Ovidius University Annals, Series Physical Education and Sport / SCIENCE, MOVEMENT AND HEALTH
Vol. XXIV, ISSUE 1, 2024, Romania
The journal is indexed in: ERIH PLUS, Ebsco, SPORTDiscus, INDEX COPERNICUS JOURNAL MASTER LIST,
DOAJ DIRECTORY OF OPEN ACCES JOURNALS, Caby, Gale Cengage Learning, Cabell's Directories

Science, Movement and Health, Vol. XXIV, ISSUE 1, 2024
January 2024, 24 (1): 86-90
Original article

INVESTIGATION OF THE EFFECT OF STRENGTH TRAINING ON THEREBAND AND RESISTANCE MACHINES IN CHILDREN

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Abstract

Aim. This study was to investigate the effects of similar exercises with elastic bands on muscular strength in strength training with prepubertal children in contrast to resistance machines.

Methods. In this study, 30 male football player candidates aged 11-12 years were used. A randomly selected group of 10 boys were trained with a resistance machine and a group of 10 boys were trained with a theraband 2 days a week for 8 weeks. A group of 10 boys was observed as a control group.

Result. A significant statistical increase in muscular strength was observed in children working with resistance machine and theraband compared to children in the control group who did not do strength training.

Conclusions. In addition, it was observed that the increase in muscular strength was higher in children working with the resistance machine than in children working with the theraband. ($P < 0.05$ The increase in muscular strength in children who do strength training is statistically significant).

Keywords: Theraband, children, strength training.

Introduction

Since the past, strength training in children has always been a controversial issue. Today, scientists emphasise the importance of strength training for children. When a well-designed strength training programme is carried out under proper supervision, it creates positive developments in children. The most important of these developments is the increase in their sportive performance and the prevention of possible sports injuries that they may encounter during their future sports life (Bompa, 2000). It should not be forgotten that strength training is not only used by bodybuilders and weightlifters. Today, it is seen that many athletes exhibit successful performances by adding strength training to their training programmes from an early age. When we look at the successful countries in sports, it is seen how important strength training for children is (Bompa, 2000). Strength is one of the basic biomotor abilities and has an indispensable value for every sport branch. This biomotor ability is divided into classes. These are; maximal strength, continuity in strength and quick strength (Acar, 2000). There are a number of methods to develop strength. These methods are provided by different equipments and machines besides their own body weight. Elastic bands, which are widely used today, are also different tools used in strength development. The biggest feature of elastic bands is that their resistance increases as they lengthen. Coaches prefer these bands because they are cheap and portable. In addition, these bands are used for many purposes. It is very common to use them in rehabilitation training after athletes are injured. The methods used to improve sportive performances are increasing day by day (Page & Ellenbecker, 2005). Whichever training method is chosen to develop strength in children, there are some important points. The most important of these is that the trainer should be an expert on this subject and should constantly check whether the children are applying the correct technique during training. Research has shown that the biggest cause of injuries in children during strength training is carelessness and accidents during exercise. Therefore, the biggest responsibility here belongs to the trainer. Another important point is a very well designed training programme. After a well-designed adaptation programme, the loads that children can apply should be selected and the programme should be followed from the beginning to the end (Zatsiorsky & Kraemer, 2006). Resistance machines designed for children are not widely available. Therefore, trainers are forced to use adult resistance machines. Especially pre-puberty children participate in sports activities in groups. It is thought that training with elastic bands in such groups will make a significant contribution to the development of muscular strength of children. In this context, the most widely used method to improve strength ability is exercises with resistance machines. It is known that strength training with these machines has a significant effect on strength development.

Objectives

The aim of this study was to investigate the effects of similar exercises with elastic bands on muscular strength in strength training with prepubertal children in contrast to resistance machines.

