https://doi.org/10.53656/str2022-4-6-ben

Research Results
Резултати от научни изследвания

BENCHMARKING FOR DEVELOPMENT OF SPEED AND POWER CHARACTERISTICS

Assist. Prof. Dr. Darinka Ignatova
Department for Information and In-Service Training of Teachers – University of Sofia
Assoc. Prof. Dr. Alexander Iliev
Institute of Mathematics and Informatics – Bulgarian Academy of Sciences

Abstract. The aim of the study was to examine the development of speed and strength dynamics of motor characteristics in 15-16-year-old volleyball players in five training sessions per week for a period of one year and the application of objective tools for its assessment differences in motor potential between the beginning of the study period and one year later, at the end of the study. **Methods**: Objects are specific indicators measured by objective tools, as well as their systematization and analysis. **Results**: In the period from September 2020 to July 2021, a measurement of the motor potential of high school students in the education system was conducted. **Conclusions**: To derive the relationship between the indicators, an analysis of the dynamics was applied by mathematical and statistical processing to derive coefficients of variation and establish the probability for the p-value, as well as to measure students' criteria.

Keywords: dynamics of development; speed-force characteristics; the establishment of motor potential; motor activity in gymnasts; wellness; statistics

Introduction

In sports training, physical training is the basis on which technical and tactical training is built (Zhelyazkov 1986). The special physical training builds the motor qualities in a specific way in direct connection with the motor stereotypes, characteristic for the volleyball game. Therefore, the issue of the complexity of training tools and finding the most effective methods is essential (Zhelyazkov, Dasheva 2002). The processes of growth and development of the growing organism are dynamic. Motor exercises have a significant impact on the quantitative and qualitative changes taking place in the body, but their impact is effective only when applied in accordance with the capabilities of the developing organism (Ivanova 2019; 2019a). The main goal of strength training in sports games and in individual athletics disciplines is the development of strength, which depends on the speed of individual movements (Veselinov 2021; Dimitrova 2020; Trendafilov, Dimitrova 2013). In sports practice, this force is known as rapid force, dynamic force, and explosive force. Therefore, in physical education lessons, where the learning content is from the sections of sports games and athletics, speed-strength exercises with small weights, but with high speed of performance/shouting types of jumps should be included; with and without weights, having an explosive character and special strength exercises related to the technique of the respective sports games and athletics disciplines. The pieces of training for increasing the speed of the races find a place in all stages of the sports preparation, as the tendency is to increase their share at the expense of the gradual reduction of the work for strength. Speed is built in direct connection with the force, dominating the work for power and speed of the individual cuts, in the preparation period. In the competition period, the frequency of movements was most prominent and was in direct connection with agility and the development of other motor qualities. Of optimal importance in speed, training is the optimal excitability of the central nervous system and the readiness of the muscles for maximum short-term tension.

Methods

The aim of the study is to study the effectiveness of the fast-power dynamics of motor characteristics in 15-16-year-old volleyball players, as well as the application of objective tools for its evaluation. The subject of analysis is shown at the beginning of the study period and one year later, at the end of the study. The site has specific indicators, measured by protective tools, as well as their systematization and analysis. In the period from September 2020 until July 2021, a measurement of the motor potential of the students from high school stage of the Bulgarian educational system was carried out. To derive the relationship between the indicators and the applied analyzes of the dynamics through mathematical and statistical processing to derive coefficients of change and establish the probability for the p-value and level of significance in conducting motor tests, as well as measuring student's criterion carrying information about the reliability of the data indicators and establishing the difference between the measured empirical values. Establishing a relationship should examine indicators obtained with programming capabilities: Excel – Data – Data Analysis – Correlation. In the present study, a program was selected, combining means for the development of strength motor activity and speed of young volleyball players. The study was conducted with 15 – 16-year-old high school volleyball players in five training sessions per week for a period of one year according to a training scheme, including fast-strength training. The research maternity hospital is located in the Sofia school. The dynamic characteristics of ten students' actively training volleyball were studied. This is how the target group of the current study is formed. Parents treat children who are politely informed and have received their informed consent regarding the publication of measurement data in our scientific analyzes and developments.

