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The Effects of 8-Week Strength, Plyometric and Combinational Trainings on Dynamic Balance of Teenage Handball Players

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ABSTRACT

This study examined the effects of eight weeks of strength training, Plyometric, and combination training on dynamic balance in teenage Handball player. 40 teenage Handball players with the means and standard deviation between the ages of 93.16$\pm$07.1years, weight of 39.72$\pm$08.3 kg and with the height of 73.176$\pm$64.3 cm and any signs of lower body damage, arterial disorders participated voluntarily. The day before training for eight weeks, subject's dynamic balance is measured by SEBT test. During eight weeks in which 3 groups did their especial trainings, Control group were asked to continue their daily activities. Descriptive statistics, one way ANOVA and Tukey's post hoc test were used at significance level of ($\alpha = 05.0$) for statistical analysis of the given data. Results showed that strength trainings, Plyometric and combinational have significant increase in subjects achievement distance in eight directions SEBT. Also, combination of strength training and plyometric and plyometric training in comparison with strength training creates more improvement in subject's dynamic balance.

KEY WORDS: Strength training; Plyometric training; combinational training; dynamic balance and Handball player.

INTRODUCTION

Human body to keep partial balance but continuous and unusual fluctuates forward, backward and laterals diagonally [1]. Balance is inseparable part of the daily activities and it is an important index in the evaluation of athletes' performances [2-3]. Blackburn and Guskiewicz (2000) introduced balance as the most important part of the athlete's abilities that are involving in different forms of activities [4]. Also in different sports including Handball, Volleyball, Basketball, Ski and Badminton that require rapid reactions, provide innate protection against injury [5-6]. We do many activities during the day that all requires keeping balance [1]. Balance in a classification is divided into static, semi-dynamic and dynamic balance [7]. And in sport activities all them, especially dynamic balance is observed. Dynamic balance is defined and measure as the ability of a person to keep balance from dynamic condition to static condition [8]. Training is any organized and regular activity done for increasing the performance of athletes and are divided into different kinds considering the performance requirements of athletes. Some training that athletes use to improve different performances is strength and plyometric training. In most of the researches, it is reported that a combination of plyometric trainings and strength trainings in comparisons with using these trainings alone and separately, cause to achieve the highest performances [9-10]. Considering the increase in ankle and knee injuries due to jumping and cutting movements in some sports such as Handball, Volleyball, Basketball and ski [11] and the role of lower body muscles to balance body skeleton, applying different training protocols in improvement of balances are taken into the consideration of researchers [12-14]. In the current research we investigate the effect of plyometric trainings, strength and combinational (strength and plyometric) on dynamic balance of teenage Handball players.

Paterno (2004) showed that using a combinational plan (Plyometric, technical, balance and strength) can improve anterior-posterior balance [13]. Jeffery et al (2001) in a research on active older adults found that strength training by itself does not increase static balance among people, but his kind of training can improves walking speed [14]. Mahio et al (2006) reported in their studies the lack of influence of vibration and resistance on balance [15]. Sofia Nidiz et al (2009) in a research titled "the effect of 10 week traditional dance protocol in static and dynamic balance control on older adults" showed that there is a significant correspondence between dance and improvement of static and dynamic control balance on old adults [16].

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Sadeghi et al (2009) indicated that all three trainings (strength, plyometric and combinational) improve dynamic balance among athlete students [17]. Skinders et al (2010) in a research investigated the effect of sport on dynamic and static balance. The results showed that there is a significant correspondence between given training programs and static and dynamic balance [18].

Considering the requirements of athletes to more improvement of some of physical fitness factors common in the related sport field, and the lack of application of some of training methods in special conditions such as injure, overweight, recognition of different training methods on physical fitness factors effective on prevention of sport injuries, especially balance, is one of the design requirements of training program. By reviewing the previous studies we can say that there are contradictory results about the effect of different training protocols on balance. There is no research about the comparison of the effect of strength training programs, plyometric and the combination of the two training programs on teenage Handball player's dynamic balance. So, the current study compares the effects of strength, plyometric and combinational trainings on dynamic balance of teenage Handball players.

