Roundtable Discussion: Youth Resistance Training

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Keywords: children; strength training; preadolescent strength training.

THE POPULARITY OF RESISTANCE training as a means of improving health, wellness, and sports performance is growing in all populations. One area where resistance training is gaining in popularity is among youth populations (preadolescents and adolescents). This phenomenon is a topic of great debate, with many individualized beliefs being expressed by strength professionals, researchers, and medical professionals. In an attempt to present a unique picture of this topic, this roundtable has gathered several distinct groups of professionals together to discuss several key issues associated with youth-based resistance training programs. Some of these professionals are (a) coaches who are working in youth-based strength training or weightlifting programs, (b) medical professionals who work with youth populations, and (c) researchers who have a special interest in resistance training. The purpose of this roundtable is to give multiple viewpoints on the topic of youth resistance training programs that may aid strength and conditioning professionals who work with these populations.

■ Question 1: Among the General Public There is Much Concern About the Safety of Resistance Training for Youth Populations. Can you Comment About the General Safety (Injury Rates, etc.) of Resistance Training for Youth Populations?

Burgener: My experience has been working with students between the ages of 8 and 20, and I can honestly say that I have never had a student or athlete become seriously injured as a result of resistance training. I have had students whose injuries resulted from negligence on their part, dropping a weight on their foot while unloading the bar, hitting their fingers while loading a weight. However, I have never seen a broken bone or dislocated shoulder/elbow during my 25 years as a strength coach. I, personally, believe that resistance training, when properly supervised, is one of the safest activities for our students.

Faigenbaum: For many years resistance training was not recommended for young people because of the presumed high risk of injury. However, during the past 10–15 years a compelling body of evidence has mounted, indicating that resistance training can be a safe and enjoyable activity for boys and girls, provided the training program is designed and supervised by qualified instructors (2, 7, 13). There is no evidence to suggest that the risk of injury associated with resistance training in youth is greater than that associated with other recreational activities in which children and teenagers participate regularly. In fact, the sport-specific forces that the musculoskeletal system of young athletes is subject to may be greater, both in magnitude and in duration, than those resulting from resistance training. Nevertheless, professionals need to be aware of the most common causes of injury resulting from resistance training activities, which include unsafe behavior, equipment malfunction, lack of supervision, and inattention (9).

Kilgore: Injury rates associated with weight training are a continual source of concern and have...
been proposed as one of the major rationales for precluding children from training with weights. One of the strongest supporting documents of this claim is a report from the U.S. Consumer Product Safety Commission (26) in which it is stated that weightlifting (as an activity, not as a sport) can cause injury to children. The report claims that 8,543 weightlifting-related injuries occurred in children younger than 14 years of age. Strains and sprains were the least severe (and most commonly reported) and fractures the most severe (and least commonly reported) injuries noted in the study. This study examined neither the conditions that may have predisposed the subjects to injury nor the training history and program of the subjects. It was noted, however, that a large percentage of the injuries occurred during unsupervised training at home. In adults, weight training is often recommended as a means to reduce the frequency of injury and also is used to reestablish normal function after joint and soft-tissue injuries. Data from adolescent male football players point to its potential use in young athletes as well. Cahill and Griffith (4) noted that the number and severity of knee injuries were reduced in athletes who trained with weights.

Epiphyseal plate (growth plate) fractures are also frequently pointed to as a reason for avoiding weight training in children. The existing medical and scientific data do not support this as a valid contraindication. An instance of epiphyseal fracture attributed to weightlifting has been reported in preadolescents (8). In pubescent athletes, 5 publications have reported instances of fractures related to weight training (2, 3, 8, 18, 19). An overwhelming majority of these injuries was attributed to the use of improper techniques in the exercises and to excessive loading. Furthermore, with proper diagnosis and treatment, this rare injury had no detrimental effect on growth (5). It also has been noted that weight training does not interfere with growth in any other way (16, 20, 23, 28). A review by Theintz et al. (25) seems to suggest that sport training of less that 15 hours per week was not disruptive to hormonal status, growth, or puberty.

Supervised training programs in which training loads are prescribed and monitored and in which training activities are supervised have proven to be remarkably safe in terms of the frequency of injury occurrence. Several studies have followed the rate of injury during training programs lasting several weeks to a year (15, 16, 17, 21, 22). A 14-week-long study by Rians (17) reported only one minor shoulder strain, which resolved itself by the end of the study. One study that is of importance to the competitive weightlifting community is the 1-year U.S.A. Weightlifting Regional Development Center program, which included more than 70 pediatric athletes and in which no reports of injury were noted (15).

