Original Article

Effect of combined plyometric-weight training on speed of male students with different body fat percent

HASSAN ALMOSLIM

Physical Education Department, King Fahd University of Petroleum & Minerals, Dhahran, SAUDI ARABIA

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Abstract:

The purpose of this study was to compare the effect of combined plyometric and resistance training on sprinting performance on males with different body fat percent. Forty participants with BMI 18.5 to 24.9 kg/m², aged between 18-22 years, according to body fat % two groups were formed, group I (n=20) consisted of 6 to 12% and group II (n=20) had 12.1 to 20% fat. Both groups were performed combined plyometric and resistance training 2 days per week, for 6 weeks, 50 minutes of training per session. A pre and post-test were performed on all the participants for measuring sprinting performance regard to 30m, 40m and 50m. For analyzing the data, independent t-test and Paired t-test were utilized. The analysis of data revealed findings of both the groups i.e. participants had shown improved performance in 30m by 5.6% (4.77 ± 0.40 vs. 4.49 ± 0.38 sec; $p = 0.000$) for group I; and by 6.3% (4.92 ± 0.37 vs. 4.61 ± 0.35 sec; $p = 0.000$) for group II after training program. In 40m sprint time of group I and II, resulted in significant decrease of 3.7% (5.80 ± 0.32 to 5.58 ± 0.35 sec; $p < 0.001$) and 5.1% (5.98 ± 0.43 to 5.66 ± 0.47 sec; $p < 0.001$) respectively. After training, there was significant decrease in 50m sprint time of 3.6% (7.06 ± 0.43 vs. 6.80 ± 0.47 sec; $p = 0.000$) in group I and 4.9% (7.28 ± 0.40 to 6.92 ± 0.46 sec; $p = 0.000$) in group II. However, there were no significant differences between groups for any of the speed distances. It was concluded that the effect of combined plyometric and resistance training program showed improve performances in both fat groups with regard to 30m, 40m and 50m sprinting performance.

Key words: plyometric training, resistance training, body fat, fitness

Introduction

Coaches, physical educators and researchers have examined that training modes became the most remarkable factor affecting performance and leading to the success in the respective events in the Olympics and World Championships or even enhancing fitness level of a person. In respect of that, plyometric in combination with weight training became the most common method to improve power, strength and speed. Coaches always combine different modes of exercise such as plyometric exercises, weight drills and sprint to prepare their athletes for competitions in order to improve their performance in sport.

Most types of sports including games (football, soccer, rugby) and individual sports (100m run) depend on speed as a physical fitness element which may lead to the success in sports. Running speed can be divided into three phases, acceleration phase, maximum phase and deceleration phase according to Ross et al (2009). In this case, 30m, 40m, and 50m sprints represent acceleration phase, maximum phase, and deceleration phase, respectively.

Combined plyometric and resistance training has positive effects on fitness variables such as speed (Rønnestad et al 2008, Rahimi et al 2006, Rahimi and Behpur 2005) and power (MacDonald et al 2012, DE Villarreal et al 2011).

Many investigators studied the combination between two training modes such as sprint and resistance training and plyometric and resistance training who indicated improvement in speed times (Herrero et al 2010, Rønnestad et al. 2008, Dodd et al 2007, Lyttle et al 1996, Ford et al 1983).

Ross et al (2009) studied 3 groups of male athletes (sprint group, resistance group and combined sprint and resistance group) on 30m sprint for 7 weeks of combined resistance and sprint (treadmill) training, 2-4 days per week; found that combined sprint and resistance training group improved significantly ($p < 0.05$) when post training was compared with pre training but there were no change between groups ($p > 0.05$) after training. Chelly et al (2010), Rønnestad et al (2008), and Rimmer & Sleivert (2000) also indicated the same results in 40m sprint time. In addition, Negussie, (2012) studied the effects of 12 weeks of combined resistance, track running, stairs (plyometric) and massage therapy on 50m sprint; found significant change after training for both combined exercise and massage training group and exercise only group however, no change was shown between groups.

