PRINT: ISSN 0972-0073 ONLINE: ISSN 2456-6802
Anthropologist, 21(3): 380-384 (2015)
DOI: 10.31901/24566802.2015/21.03.02

The Effects of Human Resistance Training on Muscular Strength

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KEYWORDS Exercise. Basketball. Sargent Jump. Human Life. Sport
ABSTRACT The aim of this study was to evaluate the impact of a resistance training program on basketball players that have been engaging in regular training processes for several years. The study participants (n=28) were Ataturk University basketball team players. The experimental group performed a 12-week, whole body resistance training. A device measured maximal power at thirty percent, forty percent, fifty percent and sixty percent of 1RM on the bench press for each subject. Both groups increased their maximal muscular power and strength, and the magnitude of increase was significantly different between them ($P<0.01$). The resistance training program induced less change than previously observed, probably because the subjects were involved in the training process for several years and were already well adapted. This study concluded muscle strength increased by 10.5 percent after 12 weeks of the resistance training program, but the power increasing amount was without growth and maturation and was more than 7.5 percent.

INTRODUCTION

Resistance training is a good method to increase neuromuscular capacity. It is used by people to enhance their levels of strength, power and muscular hypertrophy (Deschenes and Kraemer 2002; Kraemer and Ratamess 2004). The resistance training bout effects of high intensity and volume resistance exercise results in muscle harm caused by metabolic and mechanical factors (Proske and Morgan 2001; Clarkson and Hubal 2002). Progressive resistance exercise is an effective method for developing muscular strength and for the sports and fitness purposes has application especially for injury prevention and rehabilitation. Muscle strength has been defined as the most voluntary muscle torque or more recently, as the ability of the neuromuscular system to make force (Cacchio et al. 2008). Muscle strength is often assessed by measurement a 1 Repetition Maximum (1-RM) to quantify the most resistance that can be lifted in a single concentric action (Ploutz-Snyder and Giamis 2002). Muscle strength can be tested by using of three different modalities, namely, isometric, dynamic or isokinetic (Macaluso and De Vito 2004). Training and conditioning are the best ways to prepare the players for efficient performance. Fitness is the ability to recognize the needs of a physical task. Basic fitness can be classified in four main cases that is, strength, speed, stamina and flexibility. Resistance training should be developed in nature, individualized and provide a stimulus to all the major muscle groups. Resistance training involves exercises in the muscles while exerting a force against an external load (Varghese and Shelvam 2014). In recent years, some studies have evaluated the effects of resistance training programs on the improvement of adolescent athletes' explosivity levels (Christou et al. 2006; Faigenbaum et al. 2007; Kotzamanidis et al. 2005). The majority of the recent research provides convincing evidence that children and adolescents enrolled in a properly designed resistance training program can significantly enhance their muscle strength and power, above and beyond growth and maturation (Szymanski et al. 2007; Faigenbaum and Mediate 2006). Some studies have assessed the effects of base stability on chest press exercise performances (Anderson and Behm 2004). The game of basketball is very complicated in terms of skills and teamwork. In this game, every player should have the ability of the fundamental skills such as dribbling, passing, shooting, rebounding, and defense. High levels of performance, otherwise known as the playing ability in basketball, depend on proficiency in the fundamental skills. Performance high level of a basketball player depends on fundamental skills (Varghese and Shelvam 2014). The aim of this research was to evaluate some cases such as the effects of an 8-week training programs with constrained and unconstrained path chest press machines on 1-RM, selected arm and shoulder girdle muscles activity levels during the push movement performed on the different machines, and the transfer of the training effects from one machine to the other.

MATERIAL AND METHODS

Subjects

The participants of this study (n=28) were basketball players (21.5±0.7 years) in the beginning of the general preparatory training phase. Fourteen participants (age 21.6±0.8 years, height 186.4±5.9 cm, weight 72.5±8.5 kg) performed 12 weeks of the resistance training program and fourteen (age 21.5±0.8 years, height 186.1±5.8 cm, weight 73.2±8.2 kg comprised the control group. Participants were accepted only if they were involved in a basketball training process for more than 3 years. All the players volunteered to participate in the study. Subjects initially participated in a familiarization session to become acquainted with all testing and training procedures.

