American Academy of Pediatrics
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POLICY STATEMENT

Strength Training by Children and Adolescents

Organizational Principles to Guide and Define the Child Health Care System and/or Improve the Health of All Children

Council on Sports Medicine and Fitness

ABSTRACT

Pediatricians are often asked to give advice on the safety and efficacy of strength-training programs for children and adolescents. This statement, which is 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.

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Key Words
children, adolescents, strength training, resistance training, Olympic weightlifting

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STRENGTH TRAINING (ALSO known as resistance training) is a common component of sports and physical fitness programs for young people, although some adolescents may use strength training as a means to enhance muscle size for improving appearance. Strength-training programs may include the use of free weights, weight machines, elastic tubing, or an athlete's own body weight. The amount and form of resistance used and the frequency of resistance exercises are determined by specific program goals. Table 1 defines common terms used in strength training.

BENEFITS OF STRENGTH TRAINING

In addition to the obvious goal of getting stronger, strength-training programs may be undertaken to try to improve sports performance and prevent injuries, rehabilitate injuries, and/or enhance long-term health. Similar to other physical activity, strength training has been shown to have a beneficial effect on several measurable health indices, such as cardiovascular fitness, body composition, bone mineral density, blood lipid profiles, and mental health.[1,2] Recent studies have shown some benefit to increased strength, overall function, and mental well-being in children with cerebral palsy.[3,4] Resistance training is being incorporated into weight-control programs for overweight children as an activity to increase the metabolic rate without high impact. Similar to the geriatric population, strength training in youth may stimulate bone mineralization and have a positive effect on bone density.[5,6]

Multiple studies have shown that strength training, with proper technique and strict supervision, can increase strength in preadolescents and adolescents.[7,8] Frequency, mode (type of resistance), intensity, and duration all contribute to a properly structured program. Increases in strength occur with virtually all modes of strength training of at least 8 weeks' duration and can occur with training as little as once a week, although training twice a week may be more beneficial.[7–12] Appropriately supervised programs emphasizing strengthening of the core (focusing on the trunk muscles, eg, the abdominal, low back, and gluteal muscles) are also appropriate for children and theoretically benefit sports-specific skill acquisition and postural control. Unfortunately, gains in strength, muscle size, or power are lost ~6 weeks after resistance training is discontinued.[1,13]

In preadolescents, proper resistance training can enhance strength without concomitant muscle hypertrophy. Such gains in strength can be attributed to a neurologic mechanism whereby training increases the number of motor neurons that are "recruited" to fire with each muscle contraction.[11,14–16] This mechanism accounts for the increase in strength in populations with low androgen concentrations, including female individuals and preadolescent boys. In contrast, strength training augments the muscle growth that normally occurs with puberty in boys and girls by actual muscle hypertrophy.[12,14,17,18]

Strength training is a common practice in sports in which size and strength are desirable. Unfortunately, results are inconsistent regarding the translation of increased strength to enhanced youth athletic performance.[1,14,19,20] Preventive exercise (prehabilitation) refers to strength-training programs that address areas commonly subjected to overuse injuries, such as providing rotator cuff and scapular stabilization exercises preventively to reduce overuse injuries of the shoulder in overhead sports. There is limited evidence to suggest that prehabilitation may help decrease injuries in adolescents, but it is unclear whether it has the same benefit in preadolescent athletes,[1,21,22] and there is no evidence that strength training will reduce the incidence of catastrophic sports-related injuries in youth. Recent research suggested a possible reduction in sports-related anterior cruciate ligament injuries in adolescent girls

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 include use of free weights, the individual's own body weight, machines, and/or other resistance devices to attain this goal.
Core strengthening	Focusing a strengthening program to the muscles that stabilize the trunk of the body. The training emphasizes strengthening of the abdominal, low back, and gluteal muscles as well as flexibility of muscular attachments to the pelvis, such as the quadriceps and hamstring muscles.
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: athlete holds the position of feet planted flat on ground with knees at a 90° angle and back against the wall).
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.
Plyometric exercises	Repeated eccentric and concentric muscle contractions, such as jumping up onto and down from a platform.
Weightlifting	A competitive sport that involves maximum lifting ability. Weightlifting (which is sometimes called Olympic 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.

when strength training was combined with specific plyometric exercises.[23] Plyometric exercises enable a muscle to reach maximum strength in a relatively short time span through a combination of eccentric and concentric muscle contractions, such as jumping up onto and down from a platform.

