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Study on the effect of tapering and detraining programme in plyometric training on fitness components

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Abstract
In the present study attempt has been made to find the effect of tapering and detraining of plyometric training on motor fitness. The male students categorized as novice and trained players (N=25 in each group of age 18-25 years) studying in various colleges of Bengaluru, Karnataka, India during the academic year 2018-2019 were subjected to plyometric training of various types in three alternative sessions per week of one hour per day for 12 weeks from July starting of 2018 to September end of 2018 with tapering and detraining for 2 weeks each at KVAFSU, Hebbal campus grounds, Bengaluru and the motor fitness components like speed, explosive power, muscular strength, flexibility, balance, coordination and reaction time were assessed as per standard field tests before and after the training. On the whole, the selected motor fitness tests of both the groups' novice and trained players revealed significant increase among groups with respect to the parameters after the plyometric training. Both the trained and novice subjects' improved performance was maintained during the tapering period (2 weeks) with very slight changes, while during detraining programme (2 weeks) the novice subject's performance declined but ver marginally compared to values of motor fitness immediately after plyometric training for the trained subjects' even though performance started deteriorating towards the base line but not at statistically significant level.

Keywords: Plyometric, novice, explosive power, performance, tapering period, detraining programme

Introduction
A type of exercise training with speed and force of different movements to build muscle power is termed as plyometrics. Plyometrics training helps in improving physical performance and ability to do different sports activities. Plyometric training can be recommended as an effective form of physical conditioning for augmenting vertical jump performance, yet, the effects of plyometric training could vary because of a large number of variables, such as training program design, subject characteristics (gender, age), training level, the specific sport activity, familiarity with plyometric training, program duration, and training volume or intensity (De Villarreal *et al.*, 2009) [1]. A vertical jump, sprint performance and agility tests are commonly used within research and applied settings to investigate the effects of plyometric training on physical fitness of team sports (Ramirez-Campillo *et al.*, 2014, 2015) [2, 3]. Godara (2016) [4] provided plyometric training programme for a period of six weeks with explosive strength, muscular endurance, speed and agility (Vertical jump, sit ups, 50 meters run and shuttle run tests were used respectively) for 50 national level handball players aged 14 to 15 years old divided as experimental group (N=25) and control group (N=25), belonging to Kendriya Vidyalaya STPS Suratgarh, Sri Ganganagar, Rajasthan. It was interesting note that due to the training programme experimental group increased in the explosive strength 15.44%, muscular endurance 12.46%, speed 11.13% agility 1.27% and flexibility 2.15% at the end of the treatment. Rangaraj and Rajkumar (2021) [5] gave plyometric training consisting of 45-60 min/day, 3 days in a week till twelve weeks to hockey players (N=30; age 18 ± 3.04; height 1.68±6.64 cm, Weight=58±7.36 kg) of SRMIST, Kattankulathur, Tamil Nadu, India that significantly increased their speed (10.22), muscular endurance (11.17) and flexibility (18.71) exhibiting their better performance.
Bosquet *et al.* (2007) [6] defined tapering is "reductions in the training load of athletes or sports persons in the final days before important competition, with the aim of optimizing performance". A taper represents "a reduction of the training load during a defined period of time, in an attempt to reduce the physiological and psychological stress (accumulated fatigue) of daily training and optimize sports performance".

8-14 days of taper seems to be a good duration for fatigue dissipation without potential detraining drawbacks. In summary, it was suggested that the optimal taper duration might be two weeks (Vachon *et. al*., 2021) [7]. The review findings by Stone *et al.* (2023) [8] proposed that taper is a period in which athletes or sports persons become psychologically ready to compete with improvement in mood, performance and recovery from continuous plyometric training. The primary aim of tapering is to reduce the negative effects occurred under a training period and at the same time to recover and even to increase physiological capacity. Obviously the length of tapering period has to be taken into account as well. A proper combination of training load and duration of tapering will improve the adaptations obtained during training. The tapering allows dissipation of fatigue and the physiological systems to replenish themselves and even undergo "super compensation (Meur *et al.*, 2012; Brannstrom *et al.*, 2013) [9, 10]. In a study by Izuierdo *et al.* (2007) [11] forty-six physically active men assigned to tapering (n = 11), detraining (n = 14), or control group (C; n = 21) for 4 weeks each subsequent to a 16-week plyometric training. Tapering increased leg and arm maximal strength by 2% while detraining resulted in significant decrease in maximal strength and muscle power output of the arm and leg muscles.

Detraining prevention can be defined as a set of physical training strategies aimed at limiting or counteracting detraining effects. The prevention of detraining processes is a fairly new concept, which was addressed in the field of occupational physiology (Joo, 2018) [12]. 21 days of training with continuous and intermittent endurance training for 3 days/week seem to counteract detraining effects, impairments on endurance performance, resting metabolic rate, body weight and composition have been found following 35–42 days of light-moderate exercise (Girardi *et al.*, 2020) [13].

In the present study, attempt has been made to perceive the effect of plyometric training with intervention of tapering and detraining programmes on participants.

