Original Article

Short-term effect of back squat with an elastic band on the squat and vertical jump performance in trained children

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Abstract:

The aim of this study was to examine the short-term effect of squat exercises performed with an elastic band on static and dynamic squat and vertical jumps in pre-adolescents. A total of 21 children were included as Group 1, n=8 (mean age: 11.1 ±0.83 years; mean height: 151.25±6.31 cm; mean weight: 37.87±5.89 kg), Group 2, n=8 (mean age: 11.5 ±0.53 years; mean height: 150.25±5.77cm; mean weight: 37.75±5.77 kg) and Group 3, n=5 (mean age: 11.8 ±0.45; mean height: 151.2±4.54; mean weight: 38.8±5.26 kg). After taking the initial measurements, the 21 children were randomly separated into the 3 groups of Group 1 (n=8) to perform squats with band, Group 2 (n=8) to perform squats without band and Group 3 (n=5) as the control group. Group 1 performed team training +squats with elastic band, Group 2 performed team training +squats with their own body weight and Group 3 did not participate in any training and were told to refrain from any track, field or squat training and to maintain their normal activity. Measurements were taken of the height and weight of the children, then they participated in the static squat, dynamic squat and vertical jumps tests. According to the results of this 6-week research, 1) squat with elastic-band increased the duration of static squat or muscular endurance, 2) the number of squat repetitions in 30 seconds increased and 3) the height of vertical jumps increased.

Key words: back squat, elastic band, children.

Introduction

Resistance training is known to be safe and useful for children and adolescents [1,2] and a training program appropriate to the age of the child with proper guidance is always recommended. The quadriceps muscles in the lower extremities are extremely important muscles in providing standing dynamic balance and the gastrocnemius in walking and running against gravity. The squat is one of the most important exercises used in the development of these muscles, both in rehabilitation and for athletic performance [1]. There has been research related to the effectiveness of the squat used to develop lower body strength in adults, the elderly, children and on the performance of athletes. [1,3,4,5,6,7,8,9,10,11].

Leg strength in children increases with age. However, unlike in adults, the gaining of strength in children is associated with neuromotor adaptation and in the majority of adults there is a hormonal effect on strength gain. Pre-adolescence, that is, in childhood, a difference is seen [2]. It has been emphasised that back pain problems may develop because of insufficient muscle strength and stability associated with insufficient hormones and therefore intense resistance exercises are not recommended to pre-adolescence [2,8,12]. In particular, the avoidance of weight lifting before and during adolescence has been a common suggestion in many different contexts connected to physical activity, from commercial gyms to physical education courses. Takai et al (2013) determined a significant improvement in adolescent body composition, flexor muscle strength of knee, vertical jumps and sprint times following an 8-week application of squat exercises with body weight [8]. Thus it is possible to achieve development with the individual's body weight. There are also studies supporting that this development can be made in the same way with training applied with an elastic band [1,13,14] and recommending the use of an elastic band in strength-building squat exercises [15,16]. Studies have also been conducted on the effects of acute squat exercises with a band [17].

However, to the best of our knowledge, there has been no research on the short-term effects of squat exercises applied with an elastic band in pre-adolescence. The results of this study could increase the frequency of use of elastic band, as a safe and easy method for the development of lower body strength in rehabilitation programs, home-based programs or physical education lessons. According to the hypothesis of this study, squats made with an elastic band rather than only body weight in the development of dynamic and static squats will be more effective in the improvement of static strength, muscular resistance and vertical jumps. The aim of this

study was to examine the short-term effect of squat exercises performed with an elastic band on static and dynamic squat and vertical jumps in pre-adolescents.

Material and methods

Subjects

The study included children volunteers with no health problems who had undertaken track and field training for at least 1 year. Any children with health problems or injuries, who had not been training for at least 1 year or who were not compatible with the study were excluded. A total of 21 children were included as Group 1, $n=8$ (mean age: 11.1 ± 0.83 years; mean height: 151.25 ± 6.31 cm; mean weight: 37.87 ± 5.89 kg), Group 2, $n=8$ (mean age: 11.5 ± 0.53 years; mean height: 150.25 ± 5.77 cm; mean weight: 37.75 ± 5.77 kg) and Group 3, $n=5$ (mean age: 11.8 ± 0.45 ; mean height: 151.2 ± 4.54 ; mean weight: 38.8 ± 5.26 kg). After taking the initial measurements, the 21 children were randomly separated into the 3 groups of Group 1 ($n=8$) to perform squats with band, Group 2 ($n=8$) to perform squats without band and Group 3 ($n=5$) as the control group. Group 1 performed team training +squats with elastic band, Group 2 performed team training +squats with their own body weight and Group 3 did not participate in any training and were told to refrain from any track, field or squat training and to maintain their normal activity.