**Lavalle:** Three high schools in South Bend are under my care, and I do see occasional injuries as a result of strength training. Most of these injuries are due to adolescents not being properly supervised. The lack of appropriate supervision appears to be a factor for the vast majority of strength training injuries reported nationwide. Overall, it appears that when properly supervised, the risk of injury during resistance training is low (1, 4).

**Nitka:** After working with adolescent athletes for the past 26 years, I have found that a well-designed resistance training program that is supervised by an experienced coach who is a certified strength and conditioning specialist can eliminate many of the safety concerns that parents have about resistance training programs. It is my opinion that the high school weight room is an accident waiting to happen. However, it is my understanding that an appropriately supervised resistance program is no more dangerous than other activities our youth participate in (1). It is my opinion that employing an experienced, certified strength and conditioning specialist to coach in every high school weight room across the country would decrease the risks of resistance training and eliminate a lot of parental concerns. Our pools have certified lifeguards, and our training rooms have certified athletic trainers. Logic would suggest that our kids deserve to have a certified strength and conditioning specialist during this most important period of their career in athletics.

**Rippetoe:** I have been in the fitness industry for 23 years. During this time I have supervised the training of several thousands of people, including many hundreds of boys and girls, the vast majority of whom were trained in the use of free weights, relying heavily on classic barbell exercises like the squat. During this period, none of my trainees has ever suffered a traumatic injury as a result of a correctly executed exercise during properly supervised training. The injuries reported were all caused by an overuse of muscles (i.e., tendinitis or other inflammatory processes) or were the result of poor technique, excessive loading made possible by the use of a less than full range of motion, or the use of open kinetic chain exercises, which I do not teach or advocate.
It has been my experience that proper technique is desirable not only as a means of producing the greatest strength benefits but also of preventing injuries. For instance, squatting below parallel limits the weight being handled. Proper technique, when strictly adhered to, limits the weight that may be used, which, by definition, is the weight that can be correctly and safely handled. This is especially important in coaching youth populations.

**Strength professionals should be aware of the following:**

- Youth populations are forming attitudes about training that they will carry into adulthood, and correct technique must be emphasized to prevent bad habits from being formed.
- Youth populations are prone to be competitive in the weight room as well as on the field. There is as much peer pressure operating in the weight room as there is anywhere else in a young person’s social situation. If, in the attempt to compete in the weight room, form and technique are sacrificed to 1RM, unnecessary injury may be the result. The weight room can be an excellent competitive venue but only in the context of properly supervised techniques.

The risk of epiphyseal injury has been grossly exaggerated by the medical community and has been used for years as an excuse to recommend against resistance training for youth populations. This same medical community seldom recommends young people against playing organized sports such as soccer, football, and basketball, activities that generate a sizable portion of an orthopedic surgeon’s practice. Epiphyseal injuries are virtually unknown within the context of correct lifting techniques; therefore, correct techniques must be emphasized to minimize any possible concerns that medical personnel may have about the participation of youth populations in a resistance training program.

**Proulx:** While speaking with parents, physical education teachers, and coaches of youths, the concern is that resistance training can cause serious injury. It seems possible that this misconception has plagued us for so long due to the lack of communication between researchers, and parents, teachers, and coaches. It was much easier to hear about something that went wrong, as in case studies of individual injuries. The fact is that resistance training for conditioning (0.0035 per 100 hours) as well as weightlifting as a sport (0.0017 per 100 hours) involves a far lesser degree of risk of injury than most other popular forms of sport, including soccer, basketball, and football (0.20, 0.03, and 0.10 per 100 hours of participation, respectively) (19).

With respect to age groups, a 20-year survey of the trends in weight-training injury found that the 5- to 14-year-old age group actually had a decrease in the number of injuries (21).

Although these rates tell us the probability of injury, there should also be awareness regarding the extent and severity of injury. Aside from head and spinal cord injuries, a common concern seems to be injury to epiphyseal growth plates, or fractures, in immature bones of youth populations. Epiphyseal injuries tend to result from shear force, due to its perpendicular orientation to long bones, and avulsions from extreme stress pulling in the opposite direction of the secondary growth centers. This is an uncommon injury in the literature on weight training in children (4) or in any age group (21) in comparison to a very popular activity among children, i.e., in-line skating, wherein the upper extremity is reported as being the most common area of injury, 64%, with 38% of all injuries being fractures (24).

