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The Analysis of Effectiveness of Elastic Training (Resistant) Bands Application to Develop Explosive Strength

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Abstract

Purpose: to research the effectiveness of elastic training bands (resistance bands) application to develope explosive strength in a comparative aspect.
Material and methods: theoretical material for the article has been taken from the research of Ukrainian and foreign scholars and experts. The basis for the study was a research laboratory of functional diagnostics and physical rehabilitation. The study involved 60 18-19-year-old students (40 girls and 20 boys), young people with excellent, very good or good health status. The main methods used for the experiment and the article were comparison, questionnaires, final tests, statistical analysis (parametric and nonparametric analysis, systematization, creation of varieties (arrays), determination of Student's t-test and Pearson's χ2 test).
Results: the questionnaire of students on the expected effectiveness of various ways of explosive strength training revealed that the lowest result was expected from isometric exercises (5%), the average one was found out from the use of weights (61%), and the highest result was shown from the application of elastic training (resistant) bands (65%). According to the results of the experiment the following data has been obtained: 1) the smallest increase in the standing long jump was observed in the group in which there were trainings with elastic training bands – 4.3 cm; in the group where isometric exercises were applied, the increase in standing long jump was 10.9 cm; in the group in which students trained with weights, the gain in the standing long jump was 14 cm; 2) the increase of the leg press index at an angle of 45° in the group that used elastic training bands as a means of weighting was the lowest, i.e. 14 kg; in the group performing isometric exercises it turned out to be the highest – 19.5 kg; in the group that used weights – 18 kg.
Conclusion: our experiment involved comparing the impact on the explosive strength development of different means of weighting: elastic training bands, isometric exercises and weighting objects. Despite the expectations of the respondents it was demonstrated that the application of the elastic training bands does not have a significant advantage over other means of weighting. The resistance bands application show lower results compared to the training with the isometric weighting and weighting of objects. The application of exercises in the isometric mode of weighting showed a significant gain in explosive strength, although the expected results were not met. The application of objects' weighting showed the expected high results. Therefore, the prediction of the high efficiency of elastic training bands as a means of weighting turned out to be spurious.
Key words*:* weighting, weight, isometric exercises, expected effectiveness, strength

Анотація

Дишко О.Л., Косинський Е.О., Сітовський А.М., Ходінов В.М., Пасічник В.Р. Аналіз ефективності застосування еластичних стрічок для розвитку вибухової сили

Мета: дослідити ефективність застосування еластичних стрічок (джгутів) для розвитку вибухової сили в порівняльному аспекті.

Матеріал і методи: Теоретичним матеріалом для статті слугували дослідження вітчизняних та закордонних фахівців. Базою для проведення експерименту була науково-дослідна лабораторія функціональної діагностики та фізичної реабілітації. У дослідженні брали участь 60 студентів (40 дівчат і 20 юнаків) віком 18-19 років (за станом здоров'я – основна медична група). Основні методи дослідження – це порівняння, анкетування, контрольні тести, статистичний аналіз (параметричний і непараметричний аналіз, систематизація, створення варіаційних рядів, визначення t-критерію Стьюдента та критерію χ^2 Пірсона).

Результати: Анкетування студентів щодо очікуваної ефективності використання різних засобів тренування вибухової сили виявило, що найменший результат очікувався від ізометричних вправ (5%), середній – від використання обважнювачів (61 %), а найвищий – від використання еластичних стрічок (65%). За результатами експерименту отримані такі дані: 1) найменший приріст показника стрибка в довжину з місця був у групі, в якій були тренування з еластичними стрічками – на 4,3 см; у групі, де використовувалися ізометричні вправи, приріст стрибка в довжину з місця становив 10,9 см; у групі, в якій тренувалися з обважнювачами, приріст стрибка в довжину з місця був 14 см; 2) приріст показника жиму ногами під кутом 45° у групі, що використовувала як засіб обважнювання еластичні стрічки, виявився найнижчим – 14 кг; у групі, що виконувала ізометричні вправи, найвищий – 19,5 кг; у групі, яка використовувала обважнювачі, – 18 кг.