Materials and Methods

In the present study the participants and their details along with their plyometric training test performance and statistical analysis are mentioned in this section.

About the subjects

The subjects or participants (novice & trained players) of the present study were confined to fifty male students (18-25 age group) studying in various colleges involved in any type of group games in Bangalore, Karnataka, India during the academic year 2018-2019. Of which 25 each from novice (inexperienced or untrained persons) and already trained (received 1 hour training per day continuously) categories were considered.

About plyometric training

Both novice and trained players performed plyometric training of three alternative sessions of exercises like weight lifting, endurance of 1 hour per day per week for 12 weeks. The motor fitness components chosen as follows: speed, explosive power, muscular strength, flexibility, balance, coordination and reaction time were assessed as per standard field tests (Heyward and Gibson, 2014) [14] prior to and immediately after the training period.

Motor fitness components and tests carried out with unit of measurement

Variables	Test Items	Unit of Measurement
Speed	50 mts dash	Seconds
Explosive Power	Vertical Jump	Centimeters
Muscular Strength	Bent knee sit ups	Numbers
Flexibility	Sit and Reach test	Centimeters
Balance	Stork Stand test	Seconds
Co-ordination	Alternate Hand Wall Toss Test	Number
Reaction Time	Reaction Time Ruler Test	Seconds

Tapering and Detraining

Plyometric training was tapered and detraining programme was introduced 2 weeks each simultaneously and motor fitness tests during these periods were measured and data presented in tabular form.

Statistical Analysis

All the values obtained in the result of the present study were average of three trials. The data was analysed using R software (R-4.3.1 for Windows. The R Foundation for statistical Computing https://cran.r-project.org/bin/windows /base [15] for statistical computing. ANOVA tables were prepared to analyse the data and the critical difference was calculated (P=.05) and used to identify the significant differences that are indicated in the result tables through superscripts.

The formula for the critical difference (CD) was

$CD = \sqrt{2} \times MSS\ (E)\ X\ t\alpha\ @\ 0.05$ level of significance

Where, MSS (E) = Mean Sum of squares of the error; r = number of replications; tα = Table t-value at α level of significance.

Results and Discussion

The participants divided as novice & trained players of 25 male students each in the age group between 18 and 25 years studying in various colleges in Bangalore, Karnataka, India during the academic year 2018-2019 were subjected to plyometric training three alternative sessions per week for 12 weeks and the motor fitness components like speed, explosive power, muscular strength, flexibility, balance, coordination and reaction time were assessed as per standard field tests before and after the training. Table 1 presents the data on speed, explosive power, muscle strength and flexibility obtained for novice and trained players before, after, tapering period and detraining periods of plyometric training and their analysis.

Table 1: Effect of plyometric training on novice and trained groups on speed, explosive power, muscle strength and flexibility

Training Period	Type of Group							
	Novice				Trained			
	Variables							
	Speed (Sec.)	Explosive Power (cm)	Muscle Strength (no.)	Flexibility (cm)	Speed (Sec.)	Explosive Power (cm)	Muscle Strength (no.)	Flexibility (cm)
Pre	7.21[a]	24.36[a]	49.64[a]	5.64[a]	7.87[a]	34.92[a]	64.52[a]	7.52[a]
Post	7.67[b]	29.36[b]	55.60[b]	7.68[b]	8.28[b]	39.92[b]	69.52[b]	10.52[b]
Tapering	7.57[c]	29.10[c]	55.40[c]	7.58[c]	8.00[c]	39.70[c]	69.32[c]	10.36[c]
Detraining	7.56[d]	29.00[d]	55.38[d]	7.52[d]	7.96[d]	39.54[d]	69.92[d]	10.12[d]
CD (*P*=.05)	0.35	0.93	1.11	0.61	0.40	0.87	1.03	0.49

Note:
- All the values are average of 3 trials with N=25 for novice and N=25 for trained Group
- CD – Critical difference
- Different superscripts in the column indicate significant difference at *P*=.05 level

Speed Performance

The speed performance before performing plyometric training (pre) was 7.21, 7.82 and; after training (post) was 7.87 and 8.28, for novice and trained players, respectively. The running speed improved in both groups by 6 and 5 percent after training and trained group performed better than novice group with respect to data values as the continuous trained would have helped them.

Explosive Power

The explosive power performance of novice and trained players before performing plyometric training (pre) was 24.36 and 34.92; after training (post) was 29.36 and 39.92, respectively. Explosive power in novice and trained players increased after the training by 17 and 12 per cent, respectively. The trend remained the same in power performance as observed in speed.

Muscular Strength

The muscular strength performance before performing plyometric training (pre) was 49.64 in novice group and 64.52 in trained group while after training (post) was 55.60 and 69.52, among novice and trained groups, respectively. Muscle strength improved in trained group after training compared to novice group but they also showed better muscle strength by 11 per cent.

Flexibility Performance

The novice and trained players flexibility performance before performing plyometric training (pre) was 4.64 and 7.52 and after training (post) showed improvement of 8.68 and 10.52, respectively. The trained players exhibited more flexibility when compared to novice who also were better after the training by improving the performance 46 per cent.