Training Procedures

Subjects began a 12-week, whole body resistance training. The subjects participated in two training sessions every week during the period of twelve weeks (total of 24 training sessions). Strength exercises were performed for 9 exercises per session, with 2-3 exercises chosen to isolate the major muscle groups as follows: weight training exercises by use of fitness equipment for chest, upper back, shoulders, arms, abdomen and legs, with 2-3 sets per exercise, 8-12 repetitions per set, and around 90 seconds of recovery time between sets. 1-RM Tests, bench press chest, dinamometer, rotator cuff test, DLLM and the Sargent jump test were used for measuring the chest, back, shoulder, arm, abdomen and legs power, respectively. Subjects were instructed to complete the prescribed number of repetitions or until 10-12 repetitions using the correct technique, and if a greater number of repetitions were achieved, the weight was increased during the following session to permit progressive adaptation. During one training week (2 sessions) all major muscle group were exercised only once. Each session lasted for approximately 60-70 minutes. The first 5 minutes were spent in dynamic warm-up to set the tone for the training session and the last 5 minutes were spent in some stretching exercises to help relax the body. All participants continued with their regular basketball training activities (60 minutes/day, 4 days/week). All testing sessions took place at the time of the day similar to the usual training session times of the participants.

Maximal Muscle Strength Test

The determination of the maximal muscle strength in the bench press exercise was evaluated through the 1RM test (Brown and Weir 2001). The subject performed a warm up of 2-3 sets with 5-10 repetitions at nearly forty to sixty percent of the estimated 1RM before the protocol. The test was performed with a maximum of five attempts and rest intervals of 3-5 minutes between each attempt.

Statistical Analysis

Data analyses were performed using SPSS version 16.0. Mean and standard deviation were calculated for experimental variables. A repeated analysis of variance (ANOVA) was conducted to compare the 1RM scores within tests (pre-post) and between groups (experimental-control). The significance level was evaluated at five percent probability level.

RESULTS AND DISCUSSION

There are the main statistics data in the Table 1. The effects of the resistance training program were observed in both groups. Strength, measured as 1RM, increased by 6.6 kg in absolute terms and by 10.9 percent in relative terms in the experimental group, whereas the control group improved strength by 1.5 kg or 2.5 percent, respectively. The most power improving was showed at fifty percent power. There was a significant difference between experimental and control groups in terms of their muscle power. But the results indicated the raise in the power improving trend for the two groups (experimental group and control group) (Fig. 1). Post hoc analysis showed significant changes in (30, 40 and 50%) 1RM (Table 1).

The experimental program induced statistically significant changes in strength and power parameters (Ignjatovic et al. 2009). In the short-term (8 to 20 weeks) resistance training programs, the expected progress in the adolescents' team is thirty percent (Fleck and Kraemer 2003). Tenenbaum's (1996) meta-analysis found that gains in muscle strength were approximately thirteen to thirty percent more than what would be expected to result from growth and maturation. In the short-term (8 to 20 weeks) resistance training

Table 1: Main statistics data for the Experimental group and Control group

Variables	*Experimental group*						*Control group*					
	Pre-test		*Post-test*				*Primary*		*Final*			
	Mean	*SD*	*Mean*	*SD*	*F*	*p*	*Mean*	*SD*	*Mean*	*SD*	*F*	*p*
1 RM (kg)	61.3	10.2	67.5	8.7	6.62	0.01	60.2	9.3	60.9	9.1	6.62	0.01
Power 30%	439.1	99.2	489.4	94.9	5.16	0.02	417.2	88.5	423.8	86.8	5.40	0.01
Power 40%	468.6	98.9	511.4	102.2	5.53	0.02	442.5	90.6	466.5	97.6	6.02	0.02
Power 50%	491.3	102.7	538.1	98.2	6.52	0.01	485.6	81.3	498.6	90.6	6.62	0.01
Power 60%	474.5	101.4	500.5	97.8	2.90	0.08	469.2	91.4	474.4	96.6	3.11	0.06

