

Effects of varied packages of plyometric training on selected motor ability components among university students

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Abstract

Purpose: The main focus of the study was to examine the effect of varied packages of plyometric training on speed, leg explosive power, and muscular endurance among university students.

Material: Sixty students (age= 21.37±1.40) were divided into two groups namely, Control Group (CG, n=15) and Experimental Group (EG, n=45). The EG was further divided into three different groups based on the different training packages such as Low, Medium, and High-Intensity plyometric training. The .05 level of confidence was fixed as the level of significance to test the 'F' ratio obtained by the analysis of covariance, which was considered as appropriate. Plyometric training for a period of eight weeks offered to the participants of the Experimental Group.

Results: The results revealed that various plyometric training programs have produced significant development in improving motor ability components such as speed, leg explosive power, and muscular endurance of the participants ($p<.05$). The results indicated that high-intensity plyometric training was noticed as superior then low and medium intensity plyometric training in the perspective of the effect of varied packages of plyometric on selected motor ability components among participants.

Conclusions: Keeping in view the utility and importance of plyometric training, we recommended that the exercise protocol used in this study may helpful for the development and improvement of such components to get peak performance in sports.

Keywords: effect, varied packages, speed, muscular endurance, leg explosive power

Operational Definitions of the Terms:

Plyometric Training: Plyometric training refers to exercise that enables a muscle to reach maximal strength in a short time as possible.

Speed: Speed is generally defined as quickness. In the field of physical education and sports, the term speed refers to the quick action of the limbs.

Explosive Leg Power: A maximum or near maximum power output in the shortest possible is called.

Muscular Endurance: Muscle endurance is the ability of a muscle or group of muscles to exert force for a longer duration.

Introduction

Sports training is a planned and controlled process aimed to promote motor performance as well as to positively change the behavior of a person [1]. For the positive outcome of training, it is considered important to perform the training according to its principles [2].

The importance of sports training can be assessed by the fact that all other kinds of facilities provided to athletes may prove to be futile if the athletes are not provided with effective sports training. Without proper sports training, one cannot achieve or fulfill his/her potentials [3]. Comprehensive sport training has paramount significance in producing peak performance in sport [4].

Sedaghati [5] single out that body adaptations and the high level of achievement in different sporting fields depend on the degree of fitness and training. Among the numerous types of available exercises, plyometrics assist in the development of power, a foundation from which the athlete can refine the skills of their sport [6].

Regular participation in plyometric training is considered important for improving the standard of muscular endurance [7]. According to researchers [8], plyometric training is basically done for improving the endurance of muscle as well as adopting of muscles. Plyometric is not inherently dangerous, but the highly focused and intense movements used in repetition may increase the potential level of stress on joints, muscles, and tendons units [9].

El-Ashker et al. [10] assessed the impact of 8-weeks plyometric training program on the sprint and jump performance. The authors defined the plyometric training can be recommended to athletics coaches as an additional training alternative to improve sprint and long jump abilities in athletes.

Golzari et al [11] compared the impact of 6-weeks strength and plyometric exercises on some of the kinematic parameters of the lower extremities in the impact on female football players aged 20 to 25 years. The findings show that 6-week strength and plyometric exercises can significantly improve the speed parameters of the ball, the angular velocity of the knee joint and the angular velocity of the hip in the impact performance on

the foot of female soccer players.

The other investigations defined that:

- Specific stretching exercises combined with plyometrics may be more beneficial than other training strategies in young sprint-hurdles [12];
- The use of progressive plyometric exercise on an unstable surface shows an improvement in the results of the functional movement screening test and movement performance [5].
- A proper progression and detailed program planning should be utilized when implementing plyometric exercises due to their different impact kinetics and how they might influence the body upon ground contact [13].

Plyometric preparation adds to change in upright hop execution, quickening, leg quality, strong power, the increment of joint mindfulness, and in general game particular aptitudes [14].

However, little scientific information is currently available to determine whether plyometric training truly boosts skill performance in individuals [15].

Different training methods are used to develop physical fitness components. Each method aims to develop one or the other components. The selection of the method depends upon the period of training, level of athlete, age, and sex of athletes. The selection of the correct training method is very much important for the type of training being offered to the athletes. This particular study focused to examine the effect of varied packages of plyometric training on speed, leg explosive power, and muscular endurance among untrained university students.

