Adolescent Strength & Conditioning Training

For many years, the use of resistance training to increase muscular strength and endurance in prepubescent and adolescent boys and girls was highly controversial. Boys and girls were discouraged from using free weights for fear that they might injure themselves and prematurely stop the growth process. Furthermore, many scientists speculated that resistance training would have little or no effect on the muscles of the prepubescent boys because their levels of circulating androgens were still low.

Fortunately, several studies have been conducted in which both prepubescent and adolescent children have participated in resistance training. From these studies, Kraemer and Fleck have concluded that the risk of injury is very low (1). In fact, resistance training might offer some protection against injury, for example, by strengthening the muscles that cross a joint (1). Still a conservative approach is recommended in prescribing resistance exercise for children, particularly preadolescents.

For actual training programs, resistance training for children should be prescribed in much the same way as for adults. Specific guidelines (Table 1) were established at a workshop in 1985 by a group representing eight different professional organizations: the American Orthopedic Society for Sports Medicine, The American Academy of Pediatrics, the American College of Sports Medicine, the National Athletic...
Trainers Association, the National Strength and Conditioning Association, the President’s Council on Physical Fitness and Sports, the US Olympic Committee and the Society of Pediatric Orthopedics (2).

Also, Kraemer and Fleck have established basic guidelines for the progression of resistance exercise in children, which are presented in Table 2 (1). Further information on resistance training program designs for children is available. They include:


In closing, it is important to understand that the mechanisms allowing strength changes in children are accomplished largely without or little increases in muscle size. A comprehensive study of the mechanisms responsible for increases in prepubescent boys concluded that the likely determinants of the strength gains achieved are (1):

- Improved motor skill coordination,
- Increased motor unit activation and
- Other neurological adaptations

Furthermore, regular training has no apparent effect on growth in height. It does, however, affect weight and body composition. Generally, regular training results in (2):

- Lower total body fat
- Higher fat-free mass, and
- Higher total body mass
### Table 1. Strength Training Recommendations for Prepubescent Children

<table>
<thead>
<tr>
<th>Strength Training Equipment</th>
<th>Strength Training Equipment contd.</th>
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</thead>
<tbody>
<tr>
<td>1. It should be of appropriate design to accommodate the size and degree of maturity of the prepubescent.</td>
<td>5. Strength training should be preceded by a warm-up and cool-down.</td>
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<tr>
<td>2. It should be cost effective.</td>
<td>6. Emphasis should be on dynamic concentric actions.</td>
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<td>3. It should be safe, free of defects, and inspected frequently.</td>
<td>7. All exercises should be carried through a full range of motion.</td>
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<td>4. It should be located in an uncrowned area free of obstruction with adequate lighting and ventilation.</td>
<td>8. Competition is prohibited.</td>
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<td>9. No maximal lift should ever be attempted.</td>
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**Program Considerations**

1. A pre-participation physical exam is mandatory.
2. The child must have the emotional maturity to accept coaching and instruction.
3. There must be adequate supervision by coaches who are knowledgeable about strength training and the special problems of prepubescent.
4. Strength training should be a part of a comprehensive program designed to increase motor skills and level of fitness.

**Prescribed Program**

1. Training recommended two or three times a week for 20 to 30 minute periods.
2. No resistance should be applied until proper form is demonstrated. Six to 15 repetitions equal one set, one to three sets per exercise should be done.
3. Weight or resistance is increased in 0.5 to 1.4 kg (1-3 lb) increments after the prepubescent performs the exercise with good form.

Reprinted from Wilmore & Costill (1994).

### Table 2. Basic Guidelines for Resistance Exercise Progression in Children

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Considerations</th>
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<tbody>
<tr>
<td>7 or younger</td>
<td>Introduce child to basic exercises with little or no weight; develop the concept of a training session; teach exercise techniques; progress from body weight calisthenics, partner exercises and lightly resisted exercises; keep volume low.</td>
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<tr>
<td>8-10</td>
<td>Gradually increase the number of exercises; practice exercise techniques in all lifts; start gradual progressive loading of exercises; keep exercises simple; gradually increase training volume; carefully monitor toleration to the exercise stress.</td>
</tr>
<tr>
<td>11-13</td>
<td>Teach all basic techniques; continue progressive loading of each exercise; emphasize exercise techniques; introduce more advanced exercises with little or no resistance.</td>
</tr>
<tr>
<td>14-15</td>
<td>Progress to more advanced youth programs in resistance exercise; add sport-specific components; emphasize techniques; increase volume.</td>
</tr>
</tbody>
</table>
16 or older | Move child to entry-level adult programs after all background knowledge has been mastered and a basic knowledge level of training experience has been gained.

Note. If child of any age begins a program with no previous experience, start the child at previous levels and move him or her to more advanced levels as exercise toleration, skill, amount of training time, and understanding permit. Reprinted from Kraemer and Fleck (1993).

**Adolescent Aerobic and Anaerobic Training**

Do prepubescent boys and girls benefit from aerobic training to improve their cardio-respiratory systems? This has also been a highly controversial area because several early studies indicated that training prepubescent children did not change their VO2 max values. Interestingly, even without significant increases in VO2max, the running performance of the children studied improved substantially (2). They could run at a fixed distance faster following a training program. More substantial increases in VO2max appear to occur once children have reached puberty. The reason for these findings are not well defined at this time. Because stroke volume appears to be the major limitation to aerobic performance in this age group, it is quite possible that further increases in aerobic capacity depend on heart growth (2).

Anaerobic training appears to improve children’s anaerobic capacity. Following training, children have (2):

- Increased resting levels of phosphocreatine, ATP, and glycogen;
- Increased phosphofructokinase activity; and
- Increased maximal blood lactate levels.

When designing aerobic and anaerobic training programs for children and adolescents, it appears that standard training principles for adults can be applied. However, it would be prudent to be conservative to reduce the risk of injury, overtraining, and loss of interest in sport (2). This is also an appropriate time in life to focus on learning a variety of motor skills by exploring a number of activities and sports.
(2). Table 3 provides us with some cautionary measures when training children during aerobic and anaerobic activity.

### Table 3. Cautionary Thermal Stress Measures for Anaerobic and Aerobic Training in Children and Adolescents

- Children’s ability to perform anaerobic activities is limited. A child has a lower glycolytic capacity, possibly because of a limited amount of phosphofructokinase.
- Children cannot attain high respiratory exchange ratios during maximal or exhaustive exercise, suggesting less lactate production.
- Children are capable of less evaporative heat loss than adults are because children sweat less (less sweat is produced by each active sweat gland).
- Young boys acclimate to meat more slowly than adults do. Data on this topic are not available for girls.
- Children appear to have greater conductive heat loss than adults, which should place children at a greater risk for hypothermia in cold environments.

Reprinted from Wilmore & Costill (1994).

Further information on agility, aerobic and anaerobic training program designs for children are available. They include:


**References**