EFFECT OF PLYOMETRIC EXERCISES ON PHYSICAL FITNESS AND PERFORMANCE AMONG ELITE SPRINTERS

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Abstract

Sprinting is running over a short distance with fastest possible speed. To achieve fastest speed over a short distance sprinter needs appropriate body shape, muscle strength, leg strength and fine-tuned nervous system to pull the whole thing together. Therefore, the objective of present study was to see the effect of plyometric exercises on physical fitness and sprinting performance among elite athletes. Forty elite male athletes, aged 16-18 years were selected as sample for this experimental study. All the selected subjects wererandomly assigned into experimental group (n=20) and control group (n=20). Both experimental and control group were assessed on the first day and after six weeks of the interventions for leg muscle power, abdominal muscles strength, flexibility, anaerobic capacity, 100 M run and 200 M run by administering standard tests.The subjects of experimental group then underwent a training of plyometric exercises, for 30 minutes in the evening, for a total period of six weeks. The control group did not undergo any special training during this period.Data was analyzed using paired 't' tests, independent 't' test and descriptive statistical method.The result of within group comparison showed significant improvement in physical fitness and performance variables ($p<0.001$) after six weeks of plyometric exercise training. Whereas control group showed significant improvement in flexibility, anaerobic capacity and 200 M sprint performance ($P<0.01$). However, no significant change was seen in leg muscles power, abdominal muscles strength and 100 M sprint after controlled period of six weeks. Further, between group comparison revealed significant change in leg muscle power, anaerobic capacity, 100 M and 200 M sprint performance ($P<0.001$). The findings of this study conclude thatthat six week of plyometric exercise training program may lead to improvement in physical fitness and performance among elite sprinters.

Key words ;- *Plyometric exercise, sprint performance, physical fitness*

Introduction

Since, eighth century BC sprinting performance has attracted many people across the world. Sprinting is running over a short distance with fastest possible speed. To achieve fastest speed over a short distance sprinter needs appropriate body shape, muscle strength, leg strength and fine-tuned nervous system to pull the whole thing together. There are countless athletic qualities that enable sprinters to run fast and that can be developed through various training interventions. Past research studies indicated significant relation between sprinting performance and explosive power (Charag, Pal, and Yadav, 2011; Mackala and Fostiak, 2015; Markovic, Jukic, Milanovic and Metikos, 2007; Kukoli, Ropret, Ugarkovic and Jaric, 1999). In fact, explosive power can be achieved through plyometric exercises. Further, for successful sprinting performance leg muscle power and vertical jump performance are considered as critical elements (Canavan and Vescovi, 2004; Potteiger*et al*., 1999; Bobbert, 1990), as well as for carrying out daily activities and occupational tasks (kraemer*et al*., 2001). In fact, the ability of muscles to store and return elastic energy effectively is important in movements that involve the stretch-shorten cycle (SSC) (Komi, 2000).

Plyometrics refers to exercises that are designed to reinforce muscle, principally through the utilization of jump training. Plyometric exercises represent a natural part of most sport movements because they involve jumping, hopping, and skipping (i.e., like high jumping, throwing, or kicking) (Anderst, Eksten and Koceja 1994; Bauer, Thayer and Baras 1990). These exercises are characterized by stretch-shortening cycle actions; that's, they begin with a speedy stretch of a muscle (eccentric phase) and are followed by a fast shortening of the same muscle (concentric phase) (Bobbert 1990; Bosco and Komi 1980; Bosco *et al.,* 1982). Plyometric exercises enhance strength, muscle power, coordination, and athletic performance (Adams et al., 1992; Bedi*et al.,* 1987; Holcomb *et al.,* 1996). In fact, athletes with superior coaching and conditioning are stronger and better coordinated and less subject to injury. Plyometrics are training techniques used by athletes in all types of sports to increase strength and explosiveness. Plyometrics exercise consists of a rapid stretching of a muscle (eccentric action) immediately followed by a concentric or shortening action of the same muscle and connective tissue (Häkkinen, Alén, and Komi, 1985). Success in many sports greatly depends upon the athlete's

explosive leg power and muscular strength. Additionally, in track and field events the athlete has to use strength or power as quickly and forcefully as possible.Nevertheless, previous research studies indicate that plyometric training can improve muscular power (Chelly et al.,2010; Gehri*et al*., 1998). In fact, Plyometric training is a type of training that is used to enhance the ability of muscles to generate power. Plyometric training exaggerates the SSC, using activities such as jumping, hopping, and bounding. Plyometric training has been shown to improve jumping ability and other high-power movements (Davies, Riemann and Manske, 2015; Brown, Mayhew, and Boleach, 1986). This suggests that plyometric training improves the ability of muscles to return elastic energy during the SSC. Therefore, the objective of present study was to see the effect of plyometric exercises on physical fitness and sprinting performance among elite athletes.