Research Hypotheses

Based on available data it was hypothesized that:

- HA 1. There is a significant effect of varied packages of plyometric training on speed.
- HA 2. There are significant mean differences in the effects of varied packages of plyometric training on speed.
- HA 3. There is a significant effect of varied packages of plyometric training on leg explosive power.
- HA 4. There are significant mean differences in the effects of varied packages of plyometric training on leg explosive power.
- HA 5. There is a significant effect of varied packages of plyometric training on muscular endurance.
- HA 6. There are significant mean differences in the effects of varied packages of plyometric training on muscular endurance.

Material and Methods

Participants

The participants of this research comprised of Sixty (n=60) healthy undergraduate university male students of Gomal University, Dera Ismail Khan. The students (age= 21.37±1.40) were divided into two groups namely, Control Group (CG, n=15) and Experimental Group (EG, n=45). The EG was further divided into three different groups based on the different training packages such as Low, Medium, and High-Intensity plyometric training. Plyometric training for a period of eight weeks offered to

the participants of the Experimental Group.

Inclusion Criteria

The subjects included in the study by adopting the following inclusion criteria:

1. All male students included in the study;
2. The healthy student included in the study;
3. The student aging 20-23 years included in the study.

The study was conducted in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki).

Research Design

The study contains a single-dimensional design consisted of four portions by giving various sets of exercise. In order to assist the investigation, sixty unskilled healthy undergraduate university male students at the age of 20 to 23 were selected as subjects through random sampling. The subjects of the study distributed into four equal groups namely Experimental Group (EG) A. (First Package of Plyometric training) Group B. (Second Package of Plyometric training) Group C. (Third Package of Plyometric training) and Group D. (Control Group) did not involve in any training. The selected student was evaluated through different tests before administering plyometric training. Plyometric training for a period of eight weeks in the direction of the researcher offered to the selected group of individuals. At the end of eight weeks, the post-test was taken.

Test Protocol

We used a modified test protocol. A Pilot Study was conducted for the purpose of finalizing and deciding up upon the intensity and duration of the various packages of a plyometric training program. The Pilot Study was conducted with twenty (n=10) subjects to know the suitability of varied packages of plyometric training and to find out the difficulties and shortcomings of the study.

Collection of Data

Low, Medium and High Intensity of plyometric training were given as per the training schedule. The pre and post check records on the chosen criterion variables were accumulated by way of administering the test as in step with the standardized procedures before and after the eight weeks of the program.

Experimental Procedure (Fig. 1.).

Selection of the Tests

The study in hand examined the effects of assorted programs of plyometric training, (Low, Medium & High intensity) on selected motor ability components such as Speed, Leg explosive power, and Muscular endurance among college male students. On the base of the present literature, the given test was conducted to gather associated information on the dependent variables which are given below (table 1).

Criterion Measures

1. *Speed.* The Speed of the subjects was measured by using a 50 yards' dash test. The measurement will be recorded 1/100 of the seconds.
2. *Leg Explosive Power.* For measuring Leg Explosive Power, standing broad jump test was used and

the unit of measurement were taken in meters.

3. **Muscular Endurance.** For measuring Muscular Endurance, sit ups test was used and the unit of measurement were taken in counts.

Equipment used

The following equipment was used during the conduction of the test:

1. Paint;
2. Table;
3. Rope;
4. Measuring tape.

Result

Effects of varied packages of plyometric training on speed

The analysis of covariance in the perspective of the effects of varied packages of plyometric training on the speed of the pre and post score of experimental groups and control group have been presented in the table mentioned below (table 2).

The above table depicts the pre-test mean score of speed regarding the effects of low intensity, medium intensity, high intensity, and control group. According to the analysed data, the mean scores were obtained 7.116, 7.114, 7.116, and 7.117 respectively for low intensity, medium intensity, high intensity, and control group.

According to the table, the obtained 'f' ratio of 0.012 is less than the table value of 2.684.

Likewise, the post-test results in terms of different groups like low intensity, medium intensity, high intensity, and control groups were recorded as 7.064, 7.046, 7.011, and 7.115. Similarly, the 'f' ratio was recorded greater than the table value ($12.982 > 2.684$).

The adjusted mean scores of the post-test were noticed as 7.004, 7.047, 7.011, and 7.114 respectively for low intensity, medium intensity, high intensity, and control group. The analysed data have shown that the 'f' value was found greater than the table value ($18.6726 > 2.684$).