Висновки: Наш експеримент передбачав порівняння впливу на розвиток вибухової сили різних засобів – еластичних стрічок, ізометричних вправ, обтяження масою предметів; він продемонстрував, що, попри очікування респондентів, використання еластичних стрічок не має достовірної переваги над іншими засобами обважнювання. Тренутвання зі джгутами дало нижчі результати, ніж тренування з використанням ізометричного навантаження та обтяження масою предметів. Використання вправ в ізометричному режимі навантаження показало значний приріст вибухової сили, хоча це не відповідало очікуваним результатам. Використання обтяження масою предметів показало очікувано високі результати. Отже, прогноз щодо високої ефективності використання еластичних стрічок як засобу обважнювання виявися хибним.

Ключові слова: обважнювання (обтяження масою предметів), обважнювач, ізометричні вправи, очікувана ефективність, сила

Аннатоция

Дышко О.Л., Косинский Э.А., Ситовський А.Н., Ходинов В.М., Пасечник В.Р. Анализ эффективности применения эластичных лент для развития взрывной силы

Цель: исследовать эффективность применения эластичных лент (жгутов) для развития взрывной силы в сравнительном аспекте.

Материал и методы: Теоретическим материалом для статьи послужили исследования отечественных и зарубежных специалистов. Базой для проведения эксперимента была научно-исследовательская лаборатория функциональной диагностики и физической реабилитации. В исследовании принимали участие 60 студентов (40 девушек и 20 юношей) в возрасте 18-19 лет (по состоянию здоровья – основная медицинская группа). Основные методы исследовангия – сравнение, анкетирование, контрольные тесты, статистический анализ (параметрический и непараметрический анализ, систематизация, создание вариационных рядов, определение t-критерия Стьюдента и критерия χ2 Пирсона).

Результаты: Анкетирование студентов по ожидаемой эффективности использования различных средств тренировки взрывной силы показало, что наименьший результат ожидался от изометрических упражнений (5%), средний – от использования утяжелителей (61 %), а самый высокий – от использования эластичных лент (65%). По результатам эксперимента получены следующие данные: 1) наименьший прирост показателя прыжка в длину с места был в группе, в которой были тренировки с эластичными лентами – на 4,3 см; в группе, где использовались изометрические упражнения, прирост прыжка в длину с места составлял 10,9 см; в группе, в которой тренировались с утяжелителями, прирост прыжка в длину с места был 14 см; 2) прирост показателя жима ногами под углом 45 ˚ в группе, которая использовала как утяжелитель эластичные ленты, оказался самым низким – 14 кг; в группе, выполнявшей изометрические упражнения, самый высокий – 19,5 кг; в группе, которая использовала утяжелители – 18 кг.

Выводы: Наш эксперимент предусматривал сравнения влияния на развитие взрывной силы различных утяжелителей – эластичных лент, изометрических упражнений, отягощения массой предметов; он продемонстрировал, что, несмотря на ожидания респондентов, использование эластичных лент не имеет достоверного преимущества перед другими средствами нагрузки. Жгуты показали более низкие результаты, чем тренировка с использованием изометрической нагрузки и отягощения массой предметов. Использование упражнений в изометрическом режиме нагрузки показало значительный прирост взрывной силы, хотя это не соответствовало ожидаемым результатам. Использование отягощения массой предметов показало ожидаемо высокие результаты. Итак, прогноз по высокой эффективности использования эластичных лент как средства нагрузки оказался ложным.

Ключевые слова: нагрузка (обременения массой предметов), утяжелитель, изометрические упражнения, ожидаемая эффективность, сила

Introduction

Today it is impossible to imagine highachievement sports and health-related fitness without the effective development of physical qualities. At the same time, for many kinds of sports such a quality as explosive power is especially important. It is necessary in football, volleyball, handball, basketball and other kinds of sports, which are characterized by kicking or jumping, as well as in various types of martial arts, the technical implementation of the elements of which involves movements to overcome resistance for a minimum period of time (kicks, throws and protective actions).

Scientists' workanalysis confirms that the explosive power development is important for many kinds of sports. In football, in particular, according to S. Zhuravliov, the quality of the outer explosive power is manifested primarily in a quick start or a strong blow of the ball [1]. The importance of the development of explosive power for football players was also emphasized by M. Almizan, M. Desman, M. Ilham [2]. They separately analyzed the effect of explosive power exercises on the effectiveness of goal kicks, pointing to the significant effectiveness of using exercises to develop the explosive power of leg muscles to increase the effectiveness of goal kicks.