Materials and Methods

Subjects

Forty elite male athletes, aged 16-18 years were selected as sample for the experimental study. The purposive sampling technique was used to select the elite athletes from Jalgaon.

Research Design

Quasi experimental pre-post design was used for conducting this research study. The purposive sample was randomly assigned into experimental group (n=20) and control group (n=20). Prior permission was obtained from the principal of college and written informed consent was obtained from the study participants. Both experimental and control group were assessed on the first day and after six weeks of the interventions. The subjects of experimental group then underwent a training of plyometric exercises, under the supervision of expert, for 30 minutes in the evening, excluding Saturdays, Sundays and holidays for a total period of six weeks. The control group did not undergo any special training during this period. However, both the groups continued to participate in their regular extracurricular activities during school hours. After completion of six weeks of training participants of both the groups were assessed for the selected variables.

Assessment

Based on literature, this study has been delimited to four variables of physical fitness viz., leg muscle power, strength of abdominal muscles, flexibility and anaerobic power whereas performance variables were 100 & 200-meter run. All the variables were assessed by using standard tools.

Leg muscle power was assessed using vertical jump test. Three trial were given for each participant and average score was recorded. Abdominal muscles strength was measured by using sit ups. The score was recorded in number of sit ups in one minute. For assessment of flexibility sit and reach test was administered. Sit and reach box was used to score the flexibility in centimeter. To measure anaerobic capacity 300-meter run test was used. The subjects were asked to complete 300 meters in the quickest possible time. The score was recorded in second. The performance variables were 100 & 200-meter run. The subjects were instructed and motivated to complete the run in quickest possible time and score was recorded in seconds.

Intervention

The plyometric exercise training for experimental group consisted of standing long jump and sprint, single foot side to side ankle hop, alternate bounding with single arm action, multiple box to box jumps with single leg landing, combination bounding with vertical jump and depth to prescribed height. All the exercises were carried out in sets of 4 with rest after each set. The control group was not given any special training however were instructed to participate in recreational activities with no physical exertion.

Statistical analysis

Standard methods were followed for the data extraction for each of the variables. Data analysis was done using statistical software (SPSS, Statistical Package for the Social Sciences, Version 20.0). Data was analyzed using paired ‘t’ tests, independent ‘t’ test and descriptive statistical method.

Results

The outcome of within group and between group analyses of physical fitness and performance variables, for the experimental and control groups have been presented in Table 1 and Table 2 respectively.

Table 1

Descriptive statistics and t-test results for within group comparison in physical fitness & performance variables

Variable	Pre Mean ± SD	Post Mean ± SD	t value	Sig.	95% CI for mean	
					Lower	Upper
Experimental Group						
Leg muscle power	56.03 (±1.37)	64.96 (±1.76)	-22.01	0.001	-9.77	-8.07
Abdominal muscles strength	20.65 (±2.30)	24.55 (±1.93)	-5.73	0.001	-5.32	-2.47
Flexibility	14.28 (±0.96)	16.23 (±1.10)	-7.57	0.001	-2.49	-1.41
Anaerobic capacity	69.64 (±3.45)	61.46 (±3.40)	17.77	0.001	7.22	9.14
100 M sprint	15.04 (±1.42)	13.05 (±1.41)	6.86	0.001	2.59	6.86
200 M sprint	28.45 (±0.94)	23.39 (±1.18)	19.59	0.001	4.51	5.60
Control Group						
Leg muscle power	57.83 (±1.66)	58.25 (±2.52)	-0.82	0.422	-1.50	0.65
Abdominal muscles strength	23.45 (±1.43)	23.75 (±1.48)	-0.86	0.40	-1.02	0.42
Flexibility	14.44 (±0.84)	15.11 (±1.04)	-2.38	0.028	-1.24	-0.80
Anaerobic capacity	68.14 (±2.38)	66.49 (±3.52)	3.10	0.006	0.53	2.77
100 M sprint	14.29 (±0.91)	14.01 (±1.07)	1.05	0.305	-0.27	0.83
200 M sprint	27.90 (±1.36)	26.85 (±1.47)	3.14	0.005	0.35	1.74

