

STRENGTH TRAINING FOR THE YOUNG ATHLETE

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ABSTRACT

The purpose of this article was to outline the current strength guidelines by reviewing the current literature found in the following databases, Pubmed, AUSPORT, ScienceDirect, Sports discuss, Medline and the Journal of Australian Strength and Conditioning. This article will specifically examine five components of youth strength training (YST); (1) What age is appropriate to start strength training, (2) Frequency of strength training, (3) Intensity of strength training, (4) Rest periods and (5) Recommended volume. Upon revising the literature the following recommendations have been developed, the minimal age for a child to start weight training is 6-8 years of age (maturation and developmental stages present around this age making athletes more suitable), the athlete should weight train 2-3 days per week, on non-consecutive days, at an intensity of 6-15RM or 50-85% 1RM, given a rest period of at least 3 minutes (allowing for appropriate recovery) and an overall volume of 1-3 sets per muscle group of 6-15 repetitions. This paper aims to give athletes, coaches and parents a better understanding of adolescent strength training. Key words: youth strength training, children's strength programs, young athlete strength programs.

INTRODUCTION

The purpose of this review is to gain a better insight in the field of YST. The field of YST has, and still is a field where many see it as "high risk" and detrimental to the young person's health and development. The myths and misconceptions surrounding YST include:

- (1) Weights training will stunt an adolescent's growth,
- (2) Children cannot gain strength from resistance training due to lack of testosterone, and
- (3) Children are more susceptible to injury due to the un-fused growth plates.

There are a number of research papers and position stands that support the use of YST and have proven the misconceptions and myths of pediatric resistance training to be incorrect [18, 25, 26, 27]. It should be noted that there are numerous benefits gained from pediatric resistance training [11, 12, 13]:

- Improve one's cardiovascular risk profile,
- Facilitate weight control,
- Strengthen bone,
- Help promote and develop exercise habits during childhood and adolescence,
- Help improve the psychosocial wellbeing of youth,
- Enhance the muscular strength and power of youth,
- Improve motor performance skills and
- Increase a young athlete's resistance to sports-related injuries.

This article will look more specifically at five components of YST;

- (1) What age is appropriate to start strength training?
- (2) Frequency of strength training,
- (3) Intensity of strength training,
- (4) Rest periods and
- (5) Recommended volume.

The compelling body of scientific evidence [22, 23, 24] indicates that a well-designed resistance-training program can enhance muscular strength of children and adolescents beyond that, which is normally due to growth and development and limit the risk of injury.

METHODS

Articles were chosen for review dependent upon their relevance to the subject at hand, from the following databases: Pubmed, AUSPORT, ScienceDirect, Sports discuss, Medline and the Journal of Australian Strength and Conditioning.

Specific inclusion criteria included:

- (1) What age is appropriate to start strength training?
- (2) Frequency of strength training,
- (3) Intensity of strength training,
- (4) Rest periods and
- (5) Recommended volume.

WHAT AGE SHOULD CHILDREN BEGIN STRENGTH TRAINING?

The general consensus suggests the child should be 6-8 years of age, however, physical, cognitive, and social maturity must be taken into account when designing a training program, the child should also be able to follow directions, have adequate balance and proprioception. The National Strength and Conditioning association (NSCA) and Dahab and McCambridge [16] have identified the age this is reached being 7-8 years old, the Australian Strength and Conditioning Position Stand [18] states the youngest a child should begin training is 6 years of age. Effects of strength training have been shown in children as young as 5 [17]. The instruction must be appropriate for the age of the child or adolescent, involving a proper warm-up, cool-down, and appropriate choice of exercises [14, 15, 18].

One potential problem that arises with YST is the chance of growth plate injury. Micheli [1] suggests this may be less in a child (<13 years of age) than of an adolescent (13-19 years of age) because the epiphyseal plate of a child is stronger and more resistant to shearing forces. The few studies conducted on this issue have reported injuries to the epiphyseal plate from strength training have been attributed to improper lifting techniques, lifting maximal amounts of weight and lifts performed without adequate adult supervision [12, 19], such sports such as gymnastics could also increase the risk of epiphyseal injury due to the passive structure loading to the wrist.