Based on the data analysis, the study revealed that there existed significant differences in the mean scores of adjusted post-test with reference to the effect of varied packages of plyometric training such as low intensity, medium intensity, and high intensity upon speed.

As there found a significant difference in the 'f' ratio of adjusted post-test, therefore; the researcher applied Scheffe's test to analyze the paired mean differences (table 3).

The above table depicts the mean differences among different plyometric training groups including low intensity, medium intensity, high intensity, and control group of the participants upon speed. Accordingly,

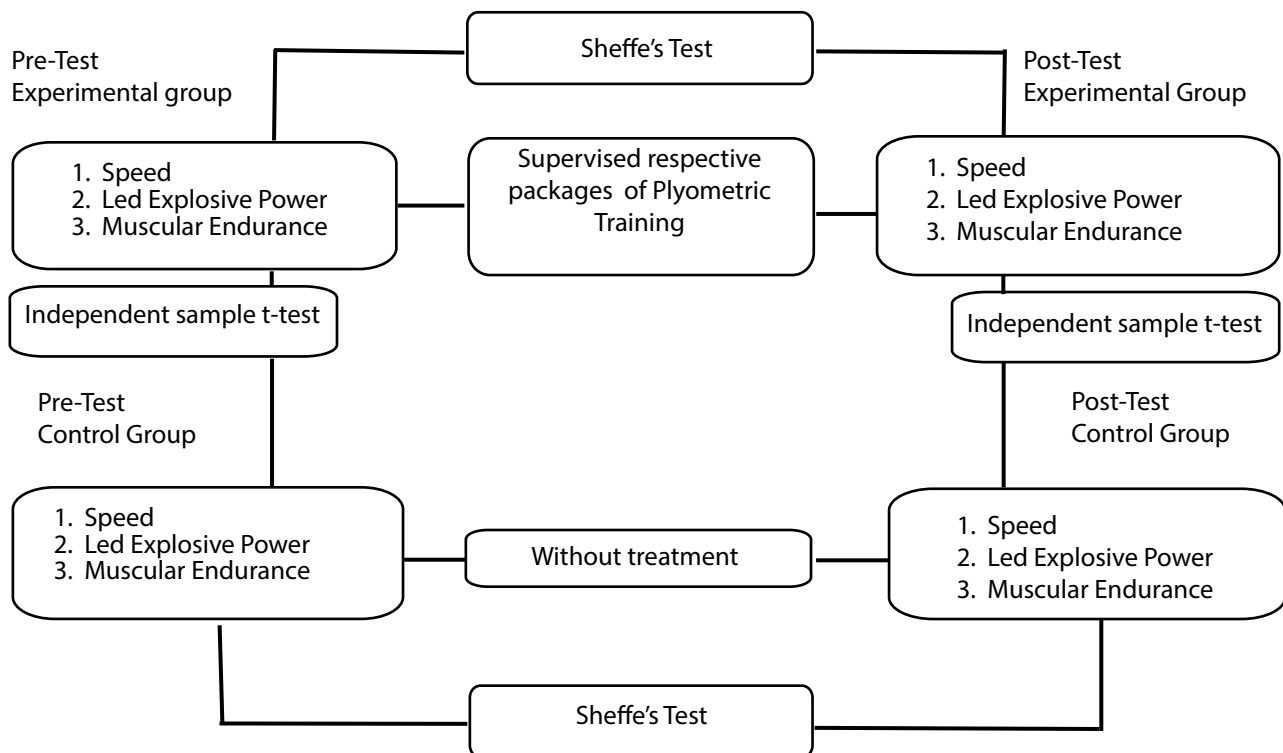


Fig. 1. Showing the experimental procedure used in the study

Table 1. Showing the description of selection of the tests

S. No	Variables	Tests applied
1	Speed	50 Yards Dash
2	Leg Explosive Power	Standing Broad Jump
3	Muscular Endurance	Sit-ups

the mean differences 0.056, 0.052, 0.665, and 0.102 respectively for low intensity, medium intensity, high intensity, and control group were found greater than the required confidence interval value (CIV) at a confidence level of 0.05. Therefore, it can be said that the above comparison was insignificant.

The table has shown the comparison between (LI) plyometric training group and (MI) plyometric training group and (MI) plyometric training group and (HI) plyometric training group. Accordingly, the results were found at 0.016 and 0.034 for the above comparison respectively. These scores were found lesser than the required confidence interval at a significant level (0.016, 0.034 < 0.04). Therefore, these two comparisons were found significant.