RISKS OF STRENGTH TRAINING

Much of the concern over injuries associated with strength training come from data from the US Consumer Product Safety Commission's National Electronic Injury Surveillance System,[24] which has estimated the number of injuries connected to strength-training equipment. The data from the National Electronic Injury Surveillance System neither specify the cause of injury nor separate recreational from competitive injuries that result from lifting weights. Muscle strains account for 40% to 70% of all strength-training injuries, with the hand, low back, and upper trunk being commonly injured areas.[24,25] Most injuries occur on home equipment with unsafe behavior and unsupervised settings.[24] Injury rates in settings with strict supervision and proper technique are lower than those that occur in other sports or general recess play at school.[26,27]

Appropriate strength-training programs have no apparent adverse effect on linear growth, growth plates, or the cardiovascular system,[1,10,11,28,29] although caution should be used for young athletes with preexisting hypertension, because they may require medical clearance to reduce the potential for additional elevation of blood pressure with strength training if they exhibit poorly controlled blood pressure. Youth who have received chemotherapy with anthracyclines may be at increased risk for cardiac problems because of the cardiotoxic effects of the medications, and resistance training in this population should be approached with caution.[30] Specific anthracyclines that have been associated with acute congestive heart failure include doxorubicin, daunomycin/daunorubicin, idarubicin, and possibly mitoxantrone. Youth with other forms of cardiomyopathy (particularly hypertrophic cardiomyopathy), who are at risk for worsening ventricular hypertrophy and restrictive cardiomyopathy or hemodynamic decompensation secondary to an acute increase in pulmonary hypertension, should be counseled against weight training. Individuals with moderate to severe pulmonary hypertension also should refrain from strenuous weight training, because they are at risk for acute decompensation with a sudden change in hemodynamics.[31] Young people with Marfan syndrome with a dilated aortic root also are counseled against participation in strength-training programs. Young athletes with seizure disorders should be withheld from strength-training programs until clearance is obtained from a physician. Overweight children may appear to be strong because of their size but often are unconditioned with poor strength and would require the same strict supervision and guidance as is necessary with any resistance program.

GUIDELINES FOR STRENGTH TRAINING

A medical evaluation of the child before beginning a formal strength-training program can identify risk factors for injury and provide an opportunity to discuss previous injuries, low-back pain, medical conditions, training goals, motives for wanting to begin such a program, techniques, and expectations from both the child and the parents. Youth should be reminded that strength training is only a small part of an overall fitness or sports program. Although research supports the safety and efficacy of resistance training for children, it is not necessary or appropriate for every child. Youth who are interested in getting bigger and stronger should be discouraged from considering the use of anabolic steroids and other performance-enhancing substances and should be provided with information regarding the risks and health consequences of using such substances. More patient-friendly information on performance-enhancing substances is available at www.aap.org/family/sportsshorts12.pdf. The American Academy of

Pediatrics (AAP) strongly condemns the use of performance-enhancing substances and vigorously endorses efforts to eliminate their use among children and adolescents.[32,33]

Because balance and postural control skills mature to adult levels by ~7 to 8 years of age,[34] it seems logical that strength programs need not start before achievement of those skills. Children also should have advanced to a certain level of skill proficiency in their sport before embarking on a disciplined strength-training program for the strength to have some potential value.

Strength gains can be acquired through various types of strength-training methods and equipment; however, most strength-training machines and gymnasium equipment are designed for adult sizes and have weight increments that are too large for young children. Free weights require better balance control and technique but are small and portable, provide small weight increments, and can be used for strengthening sports-specific movements.

Explosive and rapid lifting of weights during routine strength training is not recommended, because safe technique may be difficult to maintain and body tissues may be stressed too abruptly. This restrictive concept is applied to strength training, as opposed to the competitive sport of weightlifting, which is sometimes referred to as Olympic lifting. The sport of weightlifting is distinct from common strength training, because it involves specific types of rapid lifts, such as the "snatch" and the "clean and jerk."