In volleyball, most techniques also require the action of an explosive power. In view of this, special power training of volleyball players should be aimed primarily at developing speed and strength abilities of athletes. For example, performing an upper two-handed transmission requires a certain level of development of hand muscle power; for serving the ball – the power of the hand muscles, shoulder girdle and torso muscles; for an attacking blow – the complex development of the explosive power of the hand muscles, shoulder girdle, torso and legs [3].

At the same time, the importance of the explosive power development in basketball was studied by Aksović, Kocić, Berić, Bubanj [4]. Researchers insist on the need to pay considerable attention to training aimed at explosive power development as it is an effective means of improving the performance of basketball players.

We should note that different methods are used to develop the explosive power. However, the main component is such weights as athletes' body weight and various objects. In view of this, Yuliandra, Nugroho, Gumantan [5] developed and introduced a method of circuit training with alternating exercises of different orientation and intensity for the explosive power development. Some experts suggest the use of special programs with jumps with weights of different ranges for the training of football players in the pre-season period, in which the weight is the body weight of athletes [6]. Investigating the effect on the explosive power of football players' shoulders, J. Segaran, A. Sundaram also used weights of body weight and weight of objects [7].

The development of the explosive power of judokas with the use of weights and special training techniques in conditions of moderate hypoxia (2320 m above sea level) has been studied by a number of authors [8]. As a result, experts showed that the group of hypoxia reached higher peaks in peak speed and jump height than the group of normoxia (peak speed: 8.8 vs. 5.6%, jump height: 8.2 vs. 1.4% respectively).

In addition, the influence of different methods of isometric loading (with fast (1 s) and long (3 s) voltage) on the development of explosive power was studied by Lum, Barbosa, Joseph, Balasekaran [9]. The work proved the high efficiency of long-stress exercises for the explosive power development.

As it can be seen, experts pay considerable attention to various methods of explosive power development, but many aspects are still poorly understood, including the effectiveness of various means of weighting, such as elastic training bands (resistance bands) which have recently become very popular. At the same time, we assume that different means of weighting in the process of explosive power development will have different effects even under the conditions of application of the same method of their usage, which may not correspond to the expected results.

Purpose: to research the effectiveness of elastic training bands (resistance bands) application to develope explosive strength in a comparative aspect.

MaterialandMethods

Participants

The study was conducted on the basis of the research laboratory of functional diagnostics and physical rehabilitation of the Academy of Recreation Technologies and Law. The study involved 60 students (40 girls and 20 boys) aged 18-19 years old, who possess an excellent, very good or good health status.

Procedure

A questionnaire survey was conducted among the participants of the experiment to analyze the expected effectiveness of various means of explosive power development: objects weighting, weighting with elastic training bands and isometric exercises. During the survey, it was proposed to estimate the

level of effectiveness that students expected from the use of the proposed tools for the development of explosive and maximum power: low, medium or high.

Standing long jump (to estimate the explosive power development) and leg press in the simulator at an angle of 45° (to determine the maximum force) were used as control tests. According to the results of the jump, students were divided (randomly) into three homogeneous groups according to gender. The choice of weighting in the group was also determined randomly. It should be noted that jumping exercises were excluded from training to prevent the effect of improving the actual technique of jumping on the result of the effect. Trainings were held in all the groups twice a week for two months.

The first group performed the leg press exercise at an angle of 45°, where the weight was an elastic training band (overcoming elasticity). The amount of weighting was 80% of the maximum in this exercise. The number of repetitions in one approach was 10. The rate of motor actions – 70-100% with an emphasis on the fastest performance of the working (overcoming) phase of motor action. The number of approaches was 6. The duration of active rest was before recovery of pulse to the level of91-110 beats·min^{-1}. During the rest, the members of the first group performed exercises to restore breathing, relaxation and moderate stretching.

The second group performed a leg press lying at an angle of 45° in an isometric mode (fixing the platform). In the process of performing exercises in isometric mode, the amount of effort was 80%, the duration was 2-3 s with installation on achievement of the maximum isometric pressure as soon as possible. Tension was performed with respiratory arrest after incomplete inhalation and with tension itself. After stress, the members of the second group made slow exhalations and 2-3 incomplete breaths before re-stress. In one approach, students performed 10 repetitions. The number of approaches was 6. The duration of active rest was before recovery of pulse to the level of 91-110 beats·min^{-1}. During the rest, they performed exercises to restore breathing, relaxation and moderate stretching.