Effects of varied packages of plyometric training on leg explosive power

The analysis of covariance in the perspective of the effects of varied packages of plyometric training on leg explosive power of the pre and post score of experimental groups and control group have been presented in Table 4.

The above table represents the pre-test mean score of leg explosive power regarding the effects of low intensity, medium intensity, high intensity, and control group. According to the analysed data, the mean scores were obtained 2.223, 2.223, 2.229, and 2.228 respectively for low intensity, medium intensity, high intensity, and control group. According to the table, the obtained 'f' ratio of 0.542 is greater than the table value of 2.684.

Likewise, the post-test results in terms of different groups like low intensity, medium intensity, high intensity, and control groups were recorded as 2.247, 2.281, 2.323, and 2.229. Similarly, the 'f' ratio was recorded greater

than the table value (53.951 > 2.684).

The adjusted mean scores of the post-test were noticed as 2.260, 2.284, 2.320, and 2.227 respectively for low intensity, medium intensity, high intensity, and control group. The analysed data have shown that the 'f' value was found greater than the table value (128.915 > 2.684).

The study showed that there were significant differences in the mean scores of adjusted post-test with reference to the effect of varied packages of plyometric training upon leg explosive power of the selected participants.

As there found a significant difference in the 'f' ratio of adjusted post-test, therefore; the researcher applied Scheffe's test to analyse the paired mean differences (table 5).

The above table depicts the mean differences among different plyometric training groups including low intensity, medium intensity, high intensity, and a control group of the participants upon speed. Accordingly, the mean differences 0.059, 0.062, 0.56, and 0.092 respectively for low intensity, medium intensity, high intensity, and control group were found greater than the required confidence interval value (CIV) at a confidence level of 0.05. Therefore, it can be said that the above comparison was insignificant.

The table has shown the comparison between (LI) plyometric training group and (MI) plyometric training group and (MI) plyometric training group and (HI) plyometric training group. Accordingly, the results were found at 0.023 and 0.035 for the above comparison respectively. These scores were found lesser than the required confidence interval at a significant level (0.023, 0.035 < 0.05). Therefore, these two comparisons were

Table 2. Showing the analysis of covariance of pre-test, post-test, and Adjusted post-test on the speed of experimental and control groups

Test	LI	MI	HI	CG	Df	O' f' R
Pre-test Mean	7.116	7.114	7.116	7.117		0.012
Post-test Mean	7.064	7.046	7.011	7.115	(3,57)	12.982*
Adjusted Post-test Mean	7.004	7.047	7.011	7.114		18.6726*

NOTE: *Significant at 0.05 level of confidence, LI= low intensity, MI=medium intensity, HI= high intensity, CG= control group, df= degree of freedom & OFR=obtained 'f' ratio.

Table 3. Cheffe's Test showing the differences between paired means of different groups on speed

LI	MI	HI	CG	MD	CIV
7.056	7.039			0.016	0.04
7.056		7.011		0.056*	0.04
7.056			7.114	0.052*	0.04
	7.039	7.011		0.034	0.04
	7.039		7.114	0.665*	0.04
		7.011	7.114	0.102*	0.04

NOTE: *Significant at 0.05 level of confidence, LI= low intensity, MI=medium intensity, HI= high intensity, CG= control group, MD= mean differences, CIV= confidence interval value.

found significant.

Effects of varied packages of plyometric training on muscular endurance

The analysis of covariance in the perspective of the effects of varied packages of plyometric training on muscular endurance of the pre and post score of experimental groups and control group have been presented in the table below (table 6).

The sketched table represents the pre-test mean score of muscular endurance regarding the effects of low intensity, medium intensity, high intensity, and control group. According to the analysed data, the mean scores were obtained 27.433, 27.522, 27.498, and 27.565 respectively for low intensity, medium intensity, high intensity, and control group. According to the table, the obtained 'f' ratio of 0.030 is lesser than the table value of 2.684 required for significance at the 0.05 level.

Likewise, the post-test results in terms of different groups like low intensity, medium intensity, high intensity, and control groups were recorded as 30.798, 31.865, 33.423, and 27.764. Similarly, the 'f' ratio was recorded greater than the table value ($35.10 > 2.684$) required for

significance at the 0.05 level.

