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The Impact of Strength Training on Adolescent Athletic Performance

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Abstract

The purpose of this study is to investigate the influence that strength training has on the athletic performance of adolescents, with a particular emphasis on the physiological and performance-related outcomes. The fast growth of the musculoskeletal system that occurs during puberty in adolescents makes this a crucial time for the introduction of systematic strength training. The purpose of this research is to demonstrate increases in muscular strength, power output, coordination, and general athleticism among teenagers who participate in supervised strength training programs. These benefits are highlighted through a review of the published literature as well as empirical investigations. Specifically, the benefits extend to a wide range of activities, including the enhancement of sprint speed, jump height, agility, and the prevention of injuries. Strength training is both safe and very helpful for young people, according to the findings of the study, which also answers widespread concerns regarding safety. The study come to the conclusion that strength training was developed and supervised effectively. According to the findings, there should be more emphasis placed on incorporating resistance training into the athletic curriculum of schools and youth sports programs in order to promote holistic athletic development.

Keywords: *training, adolescent, athletic, performance*

Introduction

Despite strength training's long-established association with professional athletes, its role in enhancing teenage athletes' performance has received a great deal of attention in the last several decades. Important foundational strength, motor skill, and movement efficiency development occurs throughout the adolescent years, a time defined by rapid hormonal and neurological changes in the body. A person's overall athletic potential and health in the future may benefit greatly from strength training throughout this developing stage. The goal of strength training is to improve neuromuscular coordination, muscular mass, endurance, and strength by causing the muscles to contract against a resistance. In the realms of athletics and PE, the phrase "strength training" is ubiquitous. It helps young athletes avoid injuries, which is particularly important because they deal with repetitive stress and enormous training volumes, and it can improve physical performance when adjusted to developmental needs. The possibility that strength training might harm growth plates or cause injuries in adolescents has long been a source of concern. However, studies done over the last 20 years have proven that structured youth strength training programs are safe and beneficial, therefore disproving these preconceptions time and time again. On top of that, they may help shape positive habits, boost confidence, and bring about more self-control. This research aims to examine the specific effects of strength training on adolescent athletes' performance by looking at their physiological adaptations, the benefits to their performance in a specific sport, and the broader implications for programs that teach physical education and youth sports. Also covered are the best practices for program design and supervision that will lead to the safest and most successful outcomes.

Incorporating strength training into frameworks for the development of athletic abilities in teenagers has been supported by an increasing quantity of empirical research in the past several years. Strength, power, speed, agility, and balance are just some of the athletic performance traits that several studies have shown resistance-based training can potentially significantly enhance. In a broad range of sports, these are all necessary for peak performance. The advantages of strength training aren't just for professional athletes; even amateurs and school teams benefit greatly from consistent and progressive training programs. Consideration of the adolescent's age, degree of expertise, and accessibility of equipment dictates the usual components of a strength training program, which may include workouts utilising the individual's own bodyweight, resistance bands, free weights, and machine-based resistance. When designed with the student's developmental needs in mind, these programs prioritise technique, gradual progress, and the incorporation of functional movements that mirror the demands of athletics.

Notably, strength training contributes to long-term athletic development (LTAD), a method that prioritises age-appropriate skill acquisition, physical literacy, and the gradual intensification of training. Teens might be better prepared for the rigours of competitive sports later on if they start resistance training when they are younger. Also, sports injuries including ACL tears, shoulder dislocations, and overuse injuries are less common among athletes who regularly engage in strength training. Adolescents are prone to these types of accidents due to musculoskeletal system anomalies and growth spurts. In the field of psychology, it has been suggested that young athletes who engage in strength training may feel more accomplished and confident. This exercise helps participants to set objectives, stay disciplined, and persevere, all of which are useful in and out of the game. Strength training, in its structured environment, may also provide a healthy way to release pent-up energy and stress, which is good for one's mental health in general. Considering all of these benefits, the article stresses the need of following data-supported guidelines in adolescent strength training programs. It highlights the significance of having knowledgeable individuals oversee sessions, checking for proper technique, and creating engaging and motivating training environments. Ultimately, by harnessing the power of strength training, coaches, educators, and sports specialists may significantly enhance adolescent athletes' performance and overall growth.