The third group performed the exercise with leg press lying at an angle of 45° using weights (weighting objects). The amount of weighting was 80% of the maximum in this exercise. The number of repetitions in one approach was 10. The rate of motor actions – 70-100% with an emphasis on the fastest performance of the working (overcoming) phase of motor action. The number of approaches was 6. The duration of active rest was before recovery of pulse to the level of 91-110 beats·min^{-1}. During the rest, the members of the third group performed exercises to restore breathing, relaxation and moderate stretching.

Thus, each of the groups was asked to perform the same training exercise for the explosive power development with legs in the simulator at an angle of 45°. The difference was the use of different types of weighting.

The study materials were subjected to statistical processing using methods of parametric and nonparametric analysis. Accumulation, adjustment, systematization of source information and visualization of the results were carried out in spreadsheets Microsoft Office Excel. Statistical analysis was performed using the program STATISTICA 10.0 (developer – StatSoft.Inc).

Quantitative values were evaluated for relativeness of normal distribution by the Kolmogorov-Smirnov test (KS-d). The distribution in the sample of the obtained quantitative values of a standing long jump and a leg press lying at an angle of 45° is close to normal (KS-d = 0.092-0.121, p> 0.20).

The obtained data were combined into statistical arrays, in which the calculation of arithmetic mean values ($\bar{x}$) and standard deviations (S) within 95% of the confidence interval (95% CI) has been performed.

Table 1

Sample relativeness to the law of normal distribution, n=60

Maximumandexplosivepowervalues	$\bar{x}$	S	KS-d	p
Standing long jump	185.12	38.06	0.095	> 0.20
Foot press at an angle of 45°	122.92	31.02	0.120	> 0.20

While comparing the averages in normally distributed sets of quantitative data, Student's t-test was calculated. The obtained values of Student's t-test were evaluated by comparison with critical values. Student's t-test was used to compare the averages calculated for the related samples. The differences in values were considered statistically significant at a significance level of p <0.05.

Nominal data were described in absolute values and in percentages. The comparison of nominal data was performed using Pearson's criterion $\chi 2$. At the same time, the Yates's correction for continuity (Yates's chi-squared test) and F-test were applied if necessary.

Results

In a survey of students in order to analyze the expected effectiveness of the use of various means for the explosive power development it was found that the expected result from the use of weighting with elastic training bands were as follows: low rate was presented by 10.0% of respondents, medium – 25.0% and high – 65.0% of respondents . Isometric exercises were rated as highly effective by only 5.0% of respondents, medium- and low-effective – 38.33% and 56.66%, respectively. Explosive power training with the use of weighting of objects as low-effective was not assessed by any student as medium-effective – by 38.33%, high-effective – by 61.67% of respondents. No significant differences in responses among men and women were found in each group (Table 2).

Thus, 65% of students consider a highly effective means of explosive power training with the use of elastic training bands with the use of weight – 61.67% and isometric weight only – 5.0% of respondents.

Table 2

Self-assessment of the expected effectiveness of the explosive power development due to the use of different methods of loading, % (numbers)

The expected effectiveness of the explosive power development	Using resistance bands			Using isometric exercises			Usingweightingobjects		
	Total	Men	Women	Total	Men	Women	Total	Men	Women
Low	10.0 (6)	13.34 (2)	8.88 (4)	56.66 (34)	60.0 (9)	55.56 (25)	0 (0)	0 (0)	0 (0)
Average	25.0 (15)	33.33 (5)	22.22 (10)	38.33 (23)	33.33 (5)	40.0 (18)	38.33 (23)	40.0 (6)	37.78 (17)
High	65.0 (39)	53.33 (8)	68.89 (31)	5.0 (3)	6.67 (1)	4.44 (2)	61.67 (37)	60.0 (9)	62.22 (28)

Analysis of the expected effectiveness of the use of various means for the development of power revealed that the expected result from the use of weighting with elastic training bands was rated as low by 6.67% of respondents, as average – 50.0%, as high – 43.33% of respondents. Isometric exercises were rated as highly effective by 25.0% of respondents, medium- and low-effective – 41.67% and 33.33%, respectively. Power training with the use of weights as low-effective was not rated by 1.67% of students, as medium-effective – 13.33% highly effective – 85.0% of respondents. There were also no significant differences in responses among boys and girls in each group (Table 3).