Methods

It is a descriptive research. The population of the study consisted of a total of 30 boys aged 11-12 years who were registered in Izmir province and playing in the Football Academy. In the study, the group working with resistance

machine, the group working with theraband and the control group were randomly selected from 11 and 12 year old boys by randomisation method. In total, 30 male athlete children were divided into 3 groups of 10 each. The 1st group was the group working with resistance machine, the 2nd group was the group working with theraband and the 3rd group was the control group. All group members performed football training 2 days a week and running drills, speed 1st degree plyometric, agility training 1 day a week.[1] In the study, special leg extension resistance machine and "gold" theraband tools were used. Maximal forces were calculated using the Brzycki equation for the first test and the last test on the resistance machine.[2]

Maximal Force Measurement with Brzycki Formula

1 % of MT (as a number between 0 and 100) = 102.78 - (2.78 x "number of repetitions with weight")
Estimated 1 MT = (Weight used for repetition) x 100/1 % of MT (6).
Example: What is the maximal weight that can be lifted in 1 repetition by an individual who can lift 40 kg up to 6 times (6).

% of 1 MT = 102.78 - (2.78 x 6)
= 102.78 - 16.68
= 86.1
1 MT = 40 kg x 100/86.1
= 40 kg x 1.16
= 46.4 kg
1 MT = 46.4 kg

The exercises and resistance training programme to be used in the study were explained to the athletes and their teams beforehand and the approval of each of them was obtained. A total of 30 male athletes from U-11 (n=14) and U-12 (n=16) teams of the Football Academy who train 2 days a week participated in the study.

Training protocol: Knee extension training was applied to three separate groups working with resistance machine (RM), Theraband (TG) and control group (CG). RM and TG, 2 days a week and for each day; 3 sets of 8 repetitions with 75% of the maximal strength of the children, with 2 minutes rest between sets, right and left separately. Control gruop didn't do anything. The applications were performed in the second part of the children's daily football school training. The group working with Theraband was trained with gold rubber bands whose resistances (in kg) according to their lengths are shown in the table below.

Table 1: Classification of Theraband Resistances in Kg according to their colours (19)

Height	**Yellow**	**Red**	**Green**	**Blue**	**Black**	**Silver**	**Gold**
%25	0,45	0,67	0,90	1,35	1,57	2,25	3,60
%50	0,90	1,12	1,35	2,02	2,70	3,82	6,30
%75	1,12	1,57	1,80	2,70	3,60	4,95	8,10
%100	1,35	1,80	2,25	3,15	4,27	5,85	9,67
%125	1,57	2,02	2,47	3,60	4,95	6,75	11,02
%150	1,80	2,25	2,92	4,05	5,62	7,65	12,37
%175	2,02	2,47	3,15	4,50	6,07	8,55	13,72
%200	2,25	2,70	3,60	4,95	6,75	9,45	15,07
%250	2,70	3,15	4,27	6,07	7,87	11,47	18

Results

Paired T-Test was performed using SPSS 21.0 Windows programme. Statistical significance was based on 95% confidence interval ($P < 0.05$).

Table 2. Descriptive characteristics of participants

Men (n=30)	Average	Ss.	Min.	Max.
Year	11,53	0,5	11	12
Height (cm)	150,9	10,9	1,35	1,66
Body Weight (kg)	37,1	5,7	29,1	52,7
Cm:Santimetre, Kg: Kilogram				

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A total of 30 male football player candidates participated in the study. Fourteen of the subjects were 11 years old and 16 of them were 12 years old. The tallest among them was 1,66 cm and the shortest was 1,35 cm. Considering their body weights, the heaviest was 52,7 kg and the lightest was 29,1 kg. Considering these values, the ages of the subjects were calculated in years, height in cm and body weights in kg and the averages and standard deviations of these values were taken and shown in Table 3.

Among the group of 30 subjects who participated in the study, a group of 10 people were trained with a resistance machine, a group of 10 people were trained with a theraband twice a week for 2 months to improve knee extension strength and their development was monitored, another group of 10 people was not included in these studies as a control group and their development was monitored. The statistical data of the results of these studies are described in the tables below.