Results

Mathematical and statistical processing of the results of the conducted diagnostic tests was performed, because of which coefficients of variation were derived and the probability for the p-value and level of significance of the conducted motor tests were established, as well as the measurement of student's criterion carrying information on the reliability of the studied indicators and establishing the difference between the measured empirical values. Table 1 lists the diagnostic tests based on which the indicators were measured: explosive force, long jump, vertical rebound, dynamic force, throwing a solid ball, speed, shuttle running.

Table 1. Tests to verify the research

Tests	Units of measurement	Accuracy	Direction
Long jump from a place	centimeters	0,1	forward
Rebound height from place	centimeters	0,1	upwards
Shuttle run 10x5 meters	seconds	0,1	back and forth
Shuttle run 158 meters	seconds	0,1	back and forth
Thick ball 3kg. passes at 2 meters	Count for 60 seconds	0,1	back and forth

$$\bar{X} = \frac{\sum X}{n}$$

$$S = \sqrt{\frac{\sum (X_i - \bar{X})^2}{n - 1}}$$

Calculations were made using variation analysis. The data was attached in tables containing detailed information on the statistical indicators:

$$V = \frac{S}{\bar{\bar{X}}} . 10$$

where: $\bar{X}$ – Sum of values, n – sample size, S – standard deviation – indicator of variation (%), Xi – any value of the variable in the sample, $\bar{X}$ – Arithmetic mean

where, V – Coefficient of variation (trait variation in% of average $\bar{X}$, S – standard deviation, $\bar{X}$ – Arithmetic mean.

This coefficient gives an idea of the magnitude of the variation, from which a conclusion can be made about the homogeneity of the sample according to the studied indicator and about the stability of the average value. The higher the coefficient of variation, the more pronounced the heterogeneity of the group and the more unstable the arithmetic mean. The variation analysis also includes the values: min – the lowest value; max – highest value and R - scope.

$$R = X_{max} - X_{min}$$

where: X_{max} – the largest value of the variable, X_{min} – the smallest value of the variable.

The range – **R** is the most elementary measure of statistical scattering and represents the difference between the largest and smallest value of the variable. Characteristic of motor research are the problems of comparing the level of motor skills of different categories in adolescents and comparing the effectiveness of different methods of training. The peculiarity of such comparisons is that the conclusions that are made must relate to the whole population, and the data available to the researcher cover only a sample of it. Therefore, assumptions are initially formulated – hypotheses, which are then checked whether the sample data confirm or reject them. H0 – the zero (working) hypothesis, states that there is no statistically significant difference in the compared statistical indicators. Although some difference may be observed in the sample, it is random and cannot be summarized for the general population. The alternative hypothesis – H1, claims that the difference found in the compared statistical indicators in the samples is statistically significant and can be summarized for the general population. The decisions that are made when testing statistical hypotheses are probabilistic. This is because the studies are representative. The conclusions for the general population are made based on a study of a relatively small but representative / representative / sample. Accepting or rejecting the null hypothesis is done with a certain degree of certainty, while allowing the possibility of error in the statistical conclusions. The degree of certainty with which the alternative hypothesis is accepted as true is called the guarantee probability – P. The risk of making a mistake by accepting the alternative hypothesis as true is called the significance level. In practice, the following values are used for the guarantee probability – P and significance level:

P = 95%, which corresponds to **α = 0.05** (5% chance of error)

P = 99%, which corresponds to **α = 0.01** (1% possibility of error)

P = 99.9%, which corresponds to **α = 0.001** (0.1% chance of error)

The guarantee probability P /% /, at a certain level of significance, is calculated by the formula:

P (%) = (1 – α) * 100, (**α**) is the level of significance that correspond**s** to the empirical value of the criterion. The opportunities take the following form:

• The guarantee probability is less than the accepted one (95% or 99%) – the null hypothesis – H0 is considered true.