Table 2

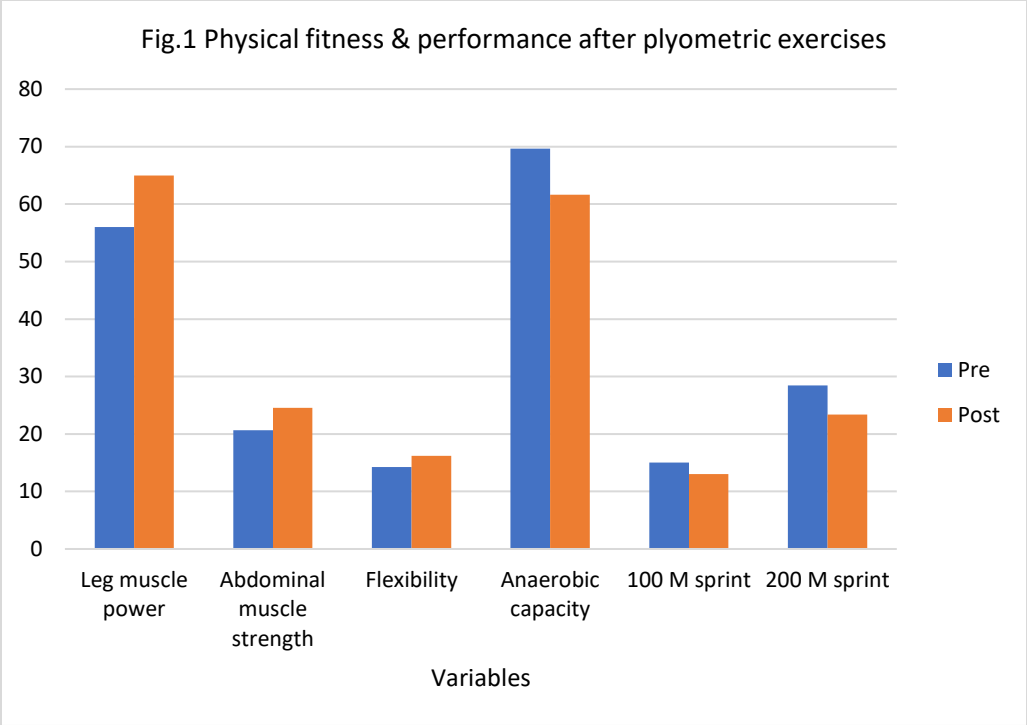
Results of independent sample t test between experimental & control group in physical fitness and performance variables

Variable	Experimental Final Mean ± SD n=32	Control-Final Mean ± SD n=29	t	Sig (2-tailed)	diff. in Mean 95% CI lower/upper
Leg muscle power	64.96 (±1.76)	58.25 (±2.52)	9.73	0.001	6.7 (5.31 - 8.09)
Abdominal muscles strength	24.55 (±1.93)	23.75 (±1.48)	1.46	0.15	0.80 (0.30 – 1.90)
Flexibility	16.23 (±1.10)	15.11 (±1.04)	3.29	0.002	1.12 (0.43 – 1.81)
Anaerobic capacity	61.46 (±3.40)	66.49 (±3.52)	4.59	0.001	5.03(7.24 – 2.81)
100 M sprint	13.05 (±1.41)	14.01 (±1.07)	2.75	0.009	0.96 (1.67 – 0.25)
200 M sprint	23.39 (±1.18)	26.85 (±1.47)	8.1	0.001	3.46 (4.32 – 2.60)

Results of paired sample t- test in experimental group showed significant change in leg muscle power (t=22.01, df=19, p<0.001); abdominal muscles strength (t=5.73, df=19, p<0.001); flexibility (t=7.57, df=19, p<0.001); and anaerobic capacity (t=17.77, df=19, *P*<0.001) after plyometric exercise training intervention. Further, significant improvement was observed in 100 M sprint (t=6.86, df=19, p<0.001)& 200 M sprint (t=19.59, df=19, p<0.001) after plyometric exercise training intervention (Fig.1). The results of paired sample t- test in control group revealed no significant change in leg muscles power (t=0.82, df= 19, *P*>0.05); abdominal muscles strength (t=0.86, df=19, *P*>0.05); and 100 M sprint (t=-1.05, df=19, *P*>0.05) after controlled period of six weeks. However, significant improvement in flexibility (t=2.38, df=19, *P*<0.05); anaerobic capacity (t=3.10, df=19, p<0.01)& 200 M (t=3.14, df=19, p<0.01) sprint was observed in control group participants.