Table 3. Resistance group, knee extension pre-post test results.

	n	Pre-test		Post-test		P	%
		Average	Ss	Average	Ss		
Right Knee	10	20,80	7,21	36,63	11,03	,000*	%85
Left Knee	10	20,06	6,44	36,23	10,49	,000*	%85

P < 0.05 In the control group, statistical significance was found at P < 0.05 level.

In the RG of 10 people, strength development was analysed as two separate values, right knee and left knee, and the data were calculated in kg. Six of the subjects in this group were 12 years old and 4 were 11 years old. Pre-test and post-test values were obtained using the Brzycki equation (explained in Section II). In the pre-test, the average right knee strength ratio was 20.80 kg and the standard deviation was 7.21 kg. When the post-test was taken for the right knee after the studies, it was seen that the average right knee strength ratios were 36.63 kg with a standard deviation of 11.03 kg. Based on these results, we can say that the average increase in strength in the right knee is 85%. In the pre-test results for the left knee, it was seen that the average of the force ratios was 20,06 kg and the standard deviation was 6,44 kg. When the post-test was taken after the studies, it was seen that the average left knee strength ratio was 36.23 kg and the standard deviation was 10.49 kg. Based on these results, we can say that the increase in left knee strength is 85% on average.

Table 4. Theraband group, knee extension pre-post test results.

	n	Pre-test		Post-test		P	%
		Ort	Ss	Ort	Ss		
Right Knee	**10**	16,08	6,04	27,19	6,79	,000*	%75
Left Knee	**10**	16,58	6,25	26,99	7,03	,000*	%70

P < 0.05 Statistical significance was found at P < 0.05 level in the group working with Theraband.

In the group of 10 people working with Theraband, strength development was analysed in two separate values as right knee and left knee as in the group working with resistance machine. The data were calculated in kg and the same training protocol was applied. In this group, 5 of the subjects were 12 years old and 5 were 11 years old. Pre-test and post-test values were taken using Brzycki formula. In the pre-test, the average right knee strength ratio was 16.08 kg and the standard deviation was 6.04 kg. After the studies, when the post-test was taken for the right knee, it was seen that the average right knee strength ratio was 27.19 kg and the standard deviation was 6.79 kg. Based on these results, we can say that the average increase in strength in the right knee is 75%. In the pre-test results for the left knee, it was seen that the average of the force ratios was 16,58 kg and the standard deviation was 6,25 kg. When the post-test was taken after the studies, it was seen that the average right knee strength ratio was 26,99 kg and the standard deviation was 7,03 kg. Based on these results, we can say that the increase in strength in the left knee is 70% on average.

Table 5. Control group, knee extension pre-post test results.

	n	Pre-test		Post-test		P	%
		Ort	Ss	Ort	Ss		
Right Knee	**10**	15,05	3,11	18,13	4,00	,000*	%20
Left Knee	**10**	15,75	3,77	19,31	4,15	,000*	%23

P < 0.05 In the control group, statistical significance was found at P < 0.05 level.

For the control group, pretest and posttest were conducted using the same methods. The 10 people in this group did not take part in the studies and continued their normal football training. The strength development of this group was followed together with the other two groups. Five of the subjects in this group were 12 years old and five were 11 years old. In the pre-test results, the mean right knee strength was 15,05 kg and the standard deviation between them was 3,11 kg. In the post-test results, the mean right knee strength was 18.13 kg and the standard deviation between them was 4 kg. No extra strength training was performed in this group, but the subjects continued their normal football training 2 days a week. Based on these results, we can say that the average increase in strength in the right knee is 20 %. The left knee strength ratios were 15.75 kg in the pre-test results and the standard deviation between them was 3.77 kg. In the post-test results, the left knee strength averages were 19.31 kg and the standard deviation between them was 4.15 kg. Considering these results, we can say that the average increase in left knee strength is 23%.