METHODOLOGY

Table 1: Plyometric training protocol

Training week		Plyometric drill	Sets*Reps	Training intensity
Week 1	90	Side to side ankle hops	15*2	Low
		Standing jump and reach	15*2	Low
		Front cone* hops	6*5	Low
Week 2	120	Side to side ankle hops	15*2	Low
		Standing long jump 5 X 6 Low	6*5	Low
		Lateral jump over barrier	15*2	Average
		Double leg hops	6*5	Average
Week 3	120	Side to side ankle hops	12*2	Low
		Standing long jump	6*4	Low
		Lateral jump over barrier	12*2	Average
		Double leg hops	8*3	Average
		Lateral cone hops	12*2	Average
Week 4	140	Diagonal cone hops	8*4	Low
		Standing long jump with lateral sprint	8*4	Average
		Lateral cone hops	12*2	Average
		Single leg bounding	7*4	High
		Lateral jump single leg	6*4	High
Week 5	140	Diagonal cone hops	7*2	Low
		Standing long jump with lateral sprint	7*4	Average
		Lateral cone hops	7*4	Average
		Cone hops with 180 degree turn	7*4	Average
		Single leg bounding	7*4	High
		Lateral jump single leg	7*2	High
Week 6	150	Diagonal cone hops	8*4	Low
		Hexagon drill	8*4	Average
		Cone hops with change of direction sprint	12*2	Average
		Double leg hops	7*4	High
		Lateral jump single leg	6*4	High
Week 7	150	Diagonal cone hops	7*2	Low
		Standing long jump with lateral sprint	7*4	Average
		Cone hops with 180 degree turn	7*4	Average
		Single leg bounding	7*4	Average
		Lateral jump single leg	7*4	High
Week 8	130	Side to side ankle hops	12*2	Low
		Standing long jump	6*4	Low
		Lateral jump over barrier	12*2	Average
		Double leg hops	8*3	Average
		Lateral cone hops	12*2	Average

Cone height: 40cm, barrier height: 50 cm

Among 57 teenage Handball players at the age of 16-18 years who are participating in Tabriz summer sports center, 40 teenage Handball players with the mean and standard deviation at the age of 16.93 ± 1.07 years old, 72.39± 3.08 kg weight, and 176.73$\pm 3.64cm$ height and also without any sign of lower body damage and arterial disorders, who are participated voluntarily in this research. Subjects were selected according to legs length, height and weight as purposive random sampling in four groups consisting of ten people. The first group did strength trainings [19], second group plyometric trainings and third group combinational trainings (strength and plyometric) [9] for 8 weeks and the fourth group participated as control group in this research. To estimated the subjects dynamic balance after a little warm up (5-10 m stretching and jogging), star Excursion Balance Test was

used in 8 directions as one of the performance tests of assessing dynamic balance [20]. Gary (1995) reported the validity of this test to estimate dynamic balance [21]. The ability of subjects dynamic balance were determined by recording achieving distance in 8 anterior direction, lateral anterior, interior anterior, external, internal, posterior, lateral posterior and internal posterior. In this test 8 directions with the shape of star is drawn on the ground with the degree of 45°. Each subject do each of the directions 3 times and finally their means are calculated and divided by leg length and then, is multiplied by 100 to obtain achievement distance based on percent of leg length. The designed protocol of plyometric is including two times in a week with the Training volume ranged from 90 foot contacts to 140 foot contacts per session (table 1) while the intensity of the exercises increased for seven weeks before tapering off during week eight so that fatigue would not be a factor during SEBT test [9].

Table 2: strength group training protocol

Week	Resistance	Resting between each stage	Sets*Reps
1	Doing all the repetitions in each stage with proper technique before adding weights	1	RM 8*3
2		1	RM 10*3
3		1	RM 8*3
4		1	RM 8*3
5		1	RM 8*3
6		1	RM 8*3
7		1	RM 8*3
8		1: 30	RM 6*3

RM: Repeated Maximum

Strength training group participated in the 8-week training program in two sessions in a week and with the intensities and repetitions shown in table 2, six strength movements were done by subjects (Squat, weight training on the stairs, angled leg press, dead lift, and forward scissor and bending knees). The intensity of strength trainings as it was considered for the previous group increased in week seven and decreased in week eight [19].

Combinational training group also started for 8-weeks and two sessions in a weak (on session strength training and one session plyometric training) based on designed training programs in table 1 and 2 [9]. After finishing training period, post-test SEBT was carried out in the same environment from four groups. To calculate means and standard deviation of age, height, weight and foot length of subjects, descriptive statistics is used. To determined homogeneity of variance between groups, the comparison of subjects achievement distance in four groups after applying training programs and also the comparison of distance difference range of subjects achievement distance before and after applying training programs in four groups of One Way ANOVA and Tukey's post hoc test at significance level $\alpha \leq 0.05$ are used.