The adjusted mean scores of the post-test were noticed as 30.858, 31.845, 33.438, and 27.718 respectively for low intensity, medium intensity, high intensity, and control group. The analysed data have shown that the 'f' value was found greater than the table value ($97.288 > 2.684$).

The study showed significant differences in the mean scores of adjusted post-test with reference to the effect of varied packages of plyometric training upon the muscular endurance of the participants included in the study.

As there found a significant difference in the 'f' ratio of adjusted post-test, therefore; the researcher applied Scheffe's test to analyse the paired mean differences (table 7).

The above table depicts the mean differences among different plyometric training groups including low intensity, medium intensity, high intensity, and a control group of the participants upon muscular endurance. Accordingly, the mean differences 0.985, 2.578, 3.137, 1.591, 4.124, and 5.718 respectively for low intensity, medium intensity, high intensity, and control group were found greater than the required confidence interval value

Table 4. showing the analysis of covariance of pre-test, post-test and Adjusted post-test on leg explosive power of experimental and control groups

Test	LI	MI	HI	CG	df	OFR
Pre-test Mean	2.223	2.223	2.229	2.228		0.542
Post-test Mean	2.247	2.281	2.323	2.229	(3,57)	53.951
Adjusted Post-test Mean	2.260	2.284	2.320	2.227		128.915

NOTE: *Significant at 0.05 level of confidence, LI= low intensity, MI=medium intensity, HI= high intensity, CG= control group, df= degree of freedom & OFR=obtained 'f' ratio.

Table 5. Scheffe's Test showing the differences between paired means of different groups on leg explosive power

LI	MI	HI	CG	MD	CIV
2.252	2.276			0.023	0.014
2.252		2.32		0.059*	0.014
2.252			2.227	0.062*	0.014
	2.276	2.32		0.035	0.014
	2.276		2.227	0.056*	0.014
		2.32	2.227	0.092*	0.014

NOTE: *Significant at 0.05 level of confidence, LI= low intensity, MI=medium intensity, HI= high intensity, CG= control group, MD= mean differences, CIV= confidence interval value.

Table 6. Showing the analysis of covariance of pre-test, post-test, and Adjusted post-test on muscular endurance of experimental and control groups

Test	LI	MI	HI	CG	df	OFR
Pre-test Mean	27.433	27.522	27.498	27.565		0.030
Post-test Mean	30.798	31.865	33.423	27.764	(3,57)	35.10*
Adjusted Post-test Mean	30.858	31.845	33.438	27.718		97.288*

NOTE: *Significant at 0.05 level of confidence, LI= low intensity, MI=medium intensity, HI= high intensity, CG= control group, df= degree of freedom & OFR=obtained 'f' ratio.

(CIV) at a confidence level of 0.05. Therefore, it can be said that the above comparison was insignificant.

Discussion

The study was conducted to assess the Effects of Varied Packages of Plyometric Training on Selected Motor Ability Components among undergraduate university students aging 20-23. The researcher collected data from the participants of four different groups such as low-intensity plyometric training, medium intensity plyometric training, high-intensity plyometric training, and control groups. The measurements were collected in perspectives of selected motor ability components including speed, leg explosive power, and muscular endurance.

In response to the first hypothesis that there would significant effects of varied packages of plyometric training on the speed of the college boys, the data revealed a significant difference in the mean score of pre and posttests of various plyometric training in respect of the speed of subjects. According to the analysed data, the mean scores were obtained 7.116, 7.114, 7.116, and 7.117 respectively for low intensity, medium intensity, high intensity, and control group. Likewise, the post-test results in terms of different groups like low intensity, medium intensity, high intensity, and control groups were recorded as 7.064, 7.046, 7.011, and 7.115.

The above significant statistical difference of the pre and post-tests in terms of average speed time showed a clear indication of the type of advantages of low intensity, medium intensity, high-intensity plyometric training aging 18-20 years. These findings are supported by the findings of [16-18]. It is evident by their findings that experimental groups had produced positive results after 6 weeks plyometric training program. Whereas, some research's findings [19, 20] did not match the results of the present study

In respect of the hypothesis that there would significant effects of varied packages of plyometric training on leg explosive power of the college boys, the analysed data indicated, the mean scores were obtained 2.223, 2.223, 2.229, and 2.228 respectively for low intensity, medium intensity, high intensity, and control group. Likewise, the post-test results in terms of different groups like low

intensity, medium intensity, high intensity, and control groups were recorded as 2.247, 2.281, 2.323, and 2.229.

