INFLUENCE OF PLYOMETRIC TRAINING ON EXPLOSIVE STRENGTH DEVELOPMENT IN SCHOOL SETTINGS

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Abstract

On a sample of 20 subjects, students of two high schools in Nis, male , aged 16 years, members of the school sports associations, a longitudinal study was conducted with the aim to, among other things, determine the effects of a plyometric training method on the development of long jump, high jump, with sprinting as a criterion variable. Two hypotheses were set claiming that through the application of the plyometric training method would yield statistically positive results in the final measurement. The exercises plan with teaching units is presented, through which an experimental program lasting 2 months, or 24 school classes, was realized. The obtained results were statistically analyzed and presented in several tables. On the basis of the obtained values it was concluded that the experimental program yielded statistically significant results and had increasingly influenced the improvement of lower limbs explosive strength.

Key words: plyometric training method, longitudinal research, criterion variable, long and high jump with sprinting, experimental program, lower limbs explosive strength

Introduction

Physical education as a special form of educational work is both focused on health care and the development of basic and complex motor dimensions, with the aim to increase functional abilities and morphological characteristics of children. Numerous studies indicate that an adequate design of teaching, and the application of the cutting edge technology can significantly raise the level of the anthropological characteristics of students and their ability to endure the increased efforts (Željaskov, C, 2004; Jaeger, K, and Oelschlagel 1992; Coh, M, 2003, Bubanj, S. et al, 2012). The application of different methods and techniques of performing particular movement structures are very important for the development of certain complex movements, both in individual and collective sports. Plyometric training method is one of them and is used for the development of different forms of manifestation of the explosive strength such as long jump and high jump, javelin throw, shotput, a ball throwing in handball, basketball, volleyball spike, etc. Specific training for explosive strength development, in the theory of strength training, uses the term plyometric training. The basic principle of plyometric training method underlies the rate of change of the eccentric and concentric muscle contraction. The essence of this method is the time it takes a muscle to change from the state of flexibility into the state of shortening. Significant role in the development of the explosive strength is attributed to the characteristics of muscle elasticity and a miostatic reflex. For the quality of eccentric-concentric contraction, it is necessary to duly activate muscles, just before the eccentric contraction, short duration of the eccentric contraction and a rapid shift of stretching and shortening phases (Milenkovic, S. et al., 2011; Stojiljkovic, D. Piršl, D.

2015; Stojiljkovic, D. Živković, M. Piršl, D. 2016; Višnjić, D. 2006). In fact, an explosive strength is the ability which enables an athlete to maximally accelerate his body, an object or partner. It is manifested in the activities such as throws, jumps, hits and sprints. Explosive strength includes short, ie, narrow groups of several explosive movement tied to a single unit. To develop explosive strength, a plyometric method is an important component of the training work in the majority of sporting disciplines, and consequently, is a significant factor in the planning of sports training. In the school settings, the application of this method is quite limited and is recommended to apply with students after the age of 14 years, thus it was the motive to point out to the teachers all the benefits of this method, but also certain prudence in its application. In general, plyometric training, or working method uses the force of gravity for guick muscle stretching when landing from a certain height (40-60 cm) in order to create a potential elastic energy for more efficient implementation of the concentric phase of the high jump in the air (Čoh, M. 2003). The primary purpose of the plyometric method is to develop a greater reactive force, and thus a better high of long jump. In order to verify this method in practice, one longitudinal research study was conducted in two secondary schools in Nis, on a sample of 20 male, second grade students. The aim was to determine, among other things, the level of impact plyometric method of work exerts on the results of the long and high jump as the criterion variables. To this purpose, two hypotheses were designed with the assumption that a plyometric training method in two month cycle will give statisticallv significant results in the final measurement, both in sprint long jump and sprint high jump.

Methods

Subject sample

A sample of 20 male subjects was derived from the population of the two high schools students, in Nis, chronological age of 16 years, included in the regular physical education classes, and who had met all good health status requirements.

None of the subjects was actively involved in sports but they were members of school sports sections in different sports disciplines.

Measurement instruments sample

Measuring instruments for results assessment in jumping disciplines: (criterion variables) were following:

a) sprint long jump (SKDALJ)

b) sprint high jump (SKVIS) (Measuring instruments and techniques description was taken from the research of N. Kurelić, et al. (1975).

Experimental research program

Research on the influence of plyometric method on the increase of the results efficiency in the explosive strength development, i.e. in jumping events was conducted in the course of 3 classes per week, within the school sports section, for a period of two months.

All subjects were tested at the beginning of the experimental treatment (initial measurement) and after a two-month program implementation (final measurement) tested the explosive strength of the lower extremities in the long jump with a running start (horizontal jump) and in the high jump with a running start (vertical jump). Structure of the training process (class) had a four-part design with an allotted time of 45 minutes, as in the regular PE classes.