Thus, 43.33% of students consider power training with the use of resistance bands a highly effective tool, using isometric weight – 33.33%, and using weights – 85.0% of respondents.

Table 3

Self-assessment of the expected efficiency of power development due to the use of different methods of loading, % (numbers)

The expected efficiency of power development	Using resistance bands			Using isometric exercises			Usingweightingobjects		
	Total	Men	Women	Total	Men	Women	Total	Men	Women
Low	6.67 (4)	0 (0)	8.89 (4)	25.0 (15)	26.67 (4)	24.44 (11)	1.67 (1)	6.67 (1)	0 (0)
Average	50.0 (30)	53.33 (8)	48.89 (22)	41.67 (25)	40.0 (6)	42.22 (19)	13.33 (8)	20.0 (3)	11.11 (5)
High	43.33 (26)	46.67 (7)	42.22 (19)	33.33 (20)	33.33 (5)	33.33 (15)	85.0 (51)	73.33 (11)	88.89 (40)

Thus, the results of the survey showed a high expected efficiency of explosive power development using elastic resistance bands as a means of loading in comparison with isometric exercises ($\chi 2 = 50.15$; $p = 0.0001$) and the use of weights ($\chi 2 = 5.32$; $p = 0.02$). The same high expected efficiency of power development using elastic resistance bands (as a means of loading) was in comparison with isometric

exercises ($\chi 2 = 5.42$; $p = 0.02$) and using weights ($\chi 2 = 4.33$; $p = 0.05$).

The next step was to test the hypothesis about the expected effectiveness of the use of elastic training bands for the development of power and explosive power.

According to the results of the experiment the following data were obtained. In the group that used elastic training bands as a means of weighting the rate of standing long jump increased by 4.3 cm ($p < 0.05$) (in the male group – 5.5 cm, $p < 0.05$, in the female group – 4.0 cm, $p < 0.05$). In the group where isometric exercises were used the increase in standing long jump was 10.9 cm ($p < 0.05$) (men – 10.1 cm, $p < 0.05$, women – 11.2 cm, $p < 0.05$). In the group using weights, the increase in standing long jump was 14 cm ($p < 0.05$) (men – 12.2 cm, $p < 0.05$, women – 15 cm, $p < 0.05$) (Table 4).

Thus, there is a significant increase in the rate of standing long jump in all groups regardless of gender. The smallest increase in the rate of standing long jump was in the group that used elastic training bands as a means of weighting. Due to the gender characteristics, the smallest increase in the rate of standing long jump was in women of the first group, and the largest – in women of the third group. Talking about men, the smallest increase in the rate of long jump was also found in the first group and the largest increase in men in the third group.

There were no statistical differences between the groups of students in different programs in both the initial and final values of the standing long jump. neither in the general samples, nor among men and women (Table 4).

We should note that the initial and final values of the standing long jump among men and women differ significantly in the three groups (Table 4).

The increase in leg pressure at an angle of 45° in the group that used elastic training bands as a means of weighting was 14 kg ($p < 0.05$) (men – 16 kg, $p < 0.05$, women – 13.3 kg, $p < 0.05$). In the group performing isometric exercises there was an increase of 19,5 kg ($p < 0,05$) (in men by 22 kg, $p < 0,05$, in women by 18,7 kg, $p < 0,05$). In the group that used weights, the increase in leg pressure at an angle of 45° was 18 kg ($p < 0,05$) (men – 26 kg, $p < 0,05$, women – 15,3 kg, $p < 0,05$) (Table 4).

Thus, there is a significant increase in the rate of leg press at an angle of 45° in all the groups regardless of gender. The smallest increase in the index of leg press at an angle of 45° was observed in the group that used elastic training bands as a means of weighting. Due to the gender characteristics, the smallest increase in the rate of leg press at an angle of 45° was presentedin women of the first group, and the largest – in women of the second group. Talking about men, the smallest increase in leg pressure at an angle of 45° was also found in the first group, and the largest increase in men was in the third group.

We should note that the initial and final values of leg press at an angle of 45° among men and women differ significantly in the three groups (Table 4).

There were no statistical differences between the groups of students in different programs, both in the initial and in the final values of the foot press at an angle of 45°, in the general samples and among men and women (Table 4).