The result of between group comparison revealed that experimental group had no significant change in abdominal muscles strength (*t*=1.46,df=39, *P*>0.05)as compared to control group

participants. However, significant improvement in leg muscle power (t=9.73, df=39P<0.001); flexibility (t=3.29, df=39 P<0.001); anaerobic capacity (t=4.59, df=39 P<0.001); 100 M sprint (t=2.75, df=39 P<0.01) and 200 M sprint(t=8.1, df=39 P<0.001) was observed in experimental group as compared to control group.



These results indicate that plyometric exercises may improve physical fitness as well as performance among elite sprinters.

Discussion

The findings of this six-week research study suggests, amply, the effectiveness of plyometric exercise training in improving physical fitness and performance of elite sprinters.

Many factors are needed to establish effective and efficient training interventions for improving physical fitness and sprint performance in young athletes. For improvement in sprint performance step length and step frequency plays an important role. Mackała and Fostiak (2015) reported that two weeks of plyometric training is effective in increasing step frequency. In the

present study reduction in sprint time was seen after plyometric exercise which is concurrent with earlier studies. Further, earlier studies have indicated reduction in sprint time after plyometric exercises in soccer and tennis players (Chaabene, & Negra, 2017; Fernandez-Fernandez, et al., 2016; Oxfeldt et al.,2019). Moreover, several studies reported that plyometric exercises can enhance muscle strength, power, speed, and jumping performance (Markovic, 2007; Diallo, Dore, Duche, &Van Praagh, 2001;Impellizzeri et al., 2008; Ramírez-Campillo et al., 2014;Arazi, Coetzee, &Asadi, 2012). In fact, these fitness components are essential for success in athletic events and our results are in line with previous investigations. The improvement in strength, power and sprint performance may be due to fact that plyometric exercises enhance muscles force and power output.

These findings suggest that plyometric exercises are efficacious to improve sprint performance and physical fitness even with a lower training volume and short duration. However, the changes in physical fitness and sprint performance cannot be considered conclusive due to small sample size and shorter duration of training intervention. In fact, larger randomized controlled trials are needed to generalize the findings of present study.

Conclusion

Our findings suggest that six week of plyometric exercise training program may lead to improvement in physical fitness and performance among elite sprinters. Even for a shorter duration of plyometric exercises could build muscle, burn fat and improve athletic performance, speed and power.

References

Adams, K., O'Shea, J., O'Shea, K., &Climstein, M. (1992). The effects of six weeks of squat, plyometric and squat-plyometric training on power production. *J Appl Sports Sci Res, 6*, 36–41.

Anderst, W. J., Eksten, F., &Koceja, M. (1994). Effects of plyometric and explosive resistance training on lower body power. *Med Sci Sports Exerc, 26*, 31.

Arazi, H., Coetzee, B., &Asadi, A. (2012). Comparative effect of land and aquatic based plyometric training on the jumping ability and agility of young basketball players. *S Afr J Res Sport Phys Edu Rec., 34*, 1–14.

Bauer, T., Thayer, R. E., &Baras, G. (1990). Comparison of training modalities for power development in the lower extremity. *J Appl Sport Sci Res, 4*, 115–121.

Bedi, J. F., Cresswell, A. G., Engel, T. J., &Nicol, S. M. (1987). Increase in jumping height associated with maximal effort vertical depth jumps. *Res Q Exerc Sport, 58*, 11–15.

Bobbert, M. F. (1990). Drop jumping as a training method for jumping ability. *Sports Med, 9*, 7–22.

Bosco, C., & Komi, P. V. (1980). Potentiation of the mechanical behaviour of the human skeletal muscle through pre-stretching. *ActaPhysiolScand, 106*, 467–472.

Bosco, C., Tihanyi, J., Komi, P., Fekete, G., &Apor, P. (1982). Store and recoil of elastic energy in slow and fast types of human skeletal muscles. *ActaPhysiolScand, 116*, 343–349.

Brown, M. E., Mayhew, J. l., &Boleach, I. W. (1986). Effect of plyometric training on vertical jump performance in high school basketball players. *J. Sports Med. 26*, 1–4.

Canavan, P. K., &Vescovi, J. D. (2004). Evaluation of power prediction equations: peak vertical jumping power in women. *Med Sci Sports Exerc, 36*, 1589–1593.

