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.

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.1-4 Gains in strength, muscle size, or power are lost after 6 weeks if resistance training is discontinued.5 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.2,6,7 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.5,6,8,9

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.6,10

Evidence that strength training programs help prevent sports-related musculoskeletal injuries in preadolescents and adolescents is inconclusive.11 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.12 According to NEISS data and other studies,13 muscle strains account for 40% to 70% of all injuries. The lumbar back is the most commonly injured area.11,14

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.12,15,16

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.2,4,17-19 Young athletes with hypertension may experience further elevation of blood pressure from the isometric demands of strength training.8

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

If children or adolescents undertake a strength
training program, they should begin with low-resis-
tance 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 per-
formed 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 addi-
tional benefit to strength training more than 4 times
per week.5

Young people who want to improve sports perfor-
ance 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 aero-
bic training program.

RECOMMENDATIONS
1. Strength training programs for preadolescents
and adolescents can be safe and effective if proper
resistance training techniques and safety precau-
tions are followed.
2. Preadolescents and adolescents should avoid
competitive weight lifting, power lifting, body
building, and maximal lifts until they reach phys-
ical and skeletal maturity.
3. When pediatricians are asked to recommend or
evaluate strength training programs for children
and adolescents, the following issues should be con-
sidered:
   a. Before beginning a formal strength training
      program, a medical evaluation should be per-
      formed 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 pread-
      olescents 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, incremen-
tal loads can be added.
   e. Progressive resistance exercise requires suc-
      cessful completion of 8 to 15 repetitions in
      good form before increasing weight or resis-
tance.
   f. A general strengthening program should ad-
      dress 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

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strength training</td>
<td>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.</td>
</tr>
<tr>
<td>Set</td>
<td>A group of repetitions separated by scheduled rest periods (eg, 3 sets of 20 reps).</td>
</tr>
<tr>
<td>Reps</td>
<td>Abbreviation for repetitions.</td>
</tr>
<tr>
<td>One rep max (1RM)</td>
<td>The maximum amount of weight that can be displaced in a single repetition.</td>
</tr>
<tr>
<td>Concentric contraction</td>
<td>The muscle shortens during contraction (eg, arm curl, leg press).</td>
</tr>
<tr>
<td>Eccentric contraction</td>
<td>The muscle lengths during contraction (eg, lowering a weight).</td>
</tr>
<tr>
<td>Isometric contraction</td>
<td>The muscle length is unchanged during contraction (eg, wall sits).</td>
</tr>
<tr>
<td>Isokinetic contraction</td>
<td>The speed of muscle contraction is fixed through the range of motion.</td>
</tr>
<tr>
<td>Progressive resistive exercises</td>
<td>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.</td>
</tr>
<tr>
<td>Weight lifting</td>
<td>A competitive sport that involves maximum lifting ability. Olympic weight lifting includes the “snatch” and the “clean and jerk.”</td>
</tr>
<tr>
<td>Power lifting</td>
<td>A competitive sport that also involves maximum lifting ability. Power lifting includes the “dead lift,” the “squat,” and the “bench press.”</td>
</tr>
<tr>
<td>Body building</td>
<td>A competition in which muscle size, symmetry, and definition are judged.</td>
</tr>
</tbody>
</table>

AMERICAN ACADEMY OF PEDIATRICS
REFERENCES

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

<table>
<thead>
<tr>
<th>Updated Information &amp; Services</th>
<th>including high resolution figures, can be found at: <a href="http://pediatrics.aappublications.org/content/107/6/1470">http://pediatrics.aappublications.org/content/107/6/1470</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>References</td>
<td>This article cites 19 articles, 3 of which you can access for free at: <a href="http://pediatrics.aappublications.org/content/107/6/1470.full#ref-list-1">http://pediatrics.aappublications.org/content/107/6/1470.full#ref-list-1</a></td>
</tr>
<tr>
<td>Subspecialty Collections</td>
<td>This article, along with others on similar topics, appears in the following collection(s): <strong>Sports Medicine/Physical Fitness</strong> <a href="http://classic.pediatrics.aappublications.org/cgi/collection/sports_medicine:physical_fitness_sub">http://classic.pediatrics.aappublications.org/cgi/collection/sports_medicine:physical_fitness_sub</a></td>
</tr>
<tr>
<td>Permissions &amp; Licensing</td>
<td>Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at: <a href="https://shop.aap.org/licensing-permissions/">https://shop.aap.org/licensing-permissions/</a></td>
</tr>
<tr>
<td>Reprints</td>
<td>Information about ordering reprints can be found online: <a href="http://classic.pediatrics.aappublications.org/content/reprints">http://classic.pediatrics.aappublications.org/content/reprints</a></td>
</tr>
</tbody>
</table>
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