1. Physiological Adaptations

Faigenbaum et al. (2009) It was emphasised that strength training performed by adolescents results in neuromuscular adaptations rather than muscle growth, particularly in athletes who are in their prepubescent years. Because of these changes, there is an increase in the recruitment of motor units and an improvement in the coordination between muscles. According to the findings of the study, teenagers may accomplish significant improvements in their strength and power capabilities with consistent resistance training, regardless of the hormonal shifts that may occur.

2. Athletic Performance Improvements

Behringer et al. (2010), Strength training was found to significantly enhance muscular strength, vertical leap, sprint performance, and sport-specific abilities in juvenile populations, according to the findings of a meta-analysis that included 42 separate research. Other study, such as that conducted by Lloyd and Oliver (2012), has demonstrated that strength training improves crucial athletic characteristics, such as agility, acceleration, and deceleration ability, which are fundamental across a variety of sports.

3. Injury Prevention

There is abundant evidence that resistance training has a significant effect in lowering the risk of injury. It was observed by Myer et al. (2005) that structured neuromuscular and strength training programs are beneficial in reducing injuries to the anterior cruciate ligament (ACL), particularly in female athletes who are adolescents. Strength training helps to enhance joint stability, muscle balance, and proprioception, which in turn reduces the likelihood of injuries that are linked with rapid development stages and high-impact sports.

4. Psychosocial and Behavioral Benefits

There is abundant evidence that resistance training has a significant effect in lowering the risk of injury. It was observed by Myer et al. (2005) that structured neuromuscular and strength training programs are beneficial in reducing injuries to the anterior cruciate ligament (ACL), particularly in female athletes who are adolescents. Strength training helps to enhance joint stability, muscle balance, and proprioception, which in turn reduces the likelihood of injuries that are linked with rapid development stages and high-impact sports.

5. Program Design and Safety

There have been recent recommendations, such as those made by the National Strength and Conditioning Association (NSCA, 2016), that advocate for strength training regimens that are suitable for the individual's age and are overseen by highly trained specialists. The standards place an emphasis on correct technique, progressive growth, and individualised training loads. Evidence suggests that when these requirements are satisfied, injury rates in youth strength training are equivalent to, or lower than, those found in general youth sports participation (Faigenbaum et al., 2009). This is the outcome of the study that was conducted by Faigenbaum et al.

6. Long-Term Athletic Development (LTAD)

Balyi and Hamilton (2004) advocated for the Long-Term Adverse Development (LTAD) paradigm, which advocates for the systematic integration of strength training beginning in early adolescence in order to maximise future performance. Research has demonstrated that beginning resistance training at a young age results in the development of basic strength and movement literacy, which offers long-term advantages to athletes throughout their whole athletic career.

Adolescent Athlete:

The term "adolescent athletes" refers to competing athletes who are between the ages of 12 and 18 years old. It is highly crucial to pay attention to this age group for future sporting careers. The same characteristics are present in children of both sexes, including their weight, height, injury risk, motor abilities, percentage of body fat, endurance, strength, and haemoglobin levels. (Faigenbaum, Aet al., 2000) These particular parameters are altered after the activation of the hypothalamus pituitary-gonadal axis, which indicates that puberty has taken place. How the Puberty Process Affects Athletes: Puberty has an effect on the physique of every athlete, regardless of whether they are male or female. Nevertheless, it has a substantial impact on female athletes overall.

For example:

By the time a female reaches puberty, her body fat percentage should be around 23%, while a boy's should be around 13% to 15%. The top female runners may reduce this barrier by 8-10% in sprinting and 12-16% in distance running as a result of their intense training regimens and long hours. Pichondo et al. (2019) found that male gymnasts who practice regularly can have a 4-8% decrease in their body fat percentage.