Table 4

Effectiveness of the influence of various means of weighting on the maximum and explosive power, $\bar{x}\pm S$

Maximumandexplosivepowervalues		Sex	1. Using resistance bands	2. Using isometric exercises	3. Usingweightingobjects
Standing long jump	Initial values	Total	185.05±40.37	185.25±38.41	185.15±37.28
		Men	232.1±30.64	231.92±27.85	232.2±24.67
		Women	168.93±27.31#	169.01±27.83#	169.05±26.5#
	Final values	Total	189.35±39.46‡	196.15±36.67‡	199.15±35.92‡
		Men	237.6±29.44	242.0±25.76‡	244.4±22.24‡
		Women	172.93±26.65‡#	180.16±25.18‡#	184.06±25.19‡#
Foot press at an angle of 45°	Initial values	Total	127.75±32.01	120.75±30.40	120.25±31.64
		Men	153.0±22.24	155.0±28.06	156.0±29.87

		Women	119.33±30.75#	109.33±21.7#	108.33±22.25#
	Final values	Total	141.75±29.70⁑	140.25±29.27⁑	138.25±33.69⁑
		Men	169.0±24.34⁑	177.0±26.36⁑	182.0±22.52⁑
		Women	132.66±25.97⁑#	128.0±17.9⁑#	123.66±21.9⁑#

Noutes: ⁑ – p < 0.05 in comparison with output data; * – p < 0.05 in comparison with the first group; ** – p < 0.05 in comparison with the second group; *** – p < 0.05 in comparison with the third group; # – p < 0.05 among men and women.

Discussion

Expected effectiveness analysis of various tools for the explosive power development shows that students consider the use of elastic training bandsas the most effective. It is noteworthy that the effectiveness of this means of weighting has been confirmed in a number of articles. In particular, the study of scientists showed the high efficiency of the use of elastic training bands in the training process of handball players of the experimental group in comparison with the control one [10]. However, it should be noted that the control group did not use special exercises to develop explosive power.

At the same time, a number of researchers in their works [11] have shown the effectiveness of using elastic training bands to develop the power of throwing the ball over a six-week cycle. However, it should be noted that the exercises with elastic training bands were performed in the experimental group before the main classes, and in the control group the main classes were only held and there were no additional exercises for the development of explosive power. It should be noted that in taekwondo exercises with ribbons are actively used to increase the power of impact. The researchers also formed three groups, within two groups,performing exercises on additional resistance with different elastic training bands in addition to basic training. At the end of the six-week period, the groups working with the tapes as additional weights received the best result in terms of impact power. However, the control group members did not perform additional training with other types of weighting [11].

It should be noted that in all the above studies, which demonstrated the effectiveness of the use of elastic training bands, the control group was not offered other types of weighting for the explosive power development, which made it impossible to estimate the effectiveness of this weighting tool compared to others. Instead, our experiment compared different weights and demonstrated that the use of elastic training bands does not have a significant advantage over other weights.

Despite a number of experts'studiesit is noteworthy that in our paper, the use of exercises in the isometric mode of loading showed a significant increase in explosive power, although it did not meet the expected results [12]. Investigating the effect of isometric stresses on the effectiveness of the jump, scientists have proven the positive effect of isometric stresses on the explosive power values [12]. In their study specialists Lum, Barbosa, Joseph, Balasekaran also described the positive effect of isometric loads with the duration of 3 s (SIST) on explosive power values [13]. S. Jadhav noted an increase in jump height due to the use of isometric training [14]. Oliveira, Oliveira, Rizatto and Denadai proved the positive effect of a six-week training cycle using isometric exercises on the explosive power development [15].

However, in our experiment the use of weights showed the expected high results (Table 3), which also did not contradict the previous studies. Individual scientists [16] in their works proved the effectiveness of exercises with weights to improve the jump. VilaÇa, Alves, Rebelo, Abrantes, Sampaio in their work showed the effectiveness of power training for the explosive power development in football players [17].

It should be noted that there is a correlation between the values of maximum power and an explosive one. This is, in particular, confirmed by the study of Ivanović and others.In their work they show a positive correlation between the values of maximum power and explosive power [18]; the investigation of Andersen and Aagaard [18] showed a correlation between maximum power and an explosive one, and was higher in cases where the reduction time lasted more than 90 ms [19].