Body fat percent is a vital factor affecting fitness level and performance of athletes in various sports. This is evident that the fat under skin is considered as a negative aspect in sport performance and fitness especially when exceeding 20%. It is also known fact that the leaner athletes perform better than their opponents (athletes with excess body fat) in activity where the body mass must be moved through space. Sports performance such as speed, endurance, balance, agility, and jumping ability are all negatively affected by a high level of fitness. Therefore performance, mainly in activities that require one to bear one's body weight over distance, will be facilitated by a large proportion of inactive tissue that is fat mass (William et al 2000, Wilmore and Costill 1999). Inacio et al (2011) investigated the effects of 0, 2, 4, 6, 8 and 10% of added body weight for both the genders on anaerobic exercise performance. Their results demonstrated significant decrement in performance of 40 yard at 2-10% loading; from 7.80 ± 0.96 to 8.39 ± 1.07 sec; $P < 0.05$). Miller et al (2002) studied and revealed that increases in body fat were also negatively correlated with performance in the 40 yard. Coaches and physical educators always give guidance to their athletes for taking balance diet to maintain their body fat. There are no studies which have compared the effects of combined plyometric- resistance training program on two groups with different normal body fat percent on speed variable and hence this study will focus on the new findings.

The purpose of this study was to compare the effect of combined plyometric and resistance training on sprinting performance on males with different body fat percent.

Method

The two experimental groups were assigned to the following groups.

Group I normal body fat (6-12%; n = 20)

Group II normal body fat (12.1-20%; n =20)

Selection of Subjects

Forty healthy active male students between the ages of 18 to 22 years from KFUPM undergoing the college courses were selected as subjects for the study. The subjects were segregated into II groups. Each group consisted of 20 subjects. Only the normal body mass index ($18.5 - 24.9 \text{ kg/m}^2$) and normal body fat (6 – 20%) subjects were considered for this study. Groups I was categorised with 6 - 12% body fat and group II with 12.1 – 20% body fat. The subjects were instructed not to participate in any type of plyometric and resistance training and were not permitted to use sprint training during the study. The subjects in all experimental groups were instructed to perform exercise in each training session with maximum effort (i.e. maximal intensity). Each jump was to be performed to reach maximal height with minimal ground contact time. The subjects were also instructed to maintain their normal dietary practices throughout the study.

Selection of Variables

The Following variables were selected to assess the influence of combined plyometric and resistance training program of the subjects for this study, age, height, body mass, body mass index, body fat %, free fat mass, 30 meter run, 40 meter run and 50meter run.

Administration of Test

The training program for the 2 experimental groups was administered for a period of fifty minutes twice per week. The duration of the total training period was six weeks. All the subjects were tested prior to and after 6 weeks of plyometric-resistance training. The test procedure to be administered was verbally explained and practically demonstrated. Quarries and doubts were answered if any. The ethics committee of research KFUPM were approached for its approval. Subjects who developed medical or orthopaedic problems during the course of the study were asked to withdraw.

Body Composition

Subjects were weighed by the (Seca medical balance-Germany) to the nearest 0.1kg in their activity dress (Trousers and T shirts). Height was measured using a Stadiometer to the nearest 1.0 cm. Body mass index was calculated by dividing weight in kg by height in metres squared. Body fat was measured by skinfold taken with a Harpenden Skinfold calliper at four sites (biceps, triceps, abdomen, and sub scapular) (Siri, W. E. 1961). Free fat mass (FFM) was measured via multiplying body mass by % body fat then subtracting the result from body mass value.

Test for dependent Variables

The list of the tests for dependent variables and the order of the administration of the tests was as follows: 30 meter run (acceleration speed), 40 meter run (maximum speed) and 50meter run (deceleration speed).

Training Program

The training program consisted of two training methods namely combined plyometric and resistance. The two training groups were trained for 50 minutes per training session twice a week, for 6 weeks. The subjects of the 2 groups were instructed about the proper execution of all the exercises to be used during the training period for all training regimes. The training protocols included leg and arm exercises. Plyometric and resistance training drills were practiced by all subjects to familiarise with the program.

Plyometric Training

The plyometric drills that were used in the training program were four; frog jump, drop jump (100 cm), double leg hop, and single leg hop. All subjects were asked to perform the four drills (5 reps x 3 sets) in the first week and increase it to (8 x 3) in the fifth week. In the last week of training the load and volume were reduced for the purpose of reducing stress in the muscle before the post measurement tests (4 reps x 2 sets). When performing the plyometric training drills the subjects were asked to concentrate on technique and speed. After each set of plyometric training drill a resting period was given to all subjects in which ranged between 30 – 60 second and 60 – 120 second between drills.

