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Resistance Training in Immature Children: A Review Article

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ABSTRACT

Resistance training is a common component of sports and physical fitness programs for children. Resistance training programs may involve the use of body weight, medical balls, bands and ropes, dumbbells, and barbells. In recent years, researchers have discussed the problems associated with resistance exercises during childhood. A similar view is the impact of these exercises on muscular strength although opinions vary on the role of these exercises on sports performance. Some researchers confirm the effects of resistance training on cardiovascular, bone density, body composition, and physical impairment. However, the main concern of physicians, coaches, and parents is the potential damage caused by these exercises. The present study aimed to reduce the damage caused by resistance training by designing special exercises.

Introduction

Practicing and exercising constitute a significant part of life during childhood. Normally, children who practice regularly become active individuals in their adulthood (1). The American Center for Disease Control and Prevention has advised that children should have 60 minutes of daily exercise (2). Recently, resistance training has been welcomed by children to improve fitness and enhance athletic performance (1).

Previous studies have confirmed the effects of resistance exercises on increasing muscular strength (3-5) and cardiovascular fitness, improving sports performance, bone density, and body composition, and reducing physical damage (6-8).

Strength training is a form of physical fitness that is used to increase the ability to withstand refractory strength (9). Resistance exercises in children increases strength through nerve adaptations (e.g., changing motor coordination), recall of motor units, and stimulating excitement. During childhood, increased muscle strength is associated with strength training independent of hypertrophy (10).

According to the literature, after 8-12 weeks of resistance training, children could experience increased strength by 30-50% (4, 11). In a study by Garrido et al. (2010), strength training was performed for eight weeks by boys and girls with the mean age of 12.08±0.76 years, and a significant increase was observed in their leg extension and bench press (37% and 43%, respectively) (4).

Given the importance of resistance training during childhood and role of these exercises in the promotion of health and development of movement abilities, the present study aimed to review the effects of resistance training on immature children.

Resistance Training Program Design

An athlete could improve strength by overcoming external or internal resistance; such example is attempting to bend the hand while the other hand resists the motion. Resistance training may involve the use of body weight, medical balls, bands and ropes, dumbbells and barbells, and constant resistance as the main sources of external resistance (1, 10, 12).

In a strength training program, free weights should be used alongside other workout tools, such as medical balls, devices, and jump movements (i.e., hybrid activities). Since these tools complement each other to intensify the effect of training, they are considered beneficial for athletes (13).

The key components of strength training programs are the course (set), which usually varies between 1-8 per each move, and repeating the movement during the sets, which varies between 5-15. The intensity of exercise, which is expressed as a percentage of a maximal repetition, varies between 35-88% depending on the purpose of the exercise (e.g., strength, power, endurance).

In order to reduce the damage caused by strength training in immature children, researchers tend to recommend moderate exercise intensities. The training volume may vary depending on the intensity of the workout (1-3 sessions per week), and each session may last 20-60 minutes. The rest time also depends on the intensity of the exercise and is measured relative to the activity time (20-220 seconds per each set) (12, 14).

Warm-up and cooling must be prioritized in designing strength training programs. Duration of each training session is often 5-10 minutes (1). Warm-up should prepare the body for further exercise, and cooling involves light-weight exercises that allow the

body to return from the state of arousal to the normal state close to rest (15).

Safety in Resistance Training

For decades, the question of whether or not children should participate in resistance training programs has been a matter of debate. Physicians believe that strength training in childhood could damage the growth plate and impair the growth of the bones. However, damage to growth sites has not been reported in the studies where resilient exercises have been principally applied (6), and no evidence suggests that these exercises have adverse effects on the growth in height in children (16). Furthermore, Cahill (1998) has stated that sports such as gymnastics and baseball, which involve movements with high frequency and torque, are more likely to cause damage to growth screens (17).

In a study conducted by Faigenbaum and Myer (2010) on 19 children receiving resistance exercises, only three out of 502 subjects reported injuries. As a result, more studies have been focused on the safety and efficacy of these training programs (6).

Today, resistance training based on proper techniques is approved by most accredited medical-sports magazines in the world (18). Immature children can use resistance exercises under the supervision of the adults who are aware of the technical limitations in the sports performance of children. In designing a training program, weight should be reduced in order to diminish the pressure on the musculoskeletal system of children, while the repetitions and interval between sets and movements should increase (19).

Boosting Strength Mechanisms with Resistance Training

Researchers believe that increased strength in adults is accompanied by an increase in the muscle size, and testosterone is the key hormone involved in such changes. However, as children grow, they experience a progressive increase in strength. It is notable that the mechanisms of increasing strength are not identical in immature children (20).

Several studies investigating muscle size changes through resistance training in children have suggested that despite the significant increase in muscular strength, the muscle size has insignificant or no effect on improving muscle strength (21, 22).