As you can see, our data confirm the results of these studies. We found a high degree of relationship between poweritself and explosive power in terms of the standing long jump and bench press at an angle of 45° (r = 0.877) in men and the average (r = 0.629) in women.

Thus, the predicted high efficiency of the use of elastic training bands as a means of weighting did not justify itself. This tool did not show better results

than training loads using isometric loading and weighting of objects. We should note that the low (56.6%) expected efficiency of the explosive power development from exercises in the isometric mode was more effective in comparison with weighting using elastic training bands.

Conclusion

1. According to the results of the questionnaire, the high expected efficiency of explosive power development was definedby the use of elastic training bands as a means of weighting in comparison with isometric exercises ($\chi 2 = 50.15$; $p = 0.0001$) and in comparison with the use of weights ($\chi 2 = 5.32$; $p = 0.02$). The same high expected efficiency of power development has been defined due to the use of elastic training bands as a means of weighting in comparison with isometric exercises ($\chi 2 = 5.42$; $p = 0.02$) and in comparison with the use of weights ($\chi 2 = 4.33$; $p = 0.05$).

2. Significant positive dynamics of the standing long jump while using various means of training loading (resistance bands, isometric exercises. weights) is established. However, in the group that used elastic training bands as a means of weighting, the rate of the standing long jump increased by 4.3 cm ($p < 0.05$). In the group where isometric exercises were used, the increase in the standing long jump was 10.9 cm ($p < 0.05$). In the group in which weights were used, the increase in the standing long jump was 14 cm ($p < 0.05$).

3. Significant positive dynamics of the leg press at an angle of 45° due to the use of various means of training load (using elastic training bands, isometric exercises, weights) was also established. The increase in leg pressure at an angle of 45° in the group that used elastic training bands as a means of weighting was 14 kg ($p < 0.05$). In the group performing isometric exercises it was 19.5 kg ($p < 0.05$). In the group that used weights – 18 kg ($p < 0.05$).

Conflict of interest

The authors declare that there is no conflict of interest.

References

1. Zhuravl'ov SO. Rozvitok shvidkisnoi sili i shvidkisno-silovoi vitrivalosti u futbolistiv komand VNZ. Materials of the XV International scientific and practical Conference «Areas of scientific thought-2018/2019» (30 December, 2018 - 7January, 2019). C. 37–40. (In Ukrainian).
2. Almizan MY, Desman MA, Ilham M. Explosive Power Exercises Models on Shooting Ability on Football Extracurricular Students at SMAN 2 Lubuk Basuk Agam. *Advances in Social Science, Education and Humanities Research.* 2019, 464 https://doi.org/10.2991 / assehr.k.200824.189.
3. Volejbol / Pod red. A. B. Beliaeva, M. V. Savina. Moskva, 2000. 368 p.(In Russian).
4. Aksović N, Kocić M, Berić D, Bubanj S. Explosive Power in Basketball Players. *Physical Education and Sport*. 2020;1(18):119–134. https://doi.org/10.22190/FUPES200119011A.
5. Yuliandra R, Nugroho RA, Gumantan A. The Effect of Circuit Training Method on Leg Muscle Explosive Power. *Journal of Physical Education, Sport, Health and Recreations.* 2020;9(3):157–161. Available from: https://journal.unnes.ac.id/sju/index.php/peshr/article/view/39989/17274.
6. Loturco I, Pereira LA, Reis VP, Bishop Ch, Zanetti V, Alcaraz PE, Freitas TT, Mcguigan MR. Power training in elite young soccer players: Effects of using loads above or below the optimum power zone. *Journal of Sports Sciences*. 2020; 38:11-12, 1416-1422. https://doi.org/10.1080/02640414.2019.1651614.
7. Segaran J, Sundaram AS. Effect of Resistance Training on Shoulder Strength and Arm Explosive Power of Football Players. *International Journal of Engineering Research and Applications*. 2021;11(1),(Series-II):01-04. https://doi.org/10.9790/9622-1101020104.
8. Almeida F, Padial P, Bonitch-Góngora J, Fuente de la B, Schoenfeld B J, Morales-Artacho AJ, Benavente C, Feriche B.Effects of Power-Oriented Resistance Training During an Altitude Camp on Strength and Technical Performance of Elite Judokas. *Frontiers in Physiology*. 2021; February 12. https://doi.org/10.3389/fphys.2021.606191.
9. Lum D, Barbosa TM, Joseph R, Balasekaran G. Effects of Two Isometric Strength Training Methods on Jump and Sprint Performances: A Randomized Controlled Trial. *Journal of Science in Sport and Exercise*. 2021;3(6). https://doi.org/10.1007/s42978-020-00095-w.
10. Aloui G, Hammami M, Fathloun M, Hermassi S, Gaamouri N, Shephard RJ, Chelly MS. Effects of an 8-Week In-Season Elastic Band Training Program on Explosive Muscle Performance, Change of Direction, and Repeated Changes of Direction in the Lower Limbs of Junior Male Handball Players. *JournalStrength Cond Res*. 2019 Jul;33(7):1804-