Data processing methods

The obtained results were statistically analyzed and presented through a number of tables. For this purpose, the program "Statistica" 8.0 for Windows was used, with the following parameters calculated:

Basic statistical parameters

Measuring discrimination (SKEWNESS -SKEW), (KURTOSIS -KURT)

Multivariate analysis and univariate canonical discriminant analysis

Specific training program structure

All plyometric exercises for the lower extremities explosive strength development were achieved mainly by using the circuit working method, in several stations, whereby strict attention was paid to the order of the exercises, not to contain the same type of exercises, carried out by the same muscle groups.

It was also taken into account the loads, number of repetitions, rest between exercises and the overall duration of the exercise tasks.

Table 1. Experimental treatment program implementation - In school settings

| Exercise | No. of |
|---|---------|
| | classes |
| 1. Squat jumps in all planes | 1 |
| 2. Pommel horse jump | 1 |
| 3. Vertical depth tuck jump | 1 |
| 4. Pommel horse step jump | 1 |
| 5. Swift pommel horse jump and stuck landing | 2 |
| 6. Depth jumps from high pommel horse | 2 |
| 7. Leap sideways jump | 1 |
| 8. Stairway both feet hops | 1 |
| 9. Stairway sideways leaps | 1 |
| 10. Upstairs leaps and jumps | 1 |
| 11. Skips on pommel horse up to 40 cm and stuck | 2 |
| landing | |
| 12. Leap jumps on pommel horse 40 cm | 1 |
| 13. Raw jumps over low hurdles (50cm) | 2 |
| 14. Sideway jumps over cones | 2 |
| 15. Sideway leaps- sprint | 1 |
| 16. Pommel horse jump (60cm), stuck landing, | 2 |
| squat and long jump | |
| 17. Two-leg jump on pommel horse (60cm), both | 2 |
| leg landing and high jump | |

Results

Basic statistical parameters of specific-motor abilities

Table 2. Basic statistical parameters for the assessment of specific-motor abilities in the initial measurement

| Spec. motor. | Ν | Mean | Min. | Max. | Std. | Skewn | Kurtos. |
|--------------|----|------|------|------|------|-------|---------|
| SKDAU | 20 | 351 | 310 | 42 | 4.63 | .523 | .864 |
| SKV1S | 20 | 122 | 95 | 142 | 3.98 | .381 | .953 |

Analyzing the obtained results in Table 2, displaying basic statistical parameters of the specific-motor abilities, it can be concluded that by comparing the results of the standard deviation (St. Dev) to the range of maximum (Max.) and minimum (Min.) results, one can notice normal sensitivity of the selected tests. In the intervals of the minimum (Min.) and the maximum (Max.) results there are at least five standard deviation (St.Dev), indicating a significant dispersion, i.e. the sensitivity of the specific -motor tests. Values of skewness and kurtosis are ranging within the limits of the normal distribution of results.

Table 3. Basic statistical parameters for the assessment of specific-motor abilities in the final measurement

| Spec. | | | | | Std. | | |
|-------|----|------|------|------|------|--------|---------|
| tests | Ν | Mean | Min. | Max. | Dev. | Skewn. | Kurtos. |
| SKDAU | 20 | 376 | 315 | 455 | .360 | .622 | .831 |
| SKV1S | 20 | 128 | 97 | 151 | .485 | .373 | .622 |

Analyzing the obtained results in Table 2, displaying basic statistical parameters of the specific-motor abilities, it can be concluded that by comparing the results of the standard deviation (St. Dev) to the range of maximum (Max.) and minimum (Min.) results, one can notice normal sensitivity of the selected tests. In the intervals of the minimum (Min.) and the maximum (Max.) results there are at least five standard deviation (St.Dev), indicating a significant dispersion, i.e. the sensitivity of the specific -motor tests. Values of skewness and kurtosis are ranging within the limits of the normal distribution of results.

Analysis of changes between the initial and final measurements of subjects examined by T test Table 4. Significance of differences in specificmotor abilities between the initial and final measurement

| Functional | Mean | Mean | T-Value | df | Р |
|------------|------|------|---------|----|-------|
| SKDAU | 351 | 376 | 2.86 | 2 | .004* |
| SKV1S | 122 | 128 | 3.45 | 2 | .000* |

Table 4 contains the results of T-test of the specficmotor abilities between the initial and final measurements of subjects. Analysis of the Tcoefficient value and its significance (r) indicates that there is a statistically significant difference in both tests of the specific- motor abilities in the final as compared to the initial state.

Analysis of changes between the initial and final measurement of subjects applying canonical discriminant analysis

In this study, in order to establish global quantitative changes between the initial and final measurements of the subjects, in the area of specific- motor abilities, discriminant analysis was applied to calculate the following:

- Coefficient of discrimination square, displayed through Eigenvalue
- Canonical correlation coefficient displayed through Canonical R.
- Separation (discriminating power) is displayed through Bertol test Wilks' Lambda,
- Statistics significance of each variable is displayed through the Chi-square test and Chi -Sqr,
- The degrees of freedom are shown through \triangleright df,
- \triangleright Any error in rejecting the hypothesis where the real value of canonical correlation is zero is shown through Sig.

