

# AMERICAN ACADEMY OF PEDIATRICS

Committee on Sports Medicine and Fitness

## Strength Training by Children and Adolescents

**ABSTRACT.** Pediatricians are often asked to give advice on the safety and efficacy of strength training programs for children and adolescents. This review, a revision of a previous American Academy of Pediatrics policy statement, defines relevant terminology and provides current information on risks and benefits of strength training for children and adolescents.

ABBREVIATION. NEISS, National Electronic Injury Surveillance System.

### INTRODUCTION

Strength training (also known as resistance training) is a common component of sports and physical fitness programs for young people. Some adolescents and preadolescents may use strength training as a means to enhance muscle size and definition or to simply improve appearance.

Strength training programs may include the use of free weights, weight machines, elastic tubing, or body weight. The amount and form of resistance used as well as the frequency of resistance exercises is determined by specific program goals. Table 1 defines common terms used in strength training.

### BENEFITS OF RESISTANCE TRAINING

In addition to the obvious goal of getting stronger, strength training programs may be undertaken to improve sports performance, rehabilitate injuries, prevent injuries, and/or enhance long-term health. Studies have shown that strength training, when properly structured with regard to frequency, mode (type of lifting), intensity, and duration of program, can increase strength in preadolescents and adolescents.<sup>1-4</sup> Gains in strength, muscle size, or power are lost after 6 weeks if resistance training is discontinued.<sup>5</sup> Maintenance exercises may offset these losses, but specific recommendations for maintaining strength gains have not been defined for preadolescents and adolescents.

In preadolescents, proper resistance training can enhance strength without concomitant muscle hypertrophy. Such gains in strength can be attributed to neuromuscular "learning," in which training increases the number of motor neurons that will fire with each muscle contraction.<sup>2,6,7</sup> This mechanism helps explain strength gains from resistance training in populations with low androgen levels, including

females and preadolescent males. Strength training can also augment the muscle enlargement that normally occurs with pubertal growth in males and females.<sup>3,6,8,9</sup>

Strength training can improve an adolescent athlete's performance in weight lifting and power lifting. Strength training is a common practice in sports like football in which size and strength are desirable. Despite theoretical benefits, scientific studies have failed to consistently show that improved strength enhances running speed, jumping ability, or overall sports performance.<sup>6,10</sup>

Evidence that strength training programs help prevent sports-related musculoskeletal injuries in preadolescents and adolescents is inconclusive.<sup>11</sup> Furthermore, there is no evidence that strength training will reduce the incidence of catastrophic sports-related injuries.

### RISKS OF STRENGTH TRAINING

The US Consumer Product Safety Commission, through its National Electronic Injury Surveillance System (NEISS), has estimated the number of injuries that are associated with strength training equipment. The NEISS data neither specifies cause of injury nor separates recreational from competitive weight lifting injuries. From 1991 to 1996, an estimated 20 940 to 26 120 injuries occurred each year in individuals under 21 years old.<sup>12</sup> According to NEISS data and other studies,<sup>13</sup> muscle strains account for 40% to 70% of all injuries. The lumbar back is the most commonly injured area.<sup>11,14</sup>

A limited number of case reports have raised concern about epiphyseal injuries in the wrist and apophyseal injuries in the spine from weight lifting in skeletally immature individuals. Such injuries are uncommon and are believed to be largely preventable by avoiding improper lifting techniques, maximal lifts, and improperly supervised lifts.<sup>12,15,16</sup>

Strength training programs do not seem to adversely affect linear growth and do not seem to have any long-term detrimental effect on cardiovascular health.<sup>2,4,17-19</sup> Young athletes with hypertension may experience further elevation of blood pressure from the isometric demands of strength training.<sup>8</sup>

### STRENGTH TRAINING GUIDELINES

A medical evaluation before commencing a formal strength training program can identify possible risk factors for injury and provide an opportunity to discuss training goals, techniques, and expectations. Risks involved with use of anabolic steroids and other body-building supplements are appropriate

The recommendations in this statement do not indicate an exclusive course of treatment or serve as a standard of medical care. Variations, taking into account individual circumstances, may be appropriate.

PEDIATRICS (ISSN 0031 4005). Copyright © 2001 by the American Academy of Pediatrics.