• The warranty probability is equal to or greater than 95% (99%). – The null hypothesis – H0 is rejected and the alternative hypothesis – H1 is accepted as true.

t – student's criterion (for dependent samples) is used to compare arithmetic means when:

• Signs are metrically scaled and have a normal distribution

• There are two samples, and they are dependent

Student's test - t - provides information about the reliability of the difference between the values. It is used to compare homogeneous quantities, its empirical value is calculated by a formula, and the one from the table is reported.

$$t_{emp} = \frac{\bar{d}}{\sqrt{\frac{\sum d^2 - n\bar{d}^2}{n^2 - n}}}$$

where: **d** – differences between I and II examination for each person, $\bar{\mathbf{d}}$ – arithmetic mean of these differences, **n** – sample size.

The development of the indicators is described by **- d -** absolute and **d%** – relative growth:

Absolute growth: $d = X_2 * X_1$, is expressed in units of measurement of the variable and shows by how much and in what value the average value of the respective group has changed. Not suitable for comparisons of test results expressed in different units of measurement or having different averages. Relative increase in %, allowing for comparison in the development of indicators, in different units. The statistical significance of the increase (comparison I and II) is checked with an appropriate criterion for comparison of average values in dependent samples. In cases where the signs are quantitative and have a normal distribution, the student's t-test for dependent samples is used, otherwise – the Wilcoxon T-test. In both cases, at the level of the achieved guarantee probability – P%, a decision is made on the reliability of the increase. If P% ≥ 95%, it is assumed to be statistically significant, and the changes found in the samples are due to the applied effects.

Table 2. Variation Analysis

Test 1. Beginning	X_{min}	X_{max}	R	$\bar{X}$	S	V%
Long jump from a place	212	232	20	218,30	6,15	2,81
Rebound height from place	49	57	8	51,70	2,45	4,74
Shuttle run 10x5 meters	16,44	19,84	3,4	17,92	1,04	5,82
Shuttle run 158 meters	42,90	50,40	7,5	45,98	2,28	4,95
Thick ball passes 3kg.	31	37	6	34	2,24	6,58

Summarizing the results of the initial search, a further conclusion can be made: damage depending on whether a one-year study was conducted with a relatively homogeneous group of sports, with similar indicators of energy activity for motor skills - strength and speed.

Table 3. Test Results 1. Beginning

Test 1. Beginning	**n**	**As**	**Ex**
Long jump from a place	10	0,99	- 0,16
Rebound height from place	10	0,80	-0,41
Shuttle run 10x5 meters	10	0,23	-0,12
Shuttle run 158 meters	10	0,36	-1,32
Thick ball passes 3kg.	10	0,01	-0,85

Note: The critical values of the asymmetry and excess coefficients at n = 10 and $\alpha = 0.05$ = 0.711 and 0.907.

Table 4. Variation analysis

Test 2. End	X_{min}	X_{max}	**R**	$\bar{X}$	**S**	**V%**
Long jump from a place	215	229	14	223	6,04	2,71
Rebound height from place	52	62	10	56,20	3,26	5,80
Shuttle run 10x5 meters	16,22	19,61	3,4	17,99	1,12	6,19
Shuttle run 158 meters	41,80	49,05	7,2	45,11	2,23	4,95
Thick ball passes 3kg.	34	40	6	37	1,97	5,33

The coefficients of variation for all tests have changed but remained in the same range – up to 10%. Which is an indicator of the homogeneity of the sample. Each of the test subjects evenly changed their result on the respective test and for the group the ratio – standard deviation to the average value remained within the same limits. The variation in the force tests tends to decrease, and in the speed tests a rate of increase is reported. The explanation is in the overall increase in the average scores for each test. There is an increase in the results of all tests. Comparison of the mean values of the two tables, at the beginning and end of the study:

- Long jump – the average achievement is 2%
- Rebound height – increase by 8%
- Shuttle run 10x5m, increases by 2.5%
- Shuttle run – 158 m. The increase is by 2%
- Thick ball passes 3kg**.** – An increase of 7%

The average% are, for speed 2.25%, for strength 5.7%, in general the increase for both motor qualities is 4.3%. In the test at the end of the study period no large individual differences were observed, the coefficient of variation was in the range of 2.71% to 5.33%. It follows that the studied contingent of athletes is satisfactorily equivalent in terms of development of their motor capacity expressed in motor skills, strength, and speed. Which is an indicator of good motor training.