RESULTS

The results of One Way ANOVA, there are no significant difference between heights, weight, age and foot length between four groups and this shows the homogeneity of four groups from personal characteristics was effective on balance (table 3). To compare subjects of four groups in SEBT pre-test in 8 directions, One Way ANOVA was used and the results didn't show any significant difference in four groups between achievement distances in SEBT eight directions (table 4).

Table 3: Descriptive statistics of personal characteristics of the subjects of four groups and the result of their compare by One Way ANOVA

Variable	Group	Means	Standard deviation	F	Significance (p)
Age (year)	Plyometric	16.85	1.14	0.647	0.588
	Strength	16.37	1.32		
	Combinational	17.33	1.17		
	Control	17.19	1.07		
Height (cm)	Plyometric	174.37	3.57	0.691	0.562
	Strength	180.06	3.91		
	Combinational	175.56	3.43		
	Control	176.93	3.72		
Weight (kg)	Plyometric	68.46	3.31	0.514	0.674
	Strength	78.87	3.31		
	Combinational	69.06	3.13		
	Control	73.20	2.74		
Foot length (cm)	Plyometric	81.57	2.11	0.35	0.56
	Strength	85.97	2.71		
	Combinational	83.06	3.1		
	Control	84.74	2.8		

Table 4: One Way ANOVA of means of subject's achievement distance of four groups in eight directions of SEBT in pre-test

Variable	Group	Pre-test (CM on foot length × 100	Standard deviation	F	Significance (p)
Anterior	Plyometric	86.17	3.35	0.554	0.423
	Strength	85.37	3.21		
	Combinational	86.33	2.59		
	Control	87.19	3.23		
External anterior	Plyometric	85.26	3.65	0.678	0.56
	Strength	85.06	2.97		
	Combinational	85.56	3.25		
	Control	84.93	2.62		
External	Plyometric	85.22	2.89	0.351	0.622
	Strength	84.87	3.14		
	Combinational	86.06	3.43		
	Control	85.20	3.84		
External posterior	Plyometric	85.66	2.20	0.691	0.35
	Strength	84.97	3.15		
	Combinational	86.06	2.93		
	Control	85.74	3.27		
Posterior	Plyometric	89.10	3.29	0.459	0.377
	Strength	87.67	2.86		
	Combinational	87.50	3.86		
	Control	88.42	3.73		
Internal posterior	Plyometric	88.37	3.09	0.563	0.554
	Strength	89.17	3.35		
	Combinational	89.53	2.88		
	Control	88.25	3.07		
Internal	Plyometric	87.83	3.34	0.347	0.587
	Strength	87.91	3.84		
	Combinational	89.08	2.97		
	Control	87.00	3.33		
Anterior- internal	Plyometric	87.40	3.00	0.614	0.56
	Strength	87.50	3.09		
	Combinational	88.92	3.18		
	Control	88.07	3.05		

Table 5: The means of subject's achievement distance of four groups in 8 directions of SEBT before and after applying training programs and the results of their compare by One Way ANOVA

Variable	Group	Pre-test (CM on foot length × 100	post-test (CM on foot length × 100	Means difference of pre-test with post-test (CM)on foot length × 100	Significance (p)
Anterior	Plyometric	86.17	91.14	97.4	0.01
	Strength	85.37	88.63	3.26	0.02
	Combinational	86.33	91.53	5.20	0.01
	Control	87.19	88.16	0.97	0.2
External anterior	Plyometric	85.26	88.73	3.47	0.02
	Strength	85.06	87.94	88.2	0.03
	Combinational	85.56	89.25	3.69	0.02
	Control	84.93	84.72	-0.21	0.1
External	Plyometric	85.22	88.84	3.62	0.02
	Strength	84.87	87.14	2.27	0.03
	Combinational	86.06	90.43	4.34	0.01
	Control	85.20	85.54	0.34	0.2
External posterior	Plyometric	85.66	89.20	3.54	0.02
	Strength	84.97	88.15	3.18	0.03
	Combinational	86.06	89.93	3.87	0.02
	Control	85.74	86.27	0.53	0.2
Posterior	Plyometric	89.10	94.25	5.15	0.01
	Strength	87.67	90.66	2.99	0.03
	Combinational	87.50	91.86	4.36	0.01
	Control	88.42	87.73	0.31	0.2
Internal posterior	Plyometric	88.37	95.07	6.7	00.0
	Strength	89.17	93.35	4.18	0.01
	Combinational	89.53	95.72	6.19	00.0
	Control	88.25	88.37	0.12	0.3
Internal	Plyometric	87.83	91.34	3.51	0.02
	Strength	87.91	90.64	2.73	0.03
	Combinational	89.08	94.77	5.69	0.01
	Control	87.00	87.33	0.33	0.2
Anterior-internal	Plyometric	87.40	90.68	3.28	0.02
	Strength	87.50	90.0	2.50	0.03
	Combinational	88.92	91.19	2.23	0.03
	Control	88.07	88.40	0.33	0.2