**TABLE 1.** Definition of Terms

Term	Definition
Strength training	The use of resistance methods to increase one's ability to exert or resist force. The training may utilize free weights, the individual's own body weight, machines, and/or other resistance devices to attain this goal.
Set	A group of repetitions separated by scheduled rest periods (eg, 3 sets of 20 reps).
Reps	Abbreviation for repetitions.
One rep max (1RM)	The maximum amount of weight that can be displaced in a single repetition.
Concentric contraction	The muscle shortens during contraction (eg, arm curl, leg press).
Eccentric contraction	The muscle lengthens during contraction (eg, lowering a weight).
Isometric contraction	The muscle length is unchanged during contraction (eg, wall sits).
Isokinetic contraction	The speed of muscle contraction is fixed through the range of motion.
Progressive resistive exercises	An exercise regimen in which the athlete progressively increases the amount of weight lifted and/or the number of repetitions. The more repetitions, the greater the work performed and the greater the endurance development. The more weight lifted, the greater the strength development.
Weight lifting	A competitive sport that involves maximum lifting ability. Olympic weight lifting includes the "snatch" and the "clean and jerk."
Power lifting	A competitive sport that also involves maximum lifting ability. Power lifting includes the "dead lift," the "squat," and the "bench press."
Body building	A competition in which muscle size, symmetry, and definition are judged.

topics for discussion with any adolescent interested in getting bigger and stronger.<sup>20,21</sup>

If children or adolescents undertake a strength training program, they should begin with low-resistance exercises until proper technique is learned. When 8 to 15 repetitions can be performed, it is reasonable to add weight in small increments. Exercises should include all muscle groups and be performed through the full range of motion at each joint. To achieve gains in strength, workouts need to be at least 20 to 30 minutes long, take place a minimum of 2 to 3 times per week, and continue to add weight or repetitions as strength improves. There is no additional benefit to strength training more than 4 times per week.<sup>5</sup>

Young people who want to improve sports performance will generally benefit more from practicing and perfecting skills of the sport than from resistance training. If long-term health benefits are the goal, strength training should be combined with an aerobic training program.

#### RECOMMENDATIONS

1. Strength training programs for preadolescents and adolescents can be safe and effective if proper resistance training techniques and safety precautions are followed.
2. Preadolescents and adolescents should avoid competitive weight lifting, power lifting, body building, and maximal lifts until they reach physical and skeletal maturity.
3. When pediatricians are asked to recommend or evaluate strength training programs for children

and adolescents, the following issues should be considered:

- a. Before beginning a formal strength training program, a medical evaluation should be performed by a pediatrician. If indicated, a referral may be made to a sports medicine physician who is familiar with various strength training methods as well as risks and benefits in preadolescents and adolescents.
- b. Aerobic conditioning should be coupled with resistance training if general health benefits are the goal.
- c. Strength training programs should include a warm-up and cool-down component.
- d. Specific strength training exercises should be learned initially with no load (resistance). Once the exercise skill has been mastered, incremental loads can be added.
- e. Progressive resistance exercise requires successful completion of 8 to 15 repetitions in good form before increasing weight or resistance.
- f. A general strengthening program should address all major muscle groups and exercise through the complete range of motion.
- g. Any sign of injury or illness from strength training should be evaluated before continuing the exercise in question.

COMMITTEE ON SPORTS MEDICINE AND FITNESS,  
2000–2001

Reginald L. Washington, MD, Chairperson  
David T. Bernhardt, MD

Jorge Gomez, MD  
Miriam D. Johnson, MD  
Thomas J. Martin, MD  
Thomas W. Rowland, MD  
Eric Small, MD

#### LIAISONS

Claire LeBlanc, MD  
Canadian Pediatric Society  
Robert Malina, PhD  
Institute for the Study of Youth Sports  
Carl Krein, AT, PT  
National Athletic Trainers Association  
Judith C. Young, PhD  
National Association for Sport and Physical Education