Resistance Training

Ten exercises were performed using single multy machines to increase the security, reduce the complicity of using free weights, and save time of the subjects. These drills were leg press, leg extension, seated leg cruel, horizontal calf, squat, abdominal press, back extension, pull-down, chest press, and shoulder press. Before the start of resistance training, the subjects were familiarised with the above resistance machine exercises and tested using 1RM strength protocol to measure the maximum strength for all drills that mentioned above. Later the 80, 85, 90, 95% of 1RM measurement strength tests of all drills were calculated for each subject. The first and second week of the resistance training, the subject performed all exercises using 80% of 1RM test and increased 5% in the following weeks until the fifth week then the intensity of training was reduced to 70% of 1RM strength test to reduce muscular stress and prepare subjects for post measurement tests after six weeks of training. The 80% of 1RM strength test was performed 8 – 10 reps x 3 sets in the first and second week, the 90% (6 – 8 x 3) in the third week, 95% (4 - 6 x 3) in the fifth week, and 70% (6 - 8 x 2) in the last week. The rest times between sets were 30 – 60 seconds. The rest period between sets were increased with the increase intensity of training.

Data Analysis

Mean, standard deviation, independent t-test and paired t-test were used to analyse the data by SPSS version 16. The level of significance was fixed at 0.05.

Results

The results with regard to physical characteristics measures are presented in table I.

Table 1. Showing Physical characteristics of the two groups

Variables	Tests	Group I (n=20) Mean $\pm$ SD	Group II (n=20) Mean $\pm$ SD	Probability
Age (y)	Pre	20.20 $\pm$ 0.95	20.50 $\pm$ 0.76	NS
Height(m)	pre	1.74 $\pm$ 0.05	1.68 $\pm$ 0.04	S
Body Mass (kg)	pre	60.26 $\pm$ 5.93	61.05 $\pm$ 3.09	NS
	post	60.83 $\pm$ 5.30	61.80 $\pm$ 3.63	NS
	Mean diff	0.57 $\pm$ 0.63	-0.75 $\pm$ 0.54	NS
BMI (kg/m ²)	pre	19.94 $\pm$ 1.71	21.48 $\pm$ 1.46	S
	post	20.02 $\pm$ 1.50	21.70 $\pm$ 1.64	NS
	Mean diff	0.08 $\pm$ -0.21	0.22 $\pm$ 0.18	NS
BF (%)	Pre	10.18 $\pm$ 1.19	15.61 $\pm$ 2.14	S
	Post	10.28 $\pm$ 1.42	14.77 $\pm$ 2.51	NS
	Mean diff	0.01 $\pm$ 0.23	-0.84 $\pm$ 0.37	NS
FFM (kg)	Pre	54.09 $\pm$ 4.98	51.49 $\pm$ 2.35	S
	Post	54.56 $\pm$ 4.74	52.64 $\pm$ 2.97	NS
	Mean diff	0.47 $\pm$ -0.51	1.15 $\pm$ 0.62	NS

Pre: before training, Post: after training, NS: not significant, S: significant, n: number of subjects in each group; SD: standard deviation; m: meters

The results in table I indicated that group I and II were differ significantly ($p < 0.05$) at baseline in some physical characteristics such as height, BMI, %BF and FFM. There were no significant differences ($p > 0.05$) between groups when post training measures were subtracted from pre training measures in all physical characteristics variables using independent t-test. However, paired t-test showed that both training groups indicated significant differences ($p = .000$) when post measures were compared with pre measures after six weeks of training on all speed variables.

Table 2. Shows data pertaining to 30m, 40m, and 50m running performance of both the training groups from pre to post test. Data shows means $\pm$ SD.