1815. https://doi.org/10.1519/JSC.0000000000002786.
11. Mascarin NC, Barbosa de Lira CA, Vancini RL, Pochini A de C, Carlos da Silva A, Dos Santos Andrade M. Strength Training Using Elastic Bands: Improvement of Muscle Power and Throwing Performance in Young Female Handball Players. *Journal of Sport Rehabilitation*. 2017 May;26(3):245-252. https://doi.org/10.1123/jsr.2015-0153.
12. Erol Kovačević, Armen Klino, Fuad Babajić, Asim Bradić. Effects of Maximum Isometric Contraction on Explosive Power of Lower Limbs (Jump Performance). *Sport SPA*. 2010;7(1):69-75. Available from: File:///C:/Users/Acer/Downloads/EFFECTS_OF_MAXIMUM_ISOMETRIC_CONTRACTION_ON_EXPLOS%20.Pdf.
13. Lum D, Barbosa TM, Joseph R et al. Effects of Two Isometric Strength Training Methods on Jump and Sprint Performances: A Randomized Controlled Trial. *Journal* of SCI. IN SPORT AND EXERCISE. 2021;3:115–124. https://doi.org/10.1007/s42978-020-00095-w.
14. Jadhav SB. Effects of Isometric Training on Explosive Strength in Adult Male Ground Activity Peoples. *Research Review*. 2020;7(92):24-26. Available from: http://www.researchreviewonline.com/issues/volume-7-issue-92-december-2020/RRJ345933.
15. Oliveira B.D. F, Oliveira S.C. A, Rizatto F. G, Denadai S. B. Resistance training for explosive and maximal strength: effects on early and late rate of force development. *Journal of Sports Science and Medicine*. 2013;2: 402-408. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3772581/pdf/jssm-12-402.pdf.
16. Wirth K, Keiner M, Hartmann H, Sander A, Mickel Ch. Effect of 8 Weeks of Free-Weight and Machine-Based Strength Training on Strength and Power Performance. *Journal of Human Kinetics.* 2016;53:201-210. https://doi.org/10.1515/hukin-2016-0023.
17. VilaÇa JM, Alves M, Rebelo AN, Abrantes C, Sampaio J. Short-Term Effects of Complex and Contrast Training in Soccer Players' Vertical Jump, Sprint, and Agility Abilities. *Journal of Strength and Conditioning Research*. 2010;24(4):936-941. https://doi.org/10.1519/JSC.0b013e3181c7c5fd.
18. Ivanović J, Dopsaj M, Ćopić N, Nešić G. Is There a Relation Between Maximal and Explosive Leg Extensors Isometric Force? *Physical Education and Sport*. 2011;9(3):239 – 254. Available from: http://facta.junis.ni.ac.rs/pe/pe201103/pe201103-03.pdf.
19. Andersen LL, Aagaard P. Influence of maximal muscle strength and intrinsic muscle contractile properties on contractile rate of force development. *European Journal of Applied Physiology*. 2006; 96(1):46-52. https://doi.org/10.1007/s00421-005-0070-z.
20. Costa-Paiva LH, Cuneo FC, Farfan JA, Pedro AO, Pinto-Neto AM. Effect of Hydrolyzed Collagen Supplementation on Bone Metebolism of Osteopenic Postmenopausal Women. *Menopause-the Journal of the North American Menopause Society.* 2008;15(6):1214-.
21. Guo L, Pan Q, Chen C, Lin S, Li Y, Li X, et al. The Effect of FGF21/GLP-1 Fusion Protein on Glucose and Lipid Metebolism Using Diabetic Mice Models. *Diabetes*. 2020;69.

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