On the contrast, findings by Micheli [1] have demonstrated the effectiveness in YST. In this study 18 prepubescent (<12 years of age) children strength trained three times per week for 9 weeks. The overall mean strength increase was 42.9%, compared with an increase of only 9.5% in the control group. Concluding that the attributes were a result in adaptations in muscle excitation-contraction coupling increased motor unit activation and improved motor skill coordination.

The Australian Strength and Conditioning Association's (ASCA) position stand should be read if considering YST and states: "If a child is ready to participate in organized and structured sports such as cricket, football, rugby, basketball, then they are generally ready to perform a supervised resistance-training program. As children typically enter formal school at the age of 6 years they may be ready to participate in an organized resistance-training program at this time. However, the actual age will vary from child to child and will be largely based on their capacity to follow clear directions. Some children at this stage of development may well see the weights area as a big playroom to run around and swing off the equipment etc. and do not have the focused attention span or commitment to apply to training or follow clear directions and are simply not ready for resistance training. One factor to keep well in mind is that a standard gym is a very dangerous place for young children filled with all sorts of weights, plates, and machines, which are all potentially very hazardous for young children. As will be detailed in the injury section, many injuries occur to children in gyms from dropping weights on fingers or toes, hitting their heads on bars. Hence prior to commencement of a resistance program the child will be required to be strictly supervised and able to follow clear directions, and understand basic safety considerations. While the age that this occurs will vary from child to child it is the position of the ASCA that the youngest a child should commence resistance training is at 6 years of age." [18]

FREQUENCY OF STRENGTH TRAINING

For the athlete to gain maximal results from their resistance program, muscular tension needs to be applied frequently. There is quite a lot of research that has been carried out on this component [2, 3, 4, 5, 14, 15, 18, 20, 21, 25, 26, 27]. The majority of research has identified that the most beneficial frequency consists of at least 2 non-consecutive days/week, as resistance training only once a week may result in suboptimal adaptations [3]. Structuring the program as such will provide an opportunity for beginners to learn proper lifting techniques while maximizing gains in muscular strength [16, 18]. Allowing adequate recovery time between sessions will help prevent growth plate injuries, as too much exercise leads to overuse injuries [19]. Conversely, too little will result in inferior gains as a study conducted by Faigenbaum [3] showed larger strength gains can be made when training twice a week compared to once a week. The study consisted of children aged 7-12 strength training over an 8 week period, the children that had trained twice a week showed a 1RM increase in chest press by 11.5%, compared with 9% (1/week), leg press was 24.9% compared to 14.2%. This research can be reinforced with another study conducted by Faigenbaum [20] that showed a 74.3% increase in strength compared to the 13.0% in the control group after 8 weeks when performing three sets of five different exercises twice a week.

The frequency of training does not change much when comparing children to adults. Rhea [21] found in a meta-analysis that the frequency changes with experience of the trainee, the study concluded that a trained athlete (>1 year

training experience) elicits the greatest strength gains when training twice per week, while an untrained (<1year training experience) should train three times per week to receive the greatest benefit.

INTENSITY OF STRENGTH TRAINING

This component of strength training could be seen as one of the more important factors, as it appears that when deciding upon the training intensity of YST most researchers and position statements advise a cautious approach, possibly to reduce the chance of injury.

The following table has been derived from the current literature:

Table 1 - Shows recommended training intensity for YST.

AUTHOR	INTENSITY
Rhea (21)	Trained = 60% 1RM Untrained = 80% 1RM
NSCA (15)	6-12RM
Micheli (1)	13 – 15RM
Faigenbaum (5)	6 - 15RM
ASCA (18)	Level 1: 6-9 years: 15+RM Level 2: 9-12 years: 10-15RM (60%1RM) Level 3: 12-15 years: 8-15RM (70%1RM) Level 4: 15-18years: 6-15RM (80%1RM)
Canadian E.P. Society (14)	Start with 60% 1RM

From observing the above table the following summary could be made, the intensity of youth strength training should be based around 6-15RM or 50-85% 1RM. If utilizing the Long Term Athlete Development Model (LTAD), the appropriate intensity should be decided upon given the maturation or degree of physical literacy the athlete displays, these being categorized into four levels [18].