Prepubertal youngsters are involved in competitive weightlifting, but philosophies often vary between Western nations and Eastern European nations.[35] Limited research on weightlifting as a sport has revealed that children have participated with few injuries,[35–37] and some programs have low rates of injury because they require stringent learning of techniques before adding any weight. As with general strength training, strict supervision and adherence to proper technique are mandatory for reducing the risk for injury. Clearly, this is an area in which more research is necessary to substantiate low injury rates as more youngsters continue to be involved with competitive weightlifting. Because of the limited research regarding prepubertal injury rates in competitive weightlifting, the AAP remains hesitant to support participation by children who are skeletally immature and is opposed to childhood involvement in power lifting, body building, or use of the 1-repetition maximum lift as a way to determine gains in strength.

For the purposes of this policy statement, the research regarding strength gains and the recommendations regarding youth involved in lifting weights apply specifically to the activity of strength training as an adjunct to exercise and sports participation.

When children or adolescents undertake a strength-training program, they should begin with low-resistance exercises until proper technique is perfected. When 8 to 15 repetitions can be performed, it is reasonable to add weight in 10% increments. Increasing the repetitions of lighter resistance may be performed to improve endurance strength of the muscles in preparation for repetitive-motion sports. Exercises should include all muscle groups, including the muscles of the core, and should be performed through the full range of motion at each joint. For achievement of gains in strength, workouts need to be at least 20 to 30 minutes long, take place 2 to 3 times per week, and continue to add weight or repetitions as strength improves. Strength training >4 times per week seems to have no additional benefit and may increase the risk for an overuse injury. Proper technique and strict supervision are mandatory for safety reasons and to reduce the risk for injury. Proper supervision is defined as an instructor-to-student ratio no more than 1:10 and an approved strength-training certification, as discussed in Table 2. Proper 10- to 15-minute warm-up and cool-down periods with appropriate stretching techniques also are recommended. Guidelines have been proposed by the AAP (as follows), the American Orthopaedic Society for Sports Medicine,[38] and the National Strength and Conditioning Association.[39,40]

Young people who want to improve sports performance generally will benefit more from practicing and perfecting the skills of their sport than from strength training alone, although strength training should be part of a multifaceted approach to exercise and fitness. If long-term health benefits are the goal, then strength training should be combined with an aerobic training program.

RECOMMENDATIONS

1. Proper resistance techniques and safety precautions should be followed so that strength-training programs for preadolescents and adolescents are safe and effective. Whether it is necessary or appropriate to start such a program and which level of proficiency the youngster already has attained in his or her sport activity should be determined before a strength-training program is started.
2. Preadolescents and adolescents should avoid power lifting, body building, and maximal lifts until they reach physical and skeletal maturity.
3. As the AAP has stated previously, athletes should not use performance-enhancing substances or anabolic steroids. Athletes who participate in strength-training programs should be educated about the risks associated with the use of such substances.
4. 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 or family physician. Youth with uncontrolled hypertension, seizure disorders, or a history of childhood cancer and chemotherapy should be withheld from participation until additional treatment or evaluation. When indicated, a referral may be made to a pediatric or family physician sports medicine specialist who is familiar with various strength-training methods as well as risks and benefits for preadolescents and adolescents.
   b. Children with complex congenital cardiac disease (cardiomyopathy, pulmonary artery hyperten-