programs, the expected progress in strength is around thirty percent (National Strength and Conditioning Association 2009). The Falk and Tenenbaum (1996) meta-analysis found that gains in muscle strength were approximately thirteen to thirty percent greater than that what would be expected to result from growth and maturation. Some researchers found even greater strength gains (from 55% to 74%) after 8 weeks of resistance training (Faigenbaum et al. 1993). Strength training program enhanced explosive muscle power and flexibility. Gains in strength and power in youth basketball players have already been noted after incorporating some type of strength training into basketball training sessions (Vamvakoudis et al. 2007). As described previously (Koutures and Gregory 2010; Myer et al. 2005), comprehensive conditioning programs that included strength and plyometric training have proven to be an effective strategy for reducing sports-related injuries in young athletes. The training protocol was designed to increase muscular strength by using few sets (Carpinelli 2002). Different dynamic conditions have been reported to produce different force output levels, with unstable conditions associated with lower force outputs (Vera-Garcia et al. 2000; Anderson and Behm 2004). In the push movement, characterized by shoulder horizontal adduction and elbow extension, the PM, DA and TB muscles act as agonists, the LD, DP and BB muscles act as antagonists, and the UT and LT act as stabilizers (Lee and An 2002). Kibele and Behm (2009) found similar results in a 7-week functional exercise program in that strength and other functional measures (dynamic balance, shuttle run) were not different compared to a more traditional resistance exercise program. However, Behm and colleagues (2002) suggested that if the instability challenge introduced during the exercise occurs at a moderate level (such as the stability ball in the current study), force production and training adaptations are not hindered. Fenwick et al. (2009) demonstrated significantly

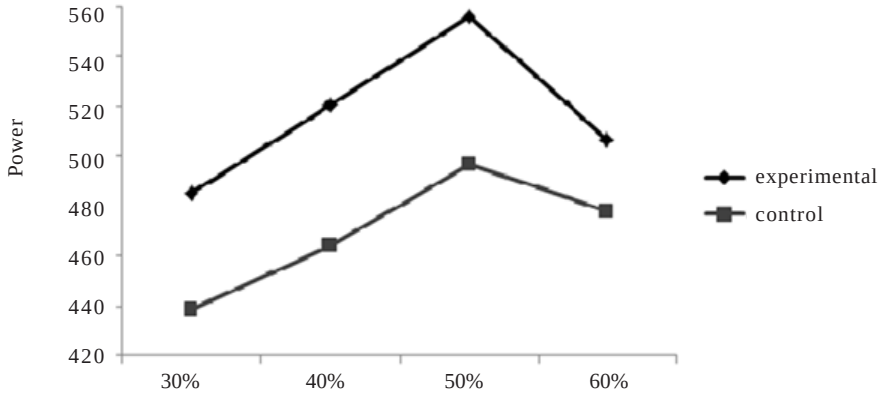

Fig. 1. Muscle power for experimental and control group

increased muscle activation in the torso during single and double arm rowing exercises. Despite the existence of several studies on the significant effects of plyometric training (Khlifa et al. 2010; Matavulj et al. 2001; Santos and Jeneira 2010, 2011) or combined training (Santos and Jeneira 2008; Tsimahidis et al. 2010) in basketball players, the available literature shows a scarcity of studies on resistance training program effects with basketball players (Hoffman et al. 1991). There are several benefits to young athletes for why they should participate in resistance training. The biggest initial effect of resistance training is on the nervous system, which reflects on muscle strength and power. Power and strength, among other fitness components, are demanded in varying degrees for success, constituting an essential part of any young athlete's overall training program (Ignjatovic et al. 2011).

CONCLUSION

This study illustrated a 10.5 percent muscle strength increase after 12 weeks of a resistance training program, but the power increasing amount was without growth and maturation and it was more than 7.5 percent. This relatively small progress compared with other results could be explained by the fact that most of the other studies were done on previously untrained participants.

Increasing the volume or intensity of the resistance training program could be conducted to better adaptation, but it would also enhance the risk of injury. In attention to this case, that no injuries were reported during this training program. Although it is accepted that properly designed resistance training programs will over time, increase the force-generating capability of a muscle, there is still considerable debate among field specialists about the loads that should be used to maximize power gains.

ACKNOWLEDGMENTS

The researchers would like to thank the students for participating in this study and also the Ataturk University management of staff to cooperate during the time of the study.

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