Canonical discriminant analysis in specific-motor area

Discriminant analysis in this paper is used to determine whether there is a statistically significant difference between the results of the initial and final measurement of the specific-motor abilities, and then to determine the jumping disciplines that make the greatest contribution to the determined difference, i.e. discrimination.

Table 5. The significance of the isolated discriminant function

| Discr. Funct. | Eugen value | Canonical R | Wilks` Lambda | Chi-Sqr. | df | Si ^g |
|------------------|----------------|----------------|------------------|----------|----|-----------------|
| 1 | .334 | 580 | .626 | 43.12 | 2 | .032* |

Table 5 shows an important discriminant function of high intensity (CR=58,0%), which indicates the data set correlation on the basis of which a discriminative analysis of the obtained results was performed. Results of the discriminative strength of the subjects specific-motor abilities in jumping disciplines are shown through Wilks' Lambda test, that is high (.626), indicating that the differences between the initial and final measurement of the specific-motor abilities in the experimental group, are significant (Sig.=032), because the size of the Chi-square test has a high value (Chi-Sqr=43.12). The obtained results indicate that there are statistically significant global differences in the specific-motor abilities between the initial and final measurement of the subjects.

Table. 6 Factor structure of the isolated discriminant function

| Spec. Motor. tests | Root 1 |
|-----------------------|--------|
| 5KV15 | .523 |
| SKDALJ | .480 |

Table 6 presents the structure of discrimination function of the specific-motor abilities variables participation in jumping events in the formation of discriminant significant functions. Presented centroides of groups represent the arithmetic means of the initial and final measurement results. In order to test the significance of the differences between the initial and final measurement in the experimental group subjects, two jumping disciplines (long jump, high jump) were measured, which are assumed to be good predictors of the subjects specific-motor abilities.

The results indicate that the largest contribution to the discriminant function has a running high jump (SKVIS.532), and a running long jump (SKDA. 480). The obtained results of discriminant analysis the final, as compared to the initial in measurement, indicate that under the influence of the experimental model applied to develop the explosive strength, there have been statistically significant changes in subjects specific-motor abilities in jumping disciplines.

On the basis of the subject, problem, aim, and set research hypotheses, following conclusions were drawn:

A canonical discriminant analysis:

The results of the canonical discriminant 1 function indicate that in the final, as compared to the initial measurement, there have been statistically significant changes in the level of results in a running high jump.

2. The results of canonical discriminant function indicate that in the final, as compared to the initial measurement, there have been statistically significant changes in the level of results in the long jump.

Conclusion

When using the interval type of work for the development of the vertical jump by plyometric method in physical education classes, scope, intensity and recovery of the organism should be individual adapted the abilities to and characteristics of students. The duration and content of the aerobic activities for recovery of the organism should depend on the structure of selected exercises for the development of the vertical jump, volume of loads, number of series, the number of repetitions in the series, and the

pace of the exercises performance. Only by proper application of aerobic activities for the accelerated recovery of the students' body, at intervals of rest in physical education classes, is it possible to enhance the regeneration of the body and prepare it for the next interval operation. Due to the specificity of plyometric work method in the development of jumping ability, physical education teachers should have the basic knowledge about the methods of recovery. Therefore, apart from the content, load and working methods, it is necessary to program and plan means on which the quality of recovery depends.

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UTJECAJ PLIOMETRIJSKOG TRENINGA NA RAZVOJ EKSPLOZIVNE SNAGE U ŠKOLSKOM OKRUŽENJU

Sažetak

Na uzorku od 20 ispitanika, studenata dviju srednjih škola u Nišu, muškaraca, u dobi od 16 godina, članova školskih sportskih udruga, longitudinalno istraživanje provedeno je s ciljem da se, između ostalog, utvrdi učinke metode pliometrijskog treninga na razvoj skoka u dalj, skoka u vis, sa sprintom kao kriterijskom varijablom. Postavljene su dvije hipoteze, tvrdeći da bi kroz primjenu pliometrijske metode trening dao statistički pozitivne rezultate u završnom mjerenju. Plan vježbe s nastavnim jedinicama je predstavljen kroz eksperimentalni program u trajanju od 2 mjeseca ili 24 školskih razreda, te ostvaren. Dobiveni rezultati su statistički analizirani i prikazani su u nekoliko tablica. Na temelju dobivenih vrijednosti zaključeno je da je eksperimentalni program dao statistički značajne rezultate i da je utjecao na poboljšanje donjih ekstremiteta eksplozivne snage.

Key words: metoda pliometrijskog treninga, longitudinalno istraživanje, kriterijska varijabla, dugi i visoki skok sa šprintom, eksperimentalni program, eksplozivna snaga donjih ekstremiteta

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