#### SECTION LIAISON

Frederick E. Reed, MD  
Section on Orthopedics

#### CONSULTANTS

Steven J. Anderson, MD  
Bernard A. Griesemer, MD  
Oded Bar-Or, MD

#### STAFF

Heather Newland

### REFERENCES

1. Falk B, Tenenbaum G. The effectiveness of resistance training in children. A meta-analysis. *Sports Med.* 1996;3:176-186
2. Ramsay JA, Blimkie CJ, Smith K, Garner S, MacDougall J, Sale DG. Strength training effects in prepubescent boys. Issues and controversies. *Med Sci Sports Exerc.* 1990;22:605-614
3. Blimkie CJ. Resistance training during preadolescence. *Sports Med.* 1993; 15:389-407
4. Faigenbaum AD, Zaichkowsky LD, Westcott WL, Micheli LJ, Fehlandt AF. The effects of a twice-a-week strength training program on children. *Pediatr Exerc Sci.* 1993;5:339-346
5. Faigenbaum AD, Westcott WL, Micheli LJ, et al. The effects of strength training and detraining on children. *J Strength Cond.* 1996;10:109-114
6. Kraemer WJ, Fry AC, Frykman PN, Conroy B, Hoffman J. Resistance training and youth. *Pediatr Exerc Sci.* 1989;1:336-350
7. Ozmun JC, Mikesky AE, Surburg PR. Neuromuscular adaptations following prepubescent strength training. *Med Sci Sports Exerc.* 1994;26: 510-514
8. Fleck SJ, Kraemer WJ. *Designing Resistance Training Programs.* 2nd ed. Champaign, IL: Human Kinetics Books; 1997
9. Webb Dr. Strength training in children and adolescents. *Pediatr Clin North Am.* 1990;37:1187-1210
10. Hakkinen K, Mero A, Kauhainen H. Specificity of endurance, sprint, and strength training on physical performance capacity in young athletes. *J Sports Med Phys Fitness.* 1989;29:27-35
11. Cahill BR, Griffith EH. Effect of preseason conditioning on the incidence and severity of high school football knee injuries. *Am J Sports Med.* 1978;6:180-184
12. National Electronic Injury Surveillance System. Washington, DC: Consumer Products Safety Commission
13. Risser WL, Risser JM, Preston D. Weight-training injuries in adolescents. *Am J Dis Child.* 1990;144:1015-1017
14. Brown EW, Kimball RG. Medical history associated with adolescent powerlifting. *Pediatrics.* 1983;72:636-644
15. Brady TA, Cahill BR, Bodnar LM. Weight training-related injuries in the high school athlete. *Am J Sports Med.* 1982;10:1-5
16. Ryan JR, Salcioli GG. Fractures of the distal radial epiphysis in adolescent weight lifters. *Am J Sports Med.* 1976;4:26-27
17. Weltman A, Janney C, Rians CB, Strand K, Katch FT. The effects of hydraulic-resistance strength training on serum lipid levels in prepubertal boys. *Am J Dis Child.* 1987;141:777-780
18. Weltman A, Janney C, Rians CB, et al. The effects of hydraulic resistance strength training in pre-pubertal males. *Med Sci Sports Exerc.* 1986;18: 629-638
19. Bailey DA, Martin AD. Physical activity and skeletal health in adolescents. *Pediatr Exerc Sci.* 1994;6:330-347
20. American Academy of Pediatrics, Committee on Sports Medicine and Fitness. Adolescents and anabolic steroids: a subject review. *Pediatrics.* 1997;99:904-908
21. American Academy of Pediatrics, Committee on Sports Medicine. Anabolic steroids and the adolescent athlete. *Pediatrics.* 1989;83:127-128

## Strength Training by Children and Adolescents

Committee on Sports Medicine and Fitness

*Pediatrics* 2001;107;1470

DOI: 10.1542/peds.107.6.1470

### Updated Information & Services

including high resolution figures, can be found at:  
<http://pediatrics.aappublications.org/content/107/6/1470>

### References

This article cites 19 articles, 3 of which you can access for free at:  
<http://pediatrics.aappublications.org/content/107/6/1470.full#ref-list-1>

### Subspecialty Collections

This article, along with others on similar topics, appears in the following collection(s):  
**Sports Medicine/Physical Fitness**  
[http://classic.pediatrics.aappublications.org/cgi/collection/sports\\_medicine:physical\\_fitness\\_sub](http://classic.pediatrics.aappublications.org/cgi/collection/sports_medicine:physical_fitness_sub)

### Permissions & Licensing

Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at:  
<https://shop.aap.org/licensing-permissions/>

### Reprints

Information about ordering reprints can be found online:  
<http://classic.pediatrics.aappublications.org/content/reprints>

Pediatrics is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since . Pediatrics is owned, published, and trademarked by the American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, Illinois, 60007. Copyright © 2001 by the American Academy of Pediatrics. All rights reserved. Print ISSN:

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™



# PEDIATRICS®

OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

**Strength Training by Children and Adolescents**  
Committee on Sports Medicine and Fitness  
*Pediatrics* 2001;107:1470  
DOI: 10.1542/peds.107.6.1470

The online version of this article, along with updated information and services, is located on the World Wide Web at:

<http://pediatrics.aappublications.org/content/107/6/1470>

Pediatrics is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since . Pediatrics is owned, published, and trademarked by the American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, Illinois, 60007. Copyright © 2001 by the American Academy of Pediatrics. All rights reserved. Print ISSN:

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™