Chaabene, H., &Negra, Y. (2017). The effect of plyometric training volume on athletic performance in prepubertal male soccer players. *Int. J. Sports Physiol. Perform., 12*, 1205–1211.

Charag, S.A., Pal, R., &Yadav, S. (2011). Effect of plyometric training on muscular power and aerobic ability of the novice sprinters. *Asian J. Phys. Educ. Comput. Sci. Sports., 4*, 77–81.

Chelly, M. S., Ghenem, M. A., Abid, K., Hermassi, S., Tabka, Z., &Shephard, R. J. (2010). Effects of in-season short-term plyometric training program on leg power, jump- and sprint performance of soccer players. *J Strength Cond Res, 24*, 2670–2676.

Davies, G., Riemann, B. L., &Manske, R. (2015). Current concepts of plyometric exercise. *International journal of sports physical therapy*, *10*(6), 760–786.

Diallo, O., Dore, E., Duche, P., &Van Praagh, E.(2001). Effects of plyometric training followed by a reduced training programme on physical performance in prepubescent soccer players.*J Sports Med Phys Fitness., 41*(3), 342-8.

Fernandez-Fernandez, J., Saez de Villarreal E., Sanz-Rivas D., &Moya, M. (2016). The effects of 8-week plyometric training on physical performance in young tennis players. *Pediatr. Exerc. Sci., 28*, 77–86.

Gehri, D. J., Ricard, M. D., Kleiner, D. M., &Kirkendall, D. T. (1998). A comparison of plyometric training techniques for improving vertical jump ability and energy production. *J Strength Cond Res, 12*, 85-89.

Hakkinen, K., Alen, M., &Komi, P. V. (1985). Changes in isometric force-and relaxation-time, electromyographic and muscle fibre characteristics of human skeletal muscle during strength training and detraining. *Acta Physiol Scand., 125*, 573–585.

Holcomb, W. R., Lander, J. E., Rutland, R. M., & Wilson, G. D. (1992). The effectiveness of a modified plyometric program on power and vertical jump. *J Strength Cond Res, 10*, 89–92.

Impellizzeri, F. M., Rampinini, E., Castagna, C., Martino, F., Fiorini, S., &Wisloff, U.(2008). Effect of plyometric training on sand versus grass on muscle soreness and jumping and sprinting ability in soccer players.*Br J Sports Med., 42*(1), 42-6.

Komi, P. V. (2000). Stretch-shortening cycle: A powerful model to study normal and fatigued muscle. *J. Biomech., 33*, 1197–1206.

Kraemer, W. J., Mazzetti, S. A., Nindl, B. C. *et al*., (2001). Effect of resistance training on women's strength/power and occupational performances. *Med Sci Sports Exerc, 33*, 1011–1025.

Kukolj, M., Ropret, R., Ugarkovic, D., &Jaric, S. (1999). Anthropometric, strength, and power predictors of sprinting performance. *J. Sports Med. Phys. Fit., 39*, 120–122.

Mackala, K., &Fostiak, M. (2015). Acute effects of plyometric intervention-performance improvement and related changes in sprinting gait variability. *J. Strength Cond. Res. 29*, 1956–1965.

Markovic, G.(2007). Does plyometric training improve vertical jump height? A meta-analytical review.*Br J Sports Med., 41*(6), 349-55.

Markovic, G., Jukic, I., Milanovic, D., &Metikos, D. (2007). Effects of sprint and plyometric training on muscle function and athletic performance. *J. Strength Cond. Res., 21*, 543–549.

Oxfeldt, M., Overgaard, K., Hvid, L.G., &Dalgas, U. (2019). Effects of plyometric training on jumping, sprint performance and lower body muscle strength in healthy adults: A systematic review and meta-analyses. *Scand. J. Med. Sci. Sports., 29*, 1453–1465.

Potteiger, J. A., Lockwood, R. H., Haub, M. D. *et al*., (1999). Muscle power and fiber characteristics following 8 weeks of plyometric training. *J Strength Cond Res, 13*, 275–279.

Ramirez-Campillo, R., Meylan, C., Alvarez, C., Henriquez-Olguin, C., Martínez, C., Canas-Jamett R., Andrade, D. C., &Izquierdo, M.(2014). Effects of in-season low-volume high-

intensity plyometric training on explosive actions and endurance of young soccer players.*J Strength Cond Res., 28*(5),1335-42.