TABLE 2 Certification Organizations

Certification	Requirements	Examination Content	Recertification	NCCA	Web Address
National Council on Strength and Fitness Certified Personal Trainer (NCSF-CPT)	18 y of age, high school diploma or equivalent	150 MC questions, 3-h proctored examination	Every 2 y, 10 CEUs	Yes	www.ncsf.org
National Academy of Sports Medicine Certified Personal Trainer (NASM-CPT)	18 y age, CPR certification	120 MC questions, 2-h proctored examination	2.0 NASM CEUs	Yes, 2003	www.nasm.org
National Strength and Conditioning Association Certified Personal Trainer (NSCS-CPT)	18 y of age, high school diploma or equivalent, CPR certification	140 questions, 3-h proctored examination	3 y, 6 CEUs; 2 different categories (conference, research publications, etc)	Yes, 1996	www.nsca-lift.org
National Strength and Conditioning Association Certified Strength and Conditioning Specialist (NSCS-CSCS)	BA/BS degree or chiropractor degree, CPR certification	Scientific 80-question, 1.5-hour proctored examination, practical 110 MC 2.5-hour proctored examination	3 y, 6 CEUs as above	Yes, 1996	www.nsca-lift.org
American Council on Exercise (ACE) Personal Trainer	18 y of age, adult CPR certification	150 MC questions, proctored examination, 2 written simulations	2 y, 2.0-hour ACE approved	Yes, 2003	www.acefitness.org
American Council on Exercise (ACE) Clinical Exercise Specialist	18 y of age, adult CPR certification, 300 h of work experience, current ACE-PT	150 MC questions, proctored examination	2 y, 2.0-hour ACE approved	Yes, 2003	www.acefitness.org
National Federation of Professional Trainers (NFPT)	18 y of age, high school diploma or equivalent, 2 y of experience	120 MC questions, 2-h proctored examination	2 CEC per year	Yes, 2005	www.nfpt.com
American College of Sports Medicine (ACSM) Certified Personal Trainer	High school diploma or equivalent, adult CPR certification	150 MC questions, proctored examination	3 y, CEC 45 h	Yes	www.acsm.org
American College of Sports Medicine (ACSM) Health Fitness Instructor	Associate's or bachelor's degree in health-related field, adult CPR certification	Written examination, 140 MC questions, proctored examination	3 y, CEC 60 h	Yes	www.acsm.org
International Fitness Professional Association (IFPA)	No requirements	105 questions at certification site	2 y, 12 CEC	No	www.ifpa-fitness.com
American Fitness Professional Association (AFPA) Personal Trainer	18 y of age, high school diploma or equivalent, adult CPR certification	Home examination, 90 d to complete	2 y, 16 CEC	No	www.Afpafitness.com
International Sports Science Association (ISSA)	No requirements	Home examination			www.issaonline.com
National Strength Professional Association (NSPA) Personal Trainer	18 y of age, adult CPR certification	Two 10-h lectures, written/practical examination, 50 MC questions, 5 practicals	2 y, 24 NSPA CEC	No	www.nspainc.com

As of 2006, instructor certifications received by the following groups are certified by the National Committee for Certifying Agencies (NCCA): National Strength and Conditioning Association, American College of Sports Medicine, American Council on Exercise, National Council on Sports & Fitness, National Academy of Sports Medicine, and the National Federation of Professional Trainers. CPR indicates cardiopulmonary resuscitation; MC, multiple choice; CEC, continuing education credits, CEU, continuing education unit.

sion, or Marfan syndrome) should have a consultation with a pediatric cardiologist before beginning a strength-training program.

c. Aerobic conditioning should be coupled with resistance training if general health benefits are the goal.

d. Strength-training programs should include a 10- to 15-minute warm-up and cool-down.

e. Athletes should have adequate intake of fluids and proper nutrition, because both are vital in maintenance of muscle energy stores, recovery, and performance.

f. Specific strength-training exercises should be learned initially with no load (no resistance). Once the exercise technique has been mastered, incremental loads can be added using either body weight or other forms of resistance. Strength training should involve 2 to 3 sets of higher repetitions (8 to 15) 2 to 3 times per week and be at least 8 weeks in duration.

g. A general strengthening program should address all major muscle groups, including the core, and exercise through the complete range of motion. More sports-specific areas may be addressed subsequently.

h. Any sign of illness or injury from strength training should be evaluated fully before allowing resumption of the exercise program.

i. Instructors or personal trainers should have certification reflecting specific qualifications in pediatric strength training. See Table 2 for the various avenues of certification and certifying organizations.

j. Proper technique and strict supervision by a qualified instructor are critical safety components in any strength-training program involving preadolescents and adolescents.

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