The results of One Way ANOVA showed a significant difference between achievement distance of three training groups (strength, plyometric and combinational) in each eight directions before and after applying training

programs (table 5). Also based on the results of One Way ANOVA in anterior, anterior-external, external, posterior-external and anterior –internal directions, there is significant difference between strength training, plyometric and combinational groups. In posterior-internal and internal directions a significant difference was not observed between strength groups with plyometric, strength with control group, plyometric and combination with control after applying training program and also there was not any significant difference between plyometric and combinational groups. But in posterior direction a significant difference was observed between strength training groups, plyometric and combinational with control group.

DISCUSSION AND CONCLUSION

The research aims to investigate the effect of 8-week strength, plyometric and combinational trainings (Strength and Plyometric) on dynamic balance of teenage Handball players. The results of the research show that 8 weeks strength training have effect on dynamic balance of teenage handball players. The probable reasons of dynamic balance increase due to strength trainings are including the increase of subjects lower body muscles strength after participating in strength training program, easy involvement of fast twitch and macro motor units, increase in muscles adjustment, applying force on Neuromuscular System and removing dis-inhibition [10, 12, 14, 19, 22].

The current research findings proved the significant effect of 8-week plyometric training on dynamic balance of teenage Handball players. The probable reasons of dynamic balance increase due to plyometric training are the improvement of muscles strength of participants in achievement action, force on Neuromuscular System, activating sensory receptors, increasing adjustment in these kinds of trainings [7, 9-10, 19, 21]. The findings proved the effect of 8-week combinational training (strength and plyometric) on dynamic balance of teenage Handball players.

As it is seen the highest effect in three groups (strength, plyometric and combinational) were in three directions of posterior-internal, internal and posterior. As during achievement action in these three directions we need Hamstring muscle activity [21]. The probable reason of increasing in this direction is the increasing effect of three kinds of trainings on increasing the strength of hamstring muscle more than the other lower parts of the body. The results of the current research is compatible with the results of Witske et al (2000), Carl et al (1997), Paterno et al 92004), Docherty et al (1998), Hut et al (1999), Sadeqi et al (2009). But it was incompatible with the results of Jeffery et al (2001), Buchner et al (1997) [12-14, 17, 22-25]. The probable interpretation of compatibility and incompatibility of the current research with the studies is related to the similarity between the type of trainings, intensity and duration of trainings and the kind of subjects. In justifying the effect of strength trainings, plyometric and combinational on dynamic balance, the mentioned principles are used. As in plyometric training more pressure is on Neuromuscular System to keep the balance and during these trainings, a person needs dynamic balance. While in strength training a person needs static balance to do special movements. So it can be said that plyometric training is a specific training to improve dynamic balance. Also combinational training (strength and plyometric) as it creates diversity for an athletes, the performance is increased considerably. Generally, it is concluded that considerable improvement of dynamic balance in strength, plyometric and combinational group indicated a requirement of these training to balance. So in people with deep sense disorder and balance, they are not able to tolerate the high pressure of plyometric and strength trainings. Here achieving a part of ideal balance as the pre-requirement of plyometric and strength trainings are more emphasized. As in combinational trainings different forms of trainings are used to make a variation for athletes, this fact is probably a factor to improve the performance of combinational trainings. It is recommended that sport team coaches especially Handball consider the especial requirements of teenage Handball player and also considering the injured backgrounds in the design of training programs (to improve dynamic balance),use the benefits of all three trainings especially combinational.

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