Methods

The research was conducted in accordance with the Helsinki Declaration. Informed consent was obtained from the parents of the study participants. Permission for the study was granted by the Local Education Authority Research Commission (protocol no: 1598844, dated 12.02.2015). The study was completed between 19 January and 30 April 2015. Measurements were taken of the height and weight of the children, then they participated in the static squat, dynamic squat and vertical jumps tests. The tests and measurements were applied in the physiology laboratory of University. For the children to be able to learn the correct technique before the tests, low numbers of repetitions of squats without resistance were applied. It was ensured that all the children had learned the correct technique. This adaptation process lasted one week. After the adaptation process, the tests were repeated and the measurements taken after the adaptation week were considered as the baseline values. During the exercises, any requested explanations of the squat were given by the researcher. Before each training session, a standardised 10-minute warm-up was applied to start the training and each session was finished with a 5-minute cool-down period. The squat program was applied to the children for 6 weeks, 2 days per week at 2 sets of 20-30 repetitions[1]. Throughout the study, blue and yellow bands were used. The colour of the band to be used by the children was determined by the band colour with which they could perform a squat 10 times with the correct technique. The first training session started 24 hours after this application. The length of the bands were adjusted according to the height of the child. Before each training session, the bands were checked and any that were torn were replaced. Instead of a bar for band attachment, a wooden pole weighing 100 gr was used. **Vertical jump;** The participants were in a standing position, and performed a counter movement jump as high as possible. The position of the jumper on the mat was the same for takeoff and in landing. When jumping, the participants kept their hands on their hips and jumped vertically on a matswitch platform. The participants completed 3 trials with a rest interval of 1 min between the trials. The highest value for the three trials was used for analysis. Measurements were taken using the Newtest Powertimer-300. **Dynamic squat;** The dynamic squat test was used to determine lower body muscle resistance. Before starting the test, the knee flexion angle of 50° was defined with a goniometer in front of the wall and marked with a pen. The children were requested to repeat the squat at that angle throughout 30 seconds and the test was repeated twice. This test was modified taking the single leg squat test as a reference[18]. **Static squat;** Before starting the test, the knee flexion angle of 90° was defined with a goniometer in front of the wall and marked with a pen. When the child was ready in the squat at that angle in front of the wall, a timer was started and at the moment that the defined angle was lost, the timer was stopped. The time held at the desired angle was recorded and the test was repeated twice[19].

Statistical analysis

Statistical analyses were made using SPSS v.15.0 software. The paired sample t-test was used in the intra-group evaluation and One Way ANOVA in the intergroup evaluation. Descriptive statistics were calculated for all data. The Levene test was used to analyse the normality of distribution of the data of groups. As a result of the variance analysis applied, when a significant difference was revealed between the groups, the Tukey HSD test was used as a multiple comparative test to determine the significance between means according to the variance homogeneity. A value of $p < 0.05$ was accepted as statistically significant.

Results

All children completed the study according to the procedure, and no injuries were reported. At the baseline, no significant difference was found in height ($f=.072$; $p=.931$), weight ($f=.053$; $p=.949$), age ($f=1.721$; $p=.207$), vertical jump ($f=.162$; $p=.840$), static squat ($f=.385$; $p=.686$) and dynamic squat ($f=0.133$; $p=.877$) in all groups.

Table 1. Changes between pre and post training of groups

	Statics squat/ s	Dynamic squat/ repeat	Vertic al jump/ cm									
	Pre	Post	Absol ute	%	Pre	Post	Absol ute	%	Pre	Post	Absolut e	%
	mean±SD	mean±SD			mean ±SD	mean±SD			mean ±SD	mean±SD		
Group Elastic-band	12.87±4.15	17.50±6.14	4.63*	35	22.37 ±4.74	32.00±3.46* *	9.63*	43	24.13 ±8.32	29.88±6.85* *	5.75*	
Group Body-weight	11.12±3.27	8.25±5.0	2.87#	25	21.12 ±4.76	28.13±4.12* *	7.01*	33	27.38 ±15.4 1	23.00±3.29	4.38#	16
Group control	12.47±5.12	6.40±2.96	6.07#	48	21.6± 5.31	23.60±5.12	2*	9	26.20 ±11.0 4	26.80±7.56	.6*	1.5

absolute decrease; ** significant increase within group; *absolute increase; % change between pre and post-training