Table 2 - Shows a description of the LTAD model outlined in the ASCA Position Stand Resistance Training for Children and Youth [18]

LTAD MODEL		
Level	Description	Goals
1: 6-9 years	<p>Programs are designed for young children 6 to 9 years of age or any older child who is just starting out in resistance training and conditioning.</p> <p>Appropriate programs involve modified body weight type exercises and light resistance work performed for relatively high repetitions (15+ reps.)</p> <p>Accustoming children to regular training, develop basic fitness abilities such as strength, muscular endurance, cardiovascular endurance, co-ordination and flexibility in a safe, low stress, fun environment.</p>	<ol style="list-style-type: none"> 1. Hover in a horizontal position with feet, elbows and forearms touching the ground and straight back position for 60 s. 2. Perform 10 well controlled back extensions to horizontal. 3. Perform 10 well controlled full range double leg squats with hands behind the head and feet flat on the floor. 4. Perform 10 well controlled push ups off their toes chest to touch the ground and arms achieve full extension. 5. Perform 5 well controlled lunges each leg with back knee touching the ground and good balance. 6. Wall squat at 90 degrees for 60 s. 7. Touch their toes in the sit and reach test.
Level 2: 9-12 years	<p>Begin to incorporate some free weights and machine weight exercises as well as body weight activities. Again it is essential that an adult strictly supervises the programs adopted with at least a Level 1 ASCA Strength and Conditioning accreditation and the machines used are an appropriate size for the children.</p>	<ol style="list-style-type: none"> 1. Satisfy the requirements for Level 1. 2. Hover in a horizontal position with feet, elbows and forearms touching the ground and straight back position for 90 s. 3. Perform 10 well-controlled repetitions of barbell bench press using a load of 40% of body weight. 4. Perform 10 well-controlled repetitions of dumbbell rowing using a load of 15% of body weight in each hand. 5. Perform 10 well-controlled lying pull ups with legs out straight using underhand grip. 6. Perform 10 well controlled lunges each leg with back knee touching the ground and good balance holding a load of 10% of body weight in each hand. 7. Reach 5 cm beyond their toes in the sit and reach test.
Level 3: 12-15 years	<p>Begin using progressively more free weight exercises but avoid complex lifts such as cleans, snatches, deadlifts and squats etc. unless competent coaching is available from a coach with at least a Level 2 ASCA strength and conditioning accreditation. Again it is essential that an adult strictly supervises the programs adopted with at least a Level 1 ASCA Strength and Conditioning accreditation and the equipment used is an appropriate size for the children.</p>	<ol style="list-style-type: none"> 1. Satisfy the requirements for Levels 2 and 3. 2. Hover in a horizontal position with feet, elbows and forearms touching the ground and straight back position for 120 s. 3. Perform 5 well controlled full range single leg squats each leg. 4. Perform 10 well-controlled parallel bar dips for boys and 10 bench dips for girls with legs out straight. 5. Perform 10 well-controlled chin-ups for boys and a 30 s arm hang at 90-degree elbow angle for girls (underhand grip). 6. Perform 10 well-controlled repetitions of barbell bench press using a load of 70% of bodyweight for boys and 50% of body weight for girls.
Level 4: 15-18 years	<p>Progressively moving towards an advanced adult program involving split routines and complex multi-joint movements demonstrating sound technique.</p>	<p>The repetition range is between 6 to 15 RM with a maximal loading of 80% of the 1 RM.</p>

REST PERIODS

The amount of time a young athlete should take between sets is subject to limited research. The research that has been undertaken and is stated in the NCSA position statement suggests that for strength training 2-3 minutes is sufficient, and hypertrophy less than 1 minute. The validity of these findings could be questioned, conflicting results provided by study conducted by Richmond [28] showed, 28 men who performed two sets of bench press to volitional exhaustion were allocated rest periods of 1, 3, and 5 minutes between sets. The findings displayed no difference between the 3 and 5-minute rest periods, but the workload decreased significantly if the rest was decreased to 1 minute.

While a 3-minute rest period may be impractical, due to time restrictions, a well-designed program could consider the inclusion of super-sets to avoid the program from taking too long to complete.

