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From Myth to Reality: Resistance Training in Children

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ABSTRACT
Children have been participating in sports with the increasing numbers day by day. With the increasing rivalry, they are trying to find the ways to improve their performance to the best possible. As a result, the number of children who are adding resistance training to their training routines is also increasing. This raises myths about the harmful and risky nature of resistance training on children with many questions about its safety and effectiveness. Recent studies can remove doubts about the risk of injury, uselessness and ineffectiveness. With the proves from many studies for some decades, it is now accepted that properly controlled and supervised resistance training during childhood is not only safe and effective but also recommended by the world's leading healthcare and sports organizations for improving health and athletic performance. In the light of the scientific data, possible benefits, risks and application areas of resistance training for child athletes are discussed in this review.

Introduction

Resistance training refers to the type of exercise that requires the muscles to contract against the opposite force created by some type of resistance. The resistance can be created by body weight, free weights, weight machines, hydraulic machines, elastic tubes, bands etc. If resistance is created through weights or specific machines, the term 'weight training' can also be used in the same sense. Strength training, on the other hand, is used in a broader sense and refers to any type of training used to increase physical strength.[1] Resistance training is one of the most popular and effective methods of increasing sportive performance and is widely practiced by high school, university and professional athletes.[2] Resistance training is known to increase the strength of adults and this improvement has been shown to arise from muscle hypertrophy, structural changes in muscle fibers, and neuromuscular and metabolic adaptations.[3-5] However, resistance training in children is a controversial topic. In early studies on the effects of resistance training on children, it was reported that these adaptations could not be seen, mainly due to insufficient androgen in the circulation.[6,7] Furthermore, resistance training hasn't been recommended for children and adolescents for a long time for its possibility of causing injuries.[8]

Clinicians once considered open growth plates in children as a definite contraindication for resistance training due to the risk of injury to the growing sensitive bones. In fact, the American Academy of Pediatrics reported that it would be impossible to increase strength or muscle mass in prepuberty due to the lack of circulating androgen hormones, making weight lifting an unnecessary risk for children.[9]

The fear that resistance training will damage the growth plate is not supported by scientific studies; on the contrary, the mechanical stress on the growth plate caused by resistance training or high-intensity sports such as weightlifting has been shown to be beneficial in bone formation and development.[10-16] In addition, there is no scientific evidence that resistance training can adversely affect the linear development of the bone or cause short stature in adulthood. [17,18]

In light of all these studies, the traditional fears and false concerns that resistance training will damage the developing skeleton have been replaced by reports stating that childhood may be an opportunity to create bone mass and improve bone structure through physical activities that contain weights.[19,20]

Children must have sufficient muscle strength to be competent in basic movement skills.[21] Insufficient muscle strength leads to difficulties in basic movement skills at an early age and as a result, physical and psychosocial problems may develop in participating in physical activities in adolescence and adulthood.[22]

Effects on Athletic Performance

Besides the arguments that resistance training will increase the risk of injury in children, there is also debate about the effectiveness of resistance training. It has long been known that resistance training can increase strength and hypertrophy in adults. Despite increasing evidence that resistance training in children can lead to enhance performance by improving strength, speed, power, and other related features, the degree of hypertrophy due to androgen hormone deficiency especially in prepubertal children has been a matter of debate among researchers.[23-26]

Recent studies clearly show that appropriate resistance training improves strength and strength-related features at all ages.[1,27] It has been clearly demonstrated that well-designed and well-supervised resistance training can make significant improvements in muscular fitness even in 5-year-olds.[28,29]

The strength increase seen in prepubertal children seems to be related to the development of the central nervous system rather than hypertrophy.[30] Especially the increase in motor unit participation, firing frequency, synchronization and improvement in neural myelination increase the neuromuscular performance.[31,32] For this reason, trainers working with prepubertal children should avoid training methods aimed at increasing muscle mass, and focus on strength development and movement ability.[33] In adolescence, in addition to neural development, structural changes due to testosterone, growth hormone and insulin-like growth factor 1 (IGF-1) increase are also of great importance.[30] Accordingly, while the gender effect is observed to be minimal in absolute and relative strength gains with resistance training in prepubertal children, the gender effect and gender-related strength difference are more pronounced as the age progresses.[33,34]

Strength training in adolescent soccer players has been shown to improve maximal strength and muscular endurance and provide better body composition, and different types of resistance training (daily wavy, linear) have similar effects on maximal strength in adolescents.[36,37]