Table 5. Test Results 2. End

Test 2. End	n	As	Ex
Long jump from a place	10	0,77	-0,35
Rebound height from place	10	0,37	-1,49
Shuttle run 10x5 meters	10	0,07	-1,50
Shuttle run 158 meters	10	0,33	-1,15
Thick ball passes 3kg.	10	0,18	-1,95

Note: The critical values of the asymmetry and excess coefficients at n = 10 and $\alpha = 0.05$ = 0.711 and 0.907.

The asymmetry coefficients – As and excess Ex, calculated from the empirical data and presented in Tables 3 and 5, show the magnitude of the deviation of the empirical distribution from the theoretical normal distribution. There is a normal distribution As = 0 and Ex = 0, the more the empirical coefficients differ from zero, the more the empirical distribution differs from the normal one. At values of the coefficients of asymmetry and excess, exceeding their theoretical values in the perceived new significance, the statistical conclusion can be made that the empirical distribution of the variable is normal. Most of the biological features have a normal distribution, by analogy it is assumed that the results of the tests for measuring the speed and strength qualities of volleyball players, as random variables are also subject to the law of normal distribution. The results obtained in the study for the values of asymmetry and excess show a normal distribution. Two of the asymmetry scores in Table 3 and one in Table 5 are higher and deviate from the normal data distribution. There is an abnormal distribution in the indicators for the jump in length and height of the rebound – the measures of force. All obtained values for the asymmetry coefficient are positive, which shows that most of the results are located to the left of the arithmetic mean – to the lower results. This shows that for a large part of the subjects the test is difficult (with increasing the coefficient of asymmetry). From the magnitude of the excess, conclusions can also be drawn about the distribution of test results. Each excess coefficient in both tables has a negative value, which means that the distribution is more even than normal. Normal distribution is important when choosing the statistical method for processing test data. In a normal distribution, the arithmetic mean is the best estimate of the actual mean level of the general data set.

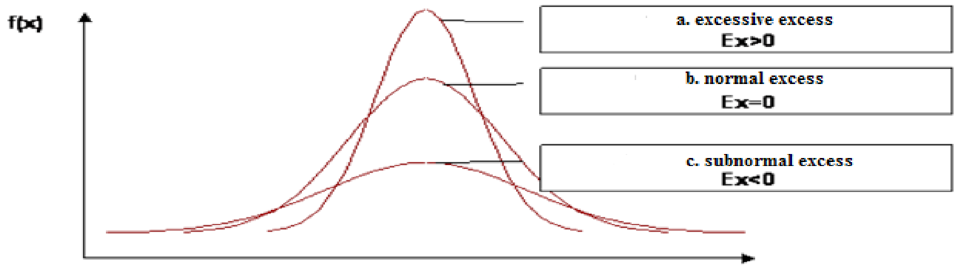

Figure 1. Dynamics coefficients of excess – Ex

The dynamics of the developed engines of quality – power and speed is described by the indicator absolute increment – d. The reliability of the differences for the period of consideration – September 2020 to July 2021 of the training program was followed by student's t-test for dependent samples. Its critical value of the subjects in the present study and the plane of significance α = 0.05 = 2.26. In any case, when the empirical value is less than the critical value, the increase in the respective indicators is unmatched and vice versa.

• **Long jump**

At the beginning of the study period, 15 – 16-year-old volleyball players had an average achievement of 218.3 cm. As a result of the purposeful training process, it has improved by 4.7 cm, in this period ***temp* > tα** – the alternative hypothesis – H1 is accepted as true, and the zero hypothesis – H0 is rejected (temp = 6.81). The same statement is supported by the guarantee probability – P% ≥ 95%, which is higher than accepted (95%). For the one-year training period, the students have increased their result in the long jump, as this trend is statistically significant and is due to the applied motor effects.