When compared to the mean score of different groups, the results exhibited significant statistical differences. The differences in the pre and post-tests showed a clear indication of the type of advantages of low intensity, medium intensity, high-intensity plyometric training holds for college boys. Similar results have been indicated by the researcher [21] as their findings revealed that concurrent endurance and circuit resistance training have produced positive effects on muscular strength and power development. Likewise, researchers [22] conducted a study and found that plyometric training has a positive effect on the perspective of the overall fitness and particularly the leg explosive power of the participants.

The hypotheses that there would significant effects of varied packages of plyometric training on muscular endurance of the college boys, the analysed inferences have shown significant mean differences in perspective of the effects of varied packages of plyometric training on muscular endurance of the pre and post score of experimental groups and control group.

These differences indicated that various plyometric training programs such as low intensity, medium intensity, high intensity have produced significant development in improving the muscular endurance of college male students. The findings of the present study are supported by the findings of [23] who found positive improvement of plyometric training on muscle functioning and athletic performance of college students. Marques et al. [24] indicated significant improvement in strength, endurance, and power performance in elite senior professional volleyball players after 6 weeks of plyometric training programs. Whereas, some other researchers [25] have found acute effects of plyometric exercise on maximum squat performance in male athletes.

Main findings of the Study

The researcher obtained the following findings after careful analysis of the collected measurements from the perspective of the effects of varied packages of plyometric training on selected motor ability components among undergraduate students aging 20-23 of Gomal University, Dera Ismail Khan, Khyber Pakhtunkhwa, Pakistan.

1. The results of the study revealed that there are

Table 7. Scheffe's Test showing the differences between paired means of different groups on muscular endurance

LI	MI	HI	CG	MD	CIV
30.858	31.845			0.985	0.982
30.858		33.438		2.578	0.982
30.858			27.718	3.137	0.982
	31.845	33.438		1.591	0.982
	31.845		27.718	4.124	0.982
		33.438	27.718	5.718	0.982

NOTE: *Significant at 0.05 level of confidence, LI= low intensity, MI=medium intensity, HI= high intensity, CG= control group, MD= mean differences, CIV= confidence interval value.

significant differences in the mean scores of adjusted post-test with reference to the effect of varied packages of plyometric training such as low intensity, medium intensity, and high intensity upon the speed of the subjects.

2. The study indicated that high-intensity plyometric training has produced a positive effect on the speed of the subjects.

3. Based on the analysed data, significant differences were noticed in the perspective of the adjusted mean scores of post-test for low intensity, medium intensity, high intensity, and control group. Therefore, it is found that plyometric training has produced a significant effect in empowering the leg explosive power among the subjects.

4. According to the analysed data, high-intensity plyometric training was noticed as superior then low and medium intensity plyometric training in the perspective of the effect on leg explosive power among the study participants.

5. Based on the significant differences in the adjusted mean scores of the post-test, the results indicated that plyometric has produced a positive effect on the muscular strength of the subjects.

6. The study has shown significant differences regarding the effect of varied packages of plyometric training upon muscular endurance as the results indicated that high-intensity plyometric training has produced a comparatively better effect upon the muscular endurance of the participants.

Conclusion

The results of the study revealed that various plyometric training programs have produced significantly

the components of motor ability components such as speed, leg explosive power, and muscular endurance of the participants. The study has shown significant differences among different training packages including low-intensity plyometric training, medium intensity plyometric training, high-intensity plyometric training, and control groups with reference to their effects on speed, leg explosive power, and muscular endurance. Based on the data analyses, the results indicated that high-intensity plyometric training was noticed as superior then low and medium intensity plyometric training in the perspective of the effect of varied packages of plyometric on selected motor ability components among college students.

Recommendations

Keeping into consideration the results of the study, the researcher recommended that:

1. The results of the study revealed that high-intensity plyometric training has produced a comparatively better effect on the research variables. Therefore, it is recommended that the coaches, trainers, and physical educationists may use high-intensity plyometric training to improve the components of motor ability components such as speed, power, and leg explosive power.

2. The researchers also recommend that the exercise protocol used in this study may help to adopt for the development and improvement of such components (Speed, Leg explosive power, and Muscle endurance) to get peak performance in sports.

Conflicts of interest

The authors declare no conflicts of interest.

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