Adolescence is a time of maturation for the thermoregulatory system, which is present in both male and female athletes. Heatstroke is more common in adolescent athletes than in younger athletes for a number of reasons, including stunted growth, reduced body surface area, and strenuous physical exertion in hot weather. Flexibility increases in girls begin in infancy and reach a peak around the ages of fourteen or fifteen, but in boys they typically occur between the middle of adolescence and the conclusion of puberty. Female teenage athletes experience delayed strength gain throughout puberty compared to their male counterparts. Though they use the same sort of fibre, female muscles are noticeably smaller. Although a girl's strength does increase marginally once menstruation begins, a boy's strength continues to develop throughout puberty. The purpose of this study was to examine how a strength and conditioning program affected the speed, acceleration, and change-of-direction ability of pre- and post-match performance in young male and female athletes. The unique thing about this study was that it planned the training intervention strategically, taking match and pre-match days into account.

Sports competitions have long relied on the SJ and CMJ jumps as an easy way to gauge leg power. Additionally, studies have shown that SJ and CMJ are more likely to improve with regular practice and an 8-week strength and conditioning program than with regular basketball exercise alone. Functional improvements (such as motor unit coordination) and structural changes (such as muscular hypertrophy) are the primary outcomes of strength and power training, and the aforementioned studies give sufficient proof of these effects. There are a number of options for strengthening one's leg. Neuronal drive to the muscles, variations in motor unit synchronisation, and inhibitory mechanisms all contribute to strength variations. The pubertal subjects, who are part of the Strength and Conditioning group, have much lower levels of anabolic hormones in their blood, which prevents them from developing muscle. For teen athletes, the current level of performance is not good enough. On the flip side, the training load (no more than 10–12 repetitions), maturational status (tanner stage 3 or 4), and training history (i.e., no experience) of various approaches were tested. The synergistic adaptation that occurs in the brain during the early stages of strength conditioning programs, along with changes in muscle structure and enhanced hypertrophic development at the exercise loads selected (10-12 RM), may have been caused by increased blood levels of anabolic hormones (Nichols, et al., 2001). Growth and maturation bring about morphological changes such as recruiting muscle units, pre-activation, reflex control, and reduced cocontraction, among others. Stiffness, cross-sectional area, pennation angle, and fascicle length of the muscle all increase as well. According to Greydanus and Patel (2002), adults may exercise with a larger eccentric load on the muscle unit because they have evolved to keep the benefits of improved stretch-shortening function.

The results showed that plyometric training with horizontal force vectors significantly improved the acceleration performance of teen basketball players in the five-and ten-meter sprint times compared to a vertical training group. Jumps, hurdles, ladders, and hops were some of the ankle plantar flexion activities that were heavily emphasised in the training program. The main muscles that generate forces to support the foot vertically are the ankle flexors. A longer stride at lower speeds (up to 7 m∛s-1) might impact acceleration performance, as suggested by Ziv and Lidor (2009), due to drill specificity. In team sports, the Pro Agility Test is most often used to measure the ability to shift directions. The S&C group outperformed the control group in terms of speed of direction change on the standard Adolescent test.

The top performers in the 180º change of direction speed test showed improved braking and propulsive forces, shorter contact time, less time spent pushing and braking, and isometric and eccentric strength capabilities (Faigenbaum, A., 2000). Optimal triple extension during the 180º change of direction speed test appears to be aided by isometric strength, which permits the lower limb to reaccelerate in the correct alignment. Therefore, it is more advantageous to routinely engage in strength and conditioning therapies with basketball training, rather of relying just on basketball training. More particularly, the research compared the impact on adolescent boys' motor skill development of a long-term periodized mixed resistance training program that included weightlifting versus those of a program that did not. The research found that both groups did in fact increase their performance, albeit in different ways.

