding results can be extended to the whole contingent of volleyball players, which was discussed above.

The perfect method for clarification of reasonable effect of use of the offered technique is statistical reliability of results of such comparative analysis. The offered technique is correct in the presence of reliable positive changes in these results.

The assessment of statistical reliability of differences between selections of characteristics of *R,* which were defined in primary and repeated experiments, can be executed within the selective method by means of criteria of statistical reliability. We will use the criterion of Student for resolving of the task which gives the chance to investigate different big selections which answer the normal law of distribution. This criterion is used for the comparison of selections on value of their average values in practice of sports researches.

In this case the criterion of Student *t* is defined by the ratio:

$$t = \frac{|\overline{x_R^1} - \overline{x_R^2}|}{\sqrt{m_1^2 + m_2^2}} \qquad (1),$$

where $\overline{x_R^1}$ ($\overline{x_R^2}$) *– the arithmetic average value of sample of the characteristic of R for the primary (repeated) experiment,* m_1 *and* m_2 *– the corresponding errors of representativeness.*

Errors of representativeness define deviations $\overline{x_R^1}$ and $\overline{x_R^2}$ from the arithmetic averages of values of the characteristic *R* corresponding populations. The formula for definition of this error for enough big selections has appearance:

$$m_i = \frac{\sigma_i^R}{\sqrt{n_i}}, \ (i = 1,2), \qquad (2),$$

where σ_i^R *i* n_i *– the average square deviation and volume of the corresponding selection.*

Using results of the analysis of statistical data, which are obtained in both experiments, for the noted above sizes, such values were found:

$\overline{x_R^1}$=1.16 m, σ_i^R=0.53 m at n_1=40 – in the work [4] i $\overline{x_R^2}$=0.70 m, σ_i^R=0.31 m at n_2=50 – in this work. Having estimated, at first, the corresponding errors of representativeness $m_1 \approx 0.084$ m i $m_2 \approx 0.044$ m, we find for the criterion of Student according to the formula (1) of value $t \approx 4.8$. We find the extreme value of this criterion t_{rp}=1.99 for volumes of selections which are stated above at reliability of *P*=0.95, that is, as a rule, used in sports researches, according to the table of Student (see, for example [5]).

As from comparison of both criteria, it comes up that $t \geq t_{gr}$, the difference between characteristics which were considered, is statistically reliable.

When comparing the different big selections for which observance of the normal law of distribution is not obligatory, is applied Fischer's criterion [5].

By means of this criterion, it is possible to compare the corresponding characteristics by the dispersion factor that is dispersions of selections which are investigated.

Fischer's criterion *F* is defined by the following expression:

$$F = \frac{(\sigma_1^R)^2}{(\sigma_2^R)^2}, \qquad (3),$$

where $(\sigma_1^R)^2$, $(\sigma_2^R)^2$ *- dispersions of the corresponding selections. At the same time* $(\sigma_1^R)^2 > (\sigma_2^R)^2$.

When comparing the different big selection samples of characteristics of *R* which are discussed for Fischer's criterion according to formula (3) is obsessed $F \approx 2.9$. Choosing reliability of *P*=0.95, we found the extreme value of criterion F_{gr}=1.6 from the table of Fischer [5] for volumes of the corresponding selections of n_1=40 and n_2=50. As comparison of both criteria shows that $F > F_{gr}$, difference is necessary to consider statistically reliable between characteristics, which are considered.

Model characteristics, which display some reference points at certain stages of their sports preparation, play the important role for the qualified athletes of different types of sport. As a rule, definition of model characteristics is based on the assessment of the corresponding average indicators, using possibilities of selective method. The certain zone which is in limits lower and top confidential borders this method is defined at their assessment near the normal value of the characteristic.

Let's define the model characteristic for size *R* in the repeated experiment in which $\overline{x_R^2}$=0.70 m, σ_2^R =0.31 m. We used the value of error of representativeness which equals $m_2 \approx 0.044$ m, and the extreme value of the criterion of Student t_{gr}=1.99, as it is noted above, when determining confidential boarders. Thus, values of the model characteristic are in the boarders, which are defined by formula:

$$\overline{x_R^2} - m_2 t_{gr} \leq \overline{x_{R_m}} \leq \overline{x_R^2} + m_2 t_{gr} \qquad (4).$$

That is, value of this model characteristic has to be in such limits: 0.62 m$\leq x_{R_m} \leq$0.79 m. As a rule, at the final choice of the model characteristic that from its extreme values which is more rigid in performance, is chosen. In this case we receive $x_{R_m} \approx 0.62$ m.

This model characteristic is rather easy way of assessment of

accuracy of performance of a power serve in jump. It does not make difficulty to introduce such assessment of accuracy of performance of serve in practice of the training process at working off of technique of its execution, by measurement of distance of R from point of touch-down of the ball to the center of the chosen target. If the value $R<\overline{x_{R_m}}$ is observed at the player after the serve, that the corresponding assessment can be considered positive, and negative otherwise. The value of the model characteristic changes over time that demands introduction of the corresponding corrections at its assessment.

Conclusions

The corresponding characteristics of trajectory of flight of the ball were calculated on the basis of statistical data of the repeated experiment, and also the correlation the analysis of these characteristics for assessment of intercommunication between them was carried out. It is offered to estimate the accuracy of performance of serve by measurement in the noted experiments value of such characteristic as deviation of point of touch-down of the ball after serve from the center of the target. The efficiency of the developed by us technique was investigated on the basis of the comparative analysis of the corresponding characteristics, which was defined in both experiments. The assessment of statistical reliability of differences between them was carried out within the selective method by means of Student's and Fischer's criteria. The uses of the developed by us technique, in practice of the training process, are possible to consider effective, considering the reliable change of these characteristics. The model characteristic for assessment of accuracy of performance of a power serve in jump was also defined on the basis of the analysis of data of the repeated experiment.

Prospects of the subsequent researches. The subsequent work is connected with use of the model characteristic, which was investigated in this work, in practice of the training process of volleyball teams. It is possible to estimate the corresponding dynamics in time aspect, fixing the value of this characteristic as for one volleyball player, and the whole team, during the certain time. Volleyball players can improve stability and accuracy of performance of a power serve in jump and by that to achieve the certain progress in the competitive activity, equaling on the noted characteristics.

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