Table 6. Benchmarking of speed and power characteristics

Test – 1 and 2	**Beginning**		**End**		Growth (d)	***temp***	**P(t)**
	X1	**S1**	**X2**	**S2**			
Long jump from a place /centimeters/	218,30	6,15	223	6,04	4,70	6,81	100
Rebound height from place /centi-meters/	51,70	2,45	56,20	3,26	4,50	10,47	98
Shuttle run 10x5 meters /seconds/	17,92	1,04	17,99	1,12	0,07	1,87	96
Shuttle run 158 meters /seconds/	45,98	2,28	45,11	2,23	-0,87	3,23	99
Thick ball passes 3kg. /times/	34	2,24	37	1,97	3,00	7,07	100

Note: The critical value of the student's t-test at k = n-1 = 9 for dependent samples and α = 0.05 = 2.26

• **Rebound height**

The results are presented in Table 6. The average achievements at the beginning and end of the considered period are 51.7sm and 56.2sm. As a result of the training process, the improvement is 4.5.temp > tα – the alternative hypothesis – H1 is accepted as true, and the null hypothesis – H0 is rejected, taking into account that the test is statistically reliable. The result of the guarantee probability is similar – (P) 98% ≥ 95%, which is higher than the accepted one. Targeted training has increased this characteristic for volleyball players, especially since the target group is composed of regular sports students who are actively involved in volleyball.

• **Shuttle run 10x5m**

The average values for both tests are: 17.92 and 17.99 sec. An increase of 0.07 sec is reported (good achievement). There is a result that is lower than the critical value, temp < tα – the zero (working) hypothesis is accepted as true – H0, (temp = 1.87; α = 0.05 = 2.26). Or temp 1.87 < tα 2.26. The fact that the achievement is unreliable is not worrying. There is a smooth positive trend.

• **Shuttle run 158m**

In Table 5, a result with a negative sign is observed. From a statistical point of view, the realized increase of – 0.87 sec (0.89%) is also reliable – P (t) ≈100%, but from a practical point of view it is too small to be considered tangible. development of speed capabilities. However, the alternative hypothesis – H1 – is valid because a value of 3.23 is obtained for the student's t test, – temp> tα; α = 0.05 = 2.26 or temp 3.23 > tα 2.26.

• **Thick ball passes 3kg.**

The difference between the first and second test is 3 - positive growth temp > tα, (α = 0.05 = 2.26) – the alternative hypothesis – H1 is accepted as true, and the zero (working) hypothesis – H0, is rejected, (temp = 7.07).

Discussion

Comparing the data from the two tests, from the beginning and the end of the study, the assessment of the extent to which the empirical data have improved shows an average result. The conclusions from the conducted tests are that appropriate, reliable tests have been selected from which one can judge the speed and strength qualities of 15 – 16-year-old volleyball players. Three equivalent strength tests and two speed tests were used to obtain more reliable information. Conducting the test, at the end of the study, it is applied under unchanged conditions for higher reliability. The tests are tailored to the specifics and specifics of the sport, so that they have a high prognostic validity and meet the capabilities of the tested persons. The results obtained in the study for the values of asymmetry – As and excess – Ex, show a normal distribution. Two of the asymmetry scores in Table 3 and one in Table 5 are higher and stand out from the normal distribution. There is an abnormal distribution in the tests for – jump in length and height of the rebound (measures for motor quality force). All values obtained for the asymmetry coefficient are positive, which is an indicator of the predominant part of the results, located to the left of the arithmetic mean and tending to lower results. And this is an indication that for a large part of the surveyed persons the test has an increased difficulty of performance. From the magnitude of the excess, conclusions can also be drawn about the distribution of test data. Each excess coefficient, and in Tables 3 and 5, has a negative value, which means that the distribution is more uniform than normal. The results for the growth and the student's coefficient are presented in Table 6. The average achievements at the beginning and the end of the study period increased. This means that there is an improvement in the results due to the volleyball training process. In each column, except for the test – shuttle run 10x5m, temp > tα and the alternative hypothesis – H1 (statistical reliability) is accepted as true. The result of the guarantee probability is similar – P, which is higher than the accepted one. Targeted training has increased this characteristic of volleyball, especially since the target group is composed of regular students, with good motor capacity, actively involved in volleyball.