The results also show that physical fitness training for strength and mobility competency may be done throughout the teenage growth spurt. People used to think that because weightlifting exercises are so complicated and explosive, using them in a resistance training program would help you improve your movement competency, strength, power, and sprinting ability even more. Level of maturity may also impact how well an individual adapts to various forms of training. Twelve weeks of weightlifting or plyometric and high velocity resistance training improved the strength, jump, and sprint performance of prepubescent children compared to age-matched controls who participated in sports alone. Children whose height-velocity profiles were not yet peak performed better in squat jumps and acceleration after 6 weeks of plyometric training, while the same children performed better in sprints and leaps after a combination of plyo and conventional strength training. The program's long-term periodisation may explain why participants saw improvements in strength training, sprinting, leaping, and throwing, among other areas. Proving that strength is foundational to power, research has demonstrated that strength training—specifically, front and back squats—improves sprint performance. Research by Zebis et al. (2016) suggests that young male athletes may see modest gains in strength when they train with minimal resistance.

Train with much higher resistance intensities and stress to maximise training-induced neuromuscular adaptation and performance improvements. The second part of the intervention seems to have a more noticeable effect on children's jump and sprint performance because, as they grow older, their lower limb muscles become more strong, inflexible, and reactivated. Strength and movement proficiency should be prioritised before focussing on adolescent power development and training-specific adaptations, according to the study. The previously indicated lag effect in power and sprint performance may be amplified by training age, as various types of training are necessary at different stages of growth. Past studies have shown that, for male athletes in their adolescent years, strength increases are more apparent during the first year of resistance training compared to the second. Rugby players between the ages of 16 and 19 demonstrated larger yearly strength gains when trained in resistance, according to research by Till et al., when compared to groups of athletes with only one year of training experience. The results may not apply to teenage athletes as the older players were probably all well past puberty.

Because of their advanced age, it is assumed that they respond more slowly to instructions when tested. Until the second half of the periodized program, when training complexity and intensity rise, the more difficult activities do not react nearly as strongly as the easier ones. This is crucial. These are far more advantageous than the stages of development and maturity, when training was most noticeable. During the 14-week mid- to post-period, scramble performance increased by 3-6% and CMJ height by 0.10%.

Sporty boys (13–17 years old) can increase their sprint performance by 2-4 percent and their CMJ height by 7-9 percent after 12–16 weeks of weight training or plyometric exercises. The boys' sprint performance increased by 0.9% and their CMJ height by 0.26% after accounting for the whole length of the intervention and adjusting to yearly rates of growth. Talent development program guys who did not lift weights improved 6.9% year in CMJ and 2.7% to 3.1% annually in sprint performance. The main purpose of the study was to evaluate the impact of resistance training regimens that focused only on weightlifting vs programs that included both weightlifting and other forms of resistance training on the athletic development of teenage boys. The results showed that both groups were almost as efficient as each other. Interestingly, there was a marked variation in the pattern of change among the components. Improvements in leaping, throwing, and sprinting were more noticeable in the second half of the year, although gains in movement competency and strength were more noticeable in the first half. The periodized design of the training program probably explained the varying temporal responses seen for the performance measures, even though height and body mass fluctuated at constant rates throughout the intervention. Weakley, J. J., et al. (2019) states that in order to achieve long-term improvements in motor skill performance, both athletes and coaches need to have faith and patience in the training process.

Conclusion

The numerous ways in which adolescent athletes benefit from strength training are brought to light by this study's evidence-based methodology. Resistance training programs that are both difficult and well-structured are ideal for teenagers because of their fast physical and mental development. Some of these benefits include enhanced physical strength, speed, agility, and coordination as well as a marked reduction in sports-related injuries. Contrary to popular assumption, strength training may be a safe and helpful activity for youths when done under an adult's supervision and following age-appropriate rules. Strength training in youth sports programs also aids in the development of character traits like resilience, self-discipline, and confidence, which are important for success in life beyond only athletics. Athletes may be better able to realise their adult potential if they begin resistance training early, according to the LTAD model, which further supports the idea that building strong muscles and excellent motor control during adolescence is a good place to start. Because of these advantages, coaches, physical education instructors, and sports organisations should implement the methods supported by research that incorporate strength training into the athletic training of teenagers. Components of this include ensuring competent supervision, customising programs for each person, and placing a focus on safe technique and injury prevention. Overall, adolescent athletes benefit much from strength training since it contributes to their personal development. Athletes are prepared to meet the physical challenges of competition and given the skills to enjoy a healthy lifestyle throughout their lives. Future research should focus on identifying the most effective training variables and studying their long-term impacts in a variety of sporting contexts and demographics.