Groups	Tests	30m run	40m run	50m run
I (6-12%) BF	Pre	4.77 ± 0.40	5.80± 0.32	7.06± 0.43
	Post	4.49 ± 0.38	5.58± 0.35	6.80± 0.47
	Mean diff	-0.28 ± -0.02*	-0.22 ± 0.03*	-0.26 ± 0.04*
II (12.1-20%) BF	Pre	4.92± 0.37	5.98± 0.43	7.28± 0.40
	Post	4.61± 0.35	5.66± 0.47	6.92± 0.46
	Mean diff	-0.31 ± -0.02*	-0.32 ± 0.04*	-0.36 ± 0.06*

BF: body fat, pre: before training, post: after training, mean diff: mean differences, *: significant

It can be seen from table II that the 30m sprint time significantly decreased by 5.6% (4.77 ± 0.40 vs. 4.49 ± 0.38 sec; $p = 0.000$) for group I; and by 6.3% (4.92 ± 0.37 vs. 4.61 ± 0.35 sec; $p = 0.000$) for group II after training program. The training program had a beneficial impact on 40m sprint time of groups I and II, resulting in significant decreases of 3.7% (5.80 ± 0.32 to 5.58 ± 0.35 sec; $p < 0.001$) and 5.1% (5.98 ± 0.43 to 5.66 ± 0.47 sec; $p < 0.001$) respectively. After training, there were significant decreases in 50m sprint time of 3.6% (7.06 ± 0.43 vs. 6.80 ± 0.47 sec; $p = 0.000$) in group I and 4.9% (7.28 ± 0.40 to 6.92 ± 0.46 sec; $p = 0.000$) in group II. However, there were no significant differences between groups for any of the speed distances.

Discussion

Findings suggested that six weeks of combined plyometric-resistance training has statistically no significant effect between groups on physical fitness performance of male college students whose body fat and body mass index were normal. These results were not expected because there were significant differences between group 1 and 2 on height, BMI, % BF, and FFM before training. Training group II is heavier, shorter and fatter than training group I. In addition, their fat free mass (FFM) increased more than 1 kg after training and may explain the similar training effect between groups. However the results confirmed that significant improvements were observed in 30m (5.6 & 6.3%), 40m (3.7 & 5.1%) and 50m (3.6 & 4.9%) for group I and group II respectively, when pre training scores were compared with post training scores.

These results were predictable because all subjects in both training groups had similar program i.e. combined plyometric-resistance training for 6 weeks, 2 days per week. The importance of these findings suggested that male college students can positively improve their fitness levels after short term combined plyometric-resistance training program even if they had significant differences in height, BMI, free fat mass, and body fat at the baseline measures.

In the 30m sprint time, the findings corroborate the results of Ross et al. (2009) who found similar improvements between groups and significant change within groups by 2% after 7 weeks of treadmill training.

The results of 40m sprint time were comparable with the findings of some previous studies who indicated improvement of 1%, 7-9%, 1.7% and 8.8% respectively (Chelly et al. 2010, Ronnestad et al. 2008, Ratamess et al. 2007, Rimer & Sleivert).

The outcome of 50m sprint time were similar with the consequence of Negussie, DE (2012) who found 5.4% and 6% improvement in 50m run after 12 weeks of resistance, stairs, running and massage program of male college students.

This ergogenic effect may take place in respect of the contribution of the increased neuromuscular solidity of the plantar flexor (Kraemer et al. 2000). Explosive power and effectiveness of motion are critical variables up to the point of the deceleration phase that occur in maximum speed phase in 40m sprint distance in which the elasticity of the plantar flexor muscles have great effect in the attainment of maximum speed (Ratamess et al. 2007). It is also reported that the most important of constant phase; maximum speed phase, are the power output of the hip flexor and strength of the knee extensors (Kraemer et al. 2000). The neuromuscular changes may interpreted the possible mechanisms of the improvement in sprint performance which include temporal sequencing of muscle activation for more efficient movement, preferential recruitment of the fastest motor units, increased nerve conduction velocity, frequency or degree of muscle innervations, and increased ability to maintain muscle recruitment and rapid firing throughout the sprint (Chelly et al. 2010). Plyometric training induced neuromuscular adaptations and that these adaptations contributed to the observed gains in sprint performance as indicated by previous studies, however, the present study did not assess neuronal adaptations.

Conclusions

It was concluded that the effect of plyometric and resistance training program had shown improved performance in group 1 (6-12% BF) and group 2 (12.1-20% BF) with regard to 30m, 40m and 50m sprinting performance.

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