The expansion that occurs in strength training could be the result of the increased inherent capacity of muscle force production. Such changes could reflect altered structures, such as stimulation-contraction pairing and myofibril bundle density. Moreover, neural adaptations, such as the changes in the coordination of the motor unit, recall of motor units, and stimulation frequencies, could be effective in increased strength (20, 21). As such, during the years before puberty, gaining strength through growth and resistance training occurs in the absence of testosterone and other anabolic hormones (20).

Disease Prevention and Treatment

With regard to the advancement of illness during childhood and adolescence, Faigenbaum (2000) acknowledged that exercise may prevent or delay coronary heart disease (23). In the field of treatment, strength training has been reported to be beneficial; such example is the study by Raiman and Lorenz (2011), which indicated that strength training could reduce the length of recovery and treatment (24).

Morton and McFadyen (2005) conducted a research on the children with spastic cerebral palsy (CP). According to the findings, the training program increased strength by 65%

in the patients through progressive resistance training in only six weeks (25).

In this regard, Flower et al. (2001) evaluated 24 children with CP, asserting that reinforcement exercises with maximum effort increased spasticity in the patients, which indicated the safety of the exercises (26).

Rehabilitation treatments are essential to reducing the disabilities caused by Down syndrome. Given the importance of balance in developing individual autonomy and the role of strength in creating balance, Sayadinezhad et al. (2013) examined the effect of progressive resistance training on improving the balance of children with Down syndrome. The researchers concluded that such exercises had a positive influence on balance in the children (27).

In another study, Tofighi and Karimnia Saheb (2017) investigated the effects of one session of high-intensity resistance exercises on coagulation factors and blood fibrinolysis before and after 10 weeks of resistance training in obese children. The researchers concluded that the exercises increased the levels of tissue plasminogen activator and von Willebrand factor and decreased plasminogen activator inhibitor-1 (28).

According to the findings of Ramezani et al. (2016), eight weeks of resistance training in inactive obese children aged 8-12 years reduced the body mass index, total cholesterol, triglyceride, low-density lipoprotein, very low-density lipoprotein, and insulin resistance, while increasing high-density lipoprotein and adiponectin (29). Furthermore, the study by Faigenbaum (2003) indicated that resistance training could improve bone mineral density, cardio-respiratory fitness, overall wellness, blood lipid profile, and body composition, while reducing the risk of exercise injuries (18).

Strength Transfer in Sports Performance

Resistance exercises could contribute to sports performance. Muscular strength plays a pivotal role in the performance of sport activities, and increased muscular strength could enhance sports performance (30-33). In a review study, Harries et al. (2012) claimed that among the studies that evaluated speed performance (n=13), resistance exercises have been reported to improve speed performance in 11 studies. Additionally, out of the studies that measured vertical jump performance (n=25), resistance training has been reported to reinforce vertical jump performance in 19 studies (34).

On the other hand, other studies have indicated that gaining strength may not result in the simultaneous progress in implementing motor skills after several weeks of resistance training. This is because the effects of resistance exercises on motor function depend on the design of the training program.

The principle of training attributes should be considered in the design of training programs. Similar to adults, adaptation practice in children and adolescents depends on the pattern of movements, movement speed, type of contraction, and force of contraction. Therefore, regardless of age, if resistance training programs consists of special sports exercises and the type of muscle activity is most similar to sports performance, the greatest improvement occurs in the implementation of motor skills (33).

In a research in this regard, Young (2006) provided data on strength transfer to sports performance, which involved leg contractions due to vertical movements (e.g., squats and jump squats), resulting in slight transitions in speed execution. On the other hand, exercises involving whole body movements in horizontal and lateral directions have a

significant effect on speed performance. Therefore, for optimal transfer, special attention must be paid to the motor pattern and type of contractions (35). Lesinski et al. (2016) have also acknowledged that the strength factor is only one of the many factors required to improve sports performance, which may not increase in parallel (14). Types of exercises also play a key role in this regard. According to the report by Toussaint and Vervoorn (1990), exercises in water have a more significant impact on swimming compared to drill exercises (36).

Tanaka et al. (1993) have stated that even in swimmers, increasing strength for better performance was not well transmitted due to the high-level techniques used by swimmers (37). In addition, Garrido et al. (2010) reported that specialized exercises in swimming may be more important than strength training (4).

In the study by Shahabadi and Bijeh (2018), the subjects were immature individuals; therefore, less intensive exercises than adult exercises were used in order to prevent injuries (38). This might have led to the insignificant effect of strength training and plyometric exercises on the implementation of swimmers.

Conclusion

According to the results, resistance training could improve muscular strength and physical and mental status in children when supervised by an instructor. The benefits of resistance training are far greater than its risks, especially in the modern society where children do not have favorable physical conditions.

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