In the literature, gains in maximum strength vary between 10 to 70% depending on different factors such as training program type, duration, and exercise type used for strength measurement. Usually, sedentary children typically have 30-40% expectation of strength gain with the beginner's program.[38]

In addition, fundamental motor skills like jumping, running, hopping etc. as main locomotor skills and object control skills like kicking, catching, throwing etc. must be gained by the end of adolescence.[39] Recent studies have shown that resistance training improved power generation, jumping, sprinting and agility performances in pre and post-pubertal children.[1,22,40-43]

Effects on the General Health

In addition to its positive effects on the athletic performance, studies have shown many other benefits of resistance training in terms of protecting and improving health. Results of studies conducted with resistance training in obese children are promising in terms of combating childhood obesity. In these studies, positive effects on the general body composition [44] in obese children, abdominal and body fat decrease[45], insulin[46] and leptin[47] sensitivity increase in overweight adolescents, improvements in cardiac functions[48] and improvement in self-perception in obese children were shown.[49] It has also been reported that the participation of overweight and obese children in resistance training can increase their muscle strength, motor coordination and self-confidence in the physical activity.[44]

In addition, it has also shown positive effects in the development of body composition[50], preventing and treating sports-related injuries[22,51], long-term protection of the health, cardiovascular fitness and blood lipid profiles in healthy children and child athletes.[22,51-52] Besides its benefits on the physical health, different studies have shown that resistance training improves children's self-confidence and has positive effects on their psychological health.[50,53,54] It has also been reported that resistance training in the form of CrossFit training can improve mental health in adolescents with risks of psychological disorders.[55]

As the positive effects of resistance training on strength and physical performance emerged, private patient groups were also started to be studied. There have been many studies recently on the effects of resistance training on children with cerebral palsy. As a result of these studies, although its effects on mobility are controversial, positive effects on muscle strength, general functions and mood were reported.[56-58]

Contrary to the historical belief that resistance training in children will increase the risk of injury, recent studies have revealed that resistance training can prevent sports-related injuries in child athletes.[59-62] It has been reported that focusing on risk factors for sports-related injuries (such as low fitness levels, muscle imbalances, training errors) resistance training can reduce overuse injuries by up to 50%.[63,64]

In addition to all these, studies conducted in different countries show that strength parameters in children tend to decrease gradually in time.[65-67] Well-designed and properly followed resistance exercises can be applied as an effective method to prevent this undesirable tendency.[38] Resistance training is especially important as it can be taken up by all children regardless of their individual abilities and body composition.[37,68] Physical education teachers, child fitness specialists, healthcare professionals and trainers working with child athletes should know the basic principles of child development and plan their exercise prescriptions to meet the individual needs of the child and independent of the chronological age due to the individual nature of growth and development.[38]

Despite all these positive effects, it is vital to ensure that children can safely coordinate and be aware of how they move with weights before resistance training.[69] For this purpose, 'Resistance training skills battery for children' was developed[53] to evaluate children's individual and general resistance training skills and it was emphasized in later studies[69] that this battery can be used by anyone to determine the competence and readiness of children before resistance training is planned.

With the increasing number of scientific evidences many meta-analyses[70-72] and reviews[73] have been conducted for resistance training in children most recently They all unveiled the benefits and the effectiveness of the resistance training on children and adolescents.

Conclusion

Correctly planned and properly supervised resistance training is very safe also for children. Contrary to historical misconceptions, it has been clearly shown that the injury rates during resistance training are not higher than other training and sports activities, and that they do not have a negative effect on children's growth and development. In addition, it

appears to be effective and safe in terms of preventing sports-related injuries and improving the overall health.

Today, when resistance training is applied under the right technical instructions and supervision, it is recognized and recommended as safe and effective by the world's leading medical and sporting communities such as American Academy of Family Physicians (AAFP), American Academy of Orthopaedic Surgeons (AAOS), American Academy of Pediatricians (AAP), Australian Strength and Conditioning Association (ASCA), American College of Sports Medicine (ACSM), American Medical Society for Sports Medicine (AMSSM), American Orthopaedic Society for Sports Medicine (AOSSM), American Osteopathic Academy of Sports Medicine (AOASM), The National Strength and Conditioning Association (NSCA), and The President's Council on Physical Fitness and Sports, United Kingdom Strength and Conditioning Association (UKSCA), Canadian Society for Exercise Physiology (CSEP).[38,67,68]

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