Discussions

According to the results of this study, when the pre-test and post-test values of the resistance machine group were analysed (Table: 4), the increases in left 85% and right 85% knee extension forces were statistically significant ($P < 0.05$).

According to the pre-test and post-test values of the Theraband group (Table: 5), the increases in left 75% and right 70% knee extension forces were statistically significant ($P < 0.05$). In the control group, according to the pre-test and post-test values (Table: 5), the increases in left 20% and right 23% knee extension forces were statistically significant ($P < 0.05$). According to the report by Pfeiffer and Français, lower limb training is easier than upper body training because the upper body requires more responsibility. The reason for this is that even children who have never trained can reach a higher weight because they work continuously on the quadriceps on a daily basis. In addition, more muscles work in the quadriceps than in the upper body (Faigenbaum et al., 1999) (Pfeiffer & Francis, 1986). Faigenbaum et al. conducted many studies on strength training in children. For example, they proved in their study that strength training performed twice a week in prepubertal children significantly increased muscular strength (Faigenbaum et al., 2002). Faigenbaum et al. also improved maximal strength in pre-pubertal children by using leg extension and chest press machines (Faigenbaum et al., 2004). (Faigenbaum et al., 2004) Faigenbaum, in another study, found that strength training in children positively increased bone mineral density and in addition, blood lipids, respiration and psychosocial improvements were also reported (Faigenbaum, 2001).

According to Faigenbaum, if training instructions are followed exactly, bone mineral density increases, motor performance ability improves, sportive performance ability increases and children are better prepared for competitions with strength training programme in children with regular training. In studies, strength training programmes provided physical and muscular development in boys and girls older than 6 years (Faigenbaum, 2000). In a study conducted by Ramsay et al. on 13 boys aged 9 and 11 years, strength training was performed on the main muscle groups 3 times a week for 20 weeks. As a result of this study; a strength increase of 30% was observed in the knee extensor muscles (Ramsay et al., 1990). In a study conducted by Ozmun et al. in a total of 16 children (8 boys and 8 girls) with an average age of 10.3 years, they applied a maximal strength training programme of 3 sets of 7 repetitions for 8 weeks, 3 times a week. In this study, significant muscular strength increases were observed in children (Omzun et al., 1994).

Much of the latest research (Faigenbaum et al., 2001, Açıkada, 2004; Drabik, 1996; Lee, 2003; Muratlı, 2007, Özer, & Özer, 2009) proves that well-designed strength training can increase muscular strength and power in children. In addition, leading world fitness and health organisations (American Academy of Pediatrics, 2008; American College of Sports Medicine, 2006; British Association of Sport and Exercise Science, 2004; Canadian Society for Exercise Physiology, 2008; National Strength and Conditioning Association, 2009) and recent scientific papers agree that strength training programmes can increase muscular strength in children (Ignjatovic et al., 2009). In meta-analyses (Falk & Tenenbaum, 1996) It has been emphasised that strength training in children gives positive results. Muscular strength increases of up to 13% and 30% were observed with typical training of developing children. In addition, a properly designed 8-week strength training programme was applied to another group of children in this period and it was found that the increase in muscular strength reached 55% and 75% (Falk & Tenenbaum, 1996), (Ignjatovic et. al., 2009).

Conclusions

The results of this study are in parallel with the studies on children. Scientists conduct various researches on strength training in children. (Bompa, 1999). As a result of these researches, important data are obtained. (Brzycki, 1995). The results of these studies show that well-designed strength training programmes give positive results in children and increase their muscular strength. The increase in strength ability is parallel to the increase in the performance of children in the sports branches, trainings and competitions they are engaged in. It has been stated by the trainers that those who do strength training increase their self-confidence psychologically compared to those who do not do strength training and accordingly their learning performance increases. With a quality infrastructure and a trained instructor, with the exact determination of the duration and degree of training, children not only increase their strength development but also start to feel good about their performance and have fun (Zatsiorsky & Kraemer, 2006).

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