Table 3 - Suggested program (15-18 years old) using the superset method.

AUTHOR	SETS	REPITITIONS
Hensch (8)	1-3	8-15
Micheli (1)	3	13-15
Canadian E.P. Society (22)	1-2	8-15
NSCA (15)	1-3	6-15 for strength 3-6 for power
President's Council (25)	2-3	6-15
Rhea (21)	4 sets per muscle group	12 reps untrained 6 reps trained

The above table is for level 4 athletes as defined by the LTAD model. Supersets are to be carried out in order of matching letters, which are displayed before the name of the exercise, (a) with (a) and (b) with (b). The rest period is 3 min between each set but the second exercise is completed during this 3 min rest period of the initial exercise.

SETS AND REPITITIONS

With frequency and intensity being determined, volume is another important factor to ensure adequate muscular time under tension is achieved. Faigenbaum and colleagues [5] performed a study comparing a group of 15 children, the group was divided into two groups, the first, strength training using a heavy load and performing one set of six to eight repetitions and a group of children training with a moderate load and performing one set of 13-15 repetitions. Participants were assigned to strength train twice per week for a total of 8 weeks. The high repetition moderate load group was found to have significantly higher increase in strength (40.9% compared with 31%). Upon reviewing this study, it should be noted that with only one set performed, the latter group might have received greater gains due to an increased time under tension. The majority of literature shows that multiple sets are superior to single sets for improving gains in strength and hypertrophy.

The topic of strength gains when performing a single set to multiple sets has been the topic of several adult studies. However, no studies on multiple sets have been performed specific to the preadolescent athletes. In a study by Rhea and colleagues [6] a leg and bench press were chosen to assess differences in strength gains between 1 and 3 sets. Sixteen men (age = 21 +/- 2.0) were randomly assigned to 1 set (n = 8) or 3 set (n = 8) groups and trained 3 days per week for 12 weeks. One repetition maximum (1RM) was recorded for bench press and leg press at pre-, mid-, and post-test. Subjects trained according to daily undulating periodization (DUP), involving the bench press and leg press exercises between 4RM and 8RM. Training intensity was equated for both groups. After 12 weeks the results showed strength increase in the leg press to be 26 and 56% for 1 set and 3 sets, respectively. For the bench press this increase was 20 and 33%, respectively. It is concluded that recreationally trained individuals using DUP training, 3 sets of training are superior to 1 set for eliciting maximal strength gains.

The NSCA supports preadolescents performing one to three sets of a variety of single and multi-joint exercises. Below is an overview of current literature:

Table 4 - Above shows the sets and repetitions recommended by each individual author.

WEEKLY CYCLE									
DAY 1					DAY 2				
Exercise	Sets	Reps	Intensity (1RM)	Rest (min)	Exercise	Sets	Reps	Intensity	Rest (min)
(a) Pull ups	3	8-10	65-75%	3	Row	3	8-10	65-75%	3
(a) Squat	3	8-10	65-75%	3	Lunges	3	8-10	65-75%	3
(b) Bench Press	3	8-10	65-75%	3	Dips	3	8-10	65-75%	3
(b) Deadlift	3	8-10	65-75%	3	Back ext.	3	8-10	65-75%	3
Planks	3	60sec	Body weight	3	Crunches	3	8-10	Body weight	3

The Rhea study should be noted, as the subjects were of college age. As per the above information, the following guidelines could be comprised; children should perform 1-3 sets, 6-15 repetitions for strength and 3-6 repetitions for power.

SUMMARY

All of the above components need to be taken into account when programming for youth strength training, what age to start strength training, frequency, intensity, rest periods and recommended volume. Given the information outlined a general summary has been developed: the minimum age for a child to start weight training is around 6-8 years of age (dependent upon maturation and development), the athlete should weight train 2-3 days per week, on non-consecutive days. Body weight is considered both safe and effective for younger athletes (6-9 years of age), although once creating a sound training foundation and using sensible progression, the athlete can increase the intensity to 6-15RM or 50-80% 1RM (15-18 year olds). The rest period should be at least 3 minutes (allowing for appropriate recovery) and an overall volume of 1-3 sets per muscle group of 6-15 repetitions.

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