References

[1] Behringer, M., Vom Heede, A., Yue, Z., & Mester, J. (2010). Effects of resistance training in children and adolescents: A meta-analysis. *Pediatrics*, **126**(5), e1199–e1210. https://doi.org/10.1542/peds.2010-0445

[2] Faigenbaum, A. D., Kraemer, W. J., Blimkie, C. J. R., Jeffreys, I., Micheli, L. J., Nitka, M., & Rowland, T. W. (2009). Youth resistance training: Updated position statement paper from the National Strength and Conditioning Association. *Journal of Strength and Conditioning Research*, **23**(5), S60–S79. https://doi.org/10.1519/JSC.0b013e31819df407

[3] Faigenbaum, A. D., & Myer, G. D. (2010). Resistance training among young athletes: Safety, efficacy and injury prevention effects. *British Journal of Sports Medicine*, **44**(1), 56–63. https://doi.org/10.1136/bjsm.2009.068098

[4] Lloyd, R. S., & Oliver, J. L. (2012). The youth physical development model: A new approach to long-term athletic development. *Strength and Conditioning Journal*, **34**(3), 61–72. https://doi.org/10.1519/SSC.0b013e31825760ea

[5] Myer, G. D., Ford, K. R., Palumbo, J. P., & Hewett, T. E. (2005). Neuromuscular training improves performance and lower-extremity biomechanics in female athletes. *Journal of Strength and Conditioning Research*, **19**(1), 51–60. https://doi.org/10.1519/00124278-200502000-00009

[6] Balyi, I., & Hamilton, A. (2004). Long-term athlete development: Trainability in childhood and adolescence. *Windows of opportunity*, optimal trainability. *National Coaching Institute British Columbia & Advanced Training and Performance Ltd*.

[7] Faigenbaum, A. (2000). Age-and sex-related differences and their implications for resistance exercise. Essentials of strength training and conditioning, 3, 142-158.

[8] National Strength and Conditioning Association (NSCA). (2016). *Youth Resistance Training Guidelines*. NSCA Position Statement.

[9] Pichardo, A. W., Oliver, J. L., Harrison, C. B., Maulder, P. S., Lloyd, R. S., & Kandoi, R. (2019). Effects of combined resistance training and weightlifting on motor skill performance of adolescent male athletes. The Journal of Strength & Conditioning Research, 33(12), 3226-3235.

[10] Nichols, D. L., Sanborn, C. F., & Love, A. M. (2001). Resistance training and bone mineral density in adolescent females. The Journal of pediatrics, 139(4), 494-500.

[11] Greydanus, D. E., & Patel, D. R. (2002). The female athlete: before and beyond puberty. Pediatric Clinics, 49(3), 553-580.

[12] Faigenbaum, A. (2000). Age-and sex-related differences and their implications for resistance exercise. Essentials of strength training and conditioning, 3, 142-158.

[13] Guagliano, J. M., Rosenkranz, R. R., & Kolt, G. S. (2013). Girls'physical activity levels during organized sports in Australia. Medicine & Science in Sports & Exercise, 45(1), 116- 122.

[14] Zebis, M. K., Andersen, L. L., Brandt, M., Myklebust, G., Bencke, J., Lauridsen, H. B., ... & Aagaard, P. (2016). Effects of evidence-based prevention training on neuromuscular and biomechanical risk factors for ACL injury in adolescent female athletes: a randomised controlled trial. British journal of sports medicine, 50(9), 552-557.

[15] Weakley, J. J., Till, K., Darrall-Jones, J., Roe, G. A., Phibbs, P. J., Read, D. B., & Jones, B. L. (2019). Strength and conditioning practices in adolescent rugby players: Relationship with changes in physical qualities. The Journal of Strength & Conditioning Research, 33(9), 2361-2369

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