The data on static squat, dynamic squat and vertical jump performance in all groups are summarized in Table1. After training period, there was significant difference in static squat ($f=9.517$; $p=.002$), dynamic squat ($f=6.403$; $p=.008$) and vertical jump ($f=2.692$; $p=.095$). In static squat, there was significant difference between the group with elastic-band and the group with body weight ($p=.005$) and the group with elastic-band and the control group ($p=.004$). In dynamic squat, there was significant difference between the group with elastic-band and control group ($p=.006$). In between pre-and post training there was significant difference in dynamic squat ($t=-9.012$; $p=.000$) and vertical jump ($t=-3.543$; $p=.009$) in the group with elastic-band. There was significant difference in dynamic squat in the group with body-weight ($t=-3.564$; $p=.009$). There was no significant difference static squat in the group with elastic-band ($t=-1.973$; $p=.089$) and the group with body-weight ($t=1.55$; $p=.163$). There was no significant difference in control group ($p>.05$).

Discussion

Elastic bands for rehabilitation are characterised by portability, light resistance and versatility and are used to increase strength in rehabilitation treatment programs and sports training programs [16,20,21,22,23]. According to the results of this 6-week research, 1) squat with elastic-band increased the duration of static squat or muscular endurance, 2) the number of squat repetitions in 30 seconds increased and 3) the height of vertical jumps increased. In other words, squat exercises with an elastic-band are a safe and effective method providing better development in a short time in pre-adolescents compared to squats performed with body-weight only.

While several studies have recommended strengthening programs made with the individual's body weight, there is increasing use of elastic bands as an alternative in strength training. Previous studies have reported that exercises made with elastic bands are more effective strengthening exercises than the traditional methods [24,25]. In previous studies, while some researchers have found that an improvement in peak power was achieved with exercise with elastic bands [16], others have found no difference between groups exercising with and without elastic bands [15].

Static squat or wall squat are used in the majority of strength training sessions, knee rehabilitation [26] and static muscular resistance testing [27]. In studies of adolescents, Takai et al found that the group performing squats with body weight only showed more improvement than the control group [8]. Similarly in the current study, the static squat performance of the group training with body weight improved more than that of the control group. Furthermore, the static squat of the group using elastic band showed better development than both the group training with body weight only and the control group. Besides increasing the static power of the leg muscles, dynamic squat also showed more development in the elastic band group than the control group. However, this increase in dynamic squat was not seen in the group training with body weight only. On the contrary, although not significant, a decrease was determined in both the control group and the group training with body weight only.

When the knee joint angle decreases, the activity of the quadriceps muscle increases while the knee is in flexion [26] and increased efficacy of the quadriceps muscle causes strengthening. Working at the same knee angles, a significant improvement was determined in dynamic squats in both of the groups performing squats with body weight and with elastic band. However, this increase showed a better result applied with the additional resistance to the knee joint in the group with the band. Unlike free weights, squat with elastic band in addition to body weight improved the static and dynamic resistance of the gastrocnemius, hamstring and quadriceps muscles of the children and vertical jumps in a short period. The vertical jumping training improved. Previous studies have also obtained these results[31,32,33].

In adolescence and after, muscle strength increases with the effect of testosterone hormone [34,35]. The results of the current study indicate that an additional training stimulus such as elastic band in pre-adolescent children could show a positive response in a short time and confirm that the strength development created in pre-adolescents occurred through adaptation to neuromuscular activity. The mean static squat of the elastic band group increased but this increase was not statistically significant. Although not significant, a decrease was seen in the group training with body weight only. Similarly in the vertical jump performance, the rate of improvement in the elastic band group was seen to be much greater than in the other groups. Training with additional resistance achieved an improvement in vertical jumps and this increase was previously determined in studies on pre-adolescents by Ingle and Sleaf (2006) [5].

Squat exercises are already in use in rehabilitation programs [29,30]. Although the strength of the leg extensor muscles is limited in children for hormonal reasons, this increase was obtained associated with neural adaptation after training [28] and this adaptation could be considered of benefit for use in treatment programs for children with limited movement or disabilities. In addition, this method can be recommended for sports training for children to increase muscle resistance without stress or overloading.

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