Table 2 indicates the mean values obtained for novice and trained players with respect to motor skills such as balance, co-ordination and reaction time and their analysis.

Balance Performance

The novice and trained players balance performance before plyometric training (pre) was 32.68 and 36.88 and after training (post) was 35.68 and 40.12, respectively. Trained players balanced better than the novice group who showed improvement by 9 per cent.

Co-ordination

The novice and trained players co-ordination performance before performing plyometric training (pre) was 19.24 and 23.52; after training (post) was 24.24 and 27.52, respectively. The performance by novice players was 20 percent and trained players accounted for 14 percent, indicating the significance of continuous training for the second group of players.

Reaction Time

The novice and trained players reaction time performance before performing plyometric training (pre) was 0.40 and 0.35; after training (post) was 0.36 and 0.33, respectively. This indicated faster reaction in trained group while novice group was also better by 12 per cent after plyometric training

All the selected motor fitness tests of both the groups' novice and trained players revealed significant increase among groups with respect to the parameters. On an average novice players exhibited 17 per cent improvement in their performance where as 11 per cent was observed in trained players which may be attributed to the continuous training provided for them.

Effect of tapering and detraining

The motor performance was maintained during the tapering period after plyometric training in both novice and trained groups, thereafter during the detraining period the novice subject's motor skill performance marginally declined while the trained subjects did not exhibit noticeable levels of reduction.

On par with the present study, Kotzamanidis (2006) [16] demonstrated improvements in vertical jump height (ranging from 4.7 to 15% that could be attributed to the enhanced coordination and muscle power after training. Godara (2016) [4] provided plyometric training programme for a period of six weeks with explosive strength, muscular endurance, speed and agility for 50 national level handball players aged 14 to 15 years old divided as experimental group (N=25) and control group (N=25), belonging to Kendriya Vidyalaya STPS Suratgarh, Sri Ganganagar, Rajasthan that revealed increased the explosive strength of 15.44%, muscular endurance of 12.46%, speed of 11.13% agility of 1.27% and flexibility of 2.15% in experimental group at the end of the treatment. Rangaraj and Rajkumar (2021) [5] also found significant increase in speed (10.22), muscular endurance (11.17) and flexibility (18.71) exhibiting better performance due to plyometric training consisting of 45-60 min/day, 3 days in a week till twelve weeks to hockey players (N=30; age 18 years of SRMIST, Kattankulathur, Tamil Nadu, India.

In agreement to the present study, Vachon *et al.* (2021) [7] opined that 8-14 days of taper seems to be a good duration for fatigue dissipation without potential detraining drawbacks. In summary, it was suggested that the optimal taper duration might be two weeks. Stone *et al.* (2023) [8] proposed that taper is a period in which athletes or sports persons become

psychologically ready to compete with improvement in mood, performance and recovery from continuous plyometric training. While Girardi *et al.* (2020) [13] also found that 21 days of training with continuous and intermittent endurance training for 3 days/week seem to counteract detraining effects, impairments on endurance performance, resting metabolic rate, body weight and composition have been found following 35–42 days of light-moderate exercise. In a study by Izuierdo *et al.* (2007) [11] forty-six physically active men assigned to tapering (n = 11), detraining (n = 14), or control group (C; N = 21) for 4 weeks each subsequent to a 16-week plyometric training. Tapering increased leg and arm maximal strength by 2% while detraining resulted in significant decrease in maximal strength and muscle power output of the arm and leg muscles.

Table 2: Effect of plyometric training on novice and trained groups on balance, coordination and reaction time

Training Period	Type of Group					
	Novice			Trained		
	Variables					
	Balance (sec.)	Co-ordination (no.)	Reaction time (sec.)	Balance (sec.)	Co-ordination (no.)	Reaction time (sec.)
Pre	32.68[a]	19.24[a]	0.40[a]	36.88[a]	23.52[a]	0.36[a]
Post	35.68[b]	24.24[b]	0.35[b]	40.12[b]	27.52[b]	0.33[b]
Tapering	35.50[c]	24.00[c]	0.36[c]	39.98[c]	27.36[c]	0.34[c]
Detraining	35.30[d]	23.94[d]	0.38[a]	39.78[d]	27.10[d]	0.35[a]
CD (*P*=.05)	0.88	0.91	0.04	0.68	0.78	0.02

Note:
- All the values are average of 3 trials with N=25 for novice and N=25 for trained group.
- CD – Critical difference.
- Different superscripts in the column indicate significant difference at *P*=.05 level.

Conclusion
Motor fitness components like speed, agility, balance, coordination, power, reaction time, are the key to all the type of sports activities especially in the competitive modern world. Motor fitness is referred to as skill-related fitness. The present study indicated the use of plyometric training to improve motor skills surely enhanced the power of novice and trained players in their sports activities, while tapering as well as detraining revealed slightly reduced activity but their recovery and mood improved.

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Conflict of Interest
Authors have declared that no competing interests exist.

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