Conclusion

Sports educators have a great contribution to the development of athletes and their improvement. They manage the teaching and training activities with means and methods that help to build moral and volitional qualities. Volleyball is a team sport and for successful interaction it is important to have cohesion, understanding, informational connection, coherence of actions and collective mood. They determine the favorable mental atmosphere, which is extremely important for the success of the sports team. Mental training in volleyball is a necessary part of the overall training process. It helps to improve the ability to anticipate the intentions of the opponent, to create a sense of superiority and mastery of the ball, to build a sense of distance, time, rhythm, and speed. One of the main shortcomings of teachers and coaches is that not enough attention is paid to the actions and training of uncomfortable limbs. It is necessary to perform catching and passing the ball over the net and shooting with both the right and left hand. This stimulates the need for symmetrical development of the muscles of the right and lava half of the body. In adolescents, efforts are focused mainly on the problems of training in the various elements of the technique and tactics of volleyball, as well as control over the acquisition of new knowledge (success). The problem of the activity and efficiency of the speed-strength training of the adolescents is insufficiently clarified, depending on the way of conducting the training process. Therefore, the results of the study will find application in the training process of sports educators, teachers and coaches involved in volleyball.

REFERENCES

BROGLIE, J., PETKOVA, L., 1983. *Statistical methods in sports*. Sofia: Medicina I fizkyltyra. [in Bulgaria]

VESELINOV, D., 2021. *Dialogue in Education, Tenth International Autumn Scientific and Educational Forum "Dialogue in Education – Present and Perspectives"*. Sofia, 11 – 16. ISBN 978-954-07-5231-0

GIGOVA, V., 1999. *Statistical Processing and Data Analysis, a textbook for NSA master's students*. Sofia.

DAMYANOVA, R., GIGOVA, V., 2000. *Statistical Methods in Sports, a guide for NSA bachelor's degree students.*

DIMITROVA, B. et al., 2020. *Dinamika na indeksite za uelbiyng i shtastie: sravnitelen analiz po svetovna baza danni, saobrazno statisticheski danni ot dokladi na OON*. Monografia. Sofia: Avangard, parvo izdanie.

IVANOVA, V., 2019. Influence of gymnastic exercises in the water environment. *International Scientific Journal: Smart Innovations in Recreational, Wellness Industry and Niche Tourism*. **1**(1), 53 – 56. ISSN: 2603 – 4921 (online). Available at: https://scjournal. globalwaterhealth.org/.

IVANOVA, V., 2019a. Development of imagery training plan for rhythmic gymnasts. *International Scientific Journal: Smart Innovations in Recreational, Wellness Industry and Niche Tourism*. **1**(2), 41 – 49. ISSN: 2603-4921 (online). Available at: https://scjournal.globalwaterhealth.org/.

TRENDAFILOV, D., DIMITROVA, B., 2013. Aqua spinning as anti-stress health prevention. *Sport Mont*. **XI** (37-38-39), 467 – 473.

ZHELYAZKOV, C., DASHEVA, I., 2002. *Fundamentals of sports training*. Sofia.

ZHELYAZKOV, T., 1986. *Theory and methodology of sports training*. Sofia.

✉ **Dr. Darinka Ignatova, Assist. Prof.**
ORCID ID 0000-0002-0564-584X
Department for Information and In-Service Training of Teachers
University of Sofia
224, Tzar Boris III Blvd.
1619 Sofia, Bulgaria
E-mail: dignatova@diuu.uni-sofia.bg

✉ **Dr. Alexander Iliev, Assoc. Prof.**
Institute of Mathematics and Informatics
Bulgarian Academy of Sciences
Sofia, Bulgaria
E-mail: ailiev@berkeley.edu