There has also been concern that intense training may lead to adverse pubertal growth (9, 35, 37) but has been attributed to possible diet and nutrition practices.

**Question 2: With Regard to Possible Injuries in Youth Resistance Training, What Are Some of the Things that the Strength and Conditioning Professional Should be Concerned About and Focus on to Minimize These Risks?**

**Burgener:** After my students have been properly instructed in techniques of the various exercises, I spend many hours a day in their general supervision. Students are instructed not only in the technique of the exercise but also in general safety requirements, i.e., spotting, breathing, eccentric patterns, concentric patterns, etc. In addition, I believe that it is important to educate the student about the body and what muscle groups are being worked while doing a particular exercise. In my opinion, this focus forces the student to be aware of the potential pitfalls when performing an exercise the wrong way.

**Faigenbaum:** Two important safety factors that should be addressed before the initiation of any youth resistance training program are the quality of instruction and the rate of progression. Professionals who work with children and teenagers should have a thorough understanding of youth strength training principles and should understand the uniqueness of childhood and adoles-
cience. A low instructor-to-student ratio may be particularly important during the first few weeks of resistance training when students are often learning proper training guidelines and exercise techniques for the first time. Unsupervised youth resistance training programs (at home or at school) are not recommended under any circumstances because of the potential for a serious injury. As such, parents and caregivers should be reminded of the dangers of resistance training at home without supervision or proper instruction. The safest option may be for youth to resistance train in schools, fitness centers, or sports conditioning facilities under the watchful eye of experienced strength and conditioning professionals.

It is also important for children and adolescents to begin at a level that is commensurate with their physical abilities. Very often, the intensity and the volume of the resistance training program exceed a youngster’s physical capabilities, and the rest periods between workouts are too short for adequate recovery. This approach to youth fitness programming may not only increase the risk of injury but also undermine the enjoyment of the resistance training experience. Although some youngsters may want to see how much weight they can lift on the first day of class, their enthusiasm and interest in resistance training should be redirected toward the development of proper form and technique on a variety of exercises. Due to the potential for low-back injuries, youth should incorporate strengthening exercises for the core musculature (i.e., abdominals, lower back, and hips) in their conditioning programs.

Kilgore:

• Appropriate supervision—This means educated, experienced, and certified personnel. My personal opinion is that this standard should extend to all sporting activities in which children participate.

• Appropriate instruction—Strength and conditioning personnel are teachers. They must teach proper techniques and assess proficiency before allowing the child to increase the load.

• Appropriate program design—In terms of effectiveness and managing risks, the strength and conditioning professional must prepare, follow, and document the training program.

• Appropriate safety precautions—Both the National Strength and Conditioning Association and the U.S.A. Weightlifting Regional Development Center have extensive literature on safety measures.

Lavalle: When looking at strength training, strength professionals need to be concerned with the following factors:

• Proper supervision—Youth who exercise without proper supervision appear to be at a greater risk for injuries! Additionally, most of the resistance training–related deaths could have been prevented with correct supervision.

• Appropriate loading—Before the age of 10, most of a child’s strength is gained from increased coordination and neuromuscular recruitment, as opposed to increased muscle mass. Therefore, it is important that the strength and conditioning professional emphasizes correct form over increasing weights.

Additionally, most strength professionals probably need not be particularly concerned about injuries to growth plates in young individuals who are participating in an appropriately designed resistance training program. There is a paucity of documented injuries to growth plates in youth, resulting from resistance training.

Nitka: Faigenbaum has developed the following guidelines for youth resistance training (2):

• Keep the instructor-to-student ratio low, approximately 1:10. (I follow a 1:25 ratio in my physical education classes.)

• Perform correct repetitions under the watchful eye of the instructor.

• Remove possible hazards from the training environment.

• Keep facility well ventilated, and the athlete well hydrated.

• Perform calisthenics and stretching exercises before and after every resistance training session.

• Begin with 1 set of 6–8 exercises for 10–15 repetitions that focus on the major muscles of the upper and lower body, then progress gradually.

• Increase the resistance gradually as strength improves.

• Multijoint exercises may be introduced into the program based on individual competency or need.

• Treat children with respect and speak to them in a language that they can understand.

• Remember that resistance training is only one part of a total fitness program. Keep it fun and they will make it a part of their daily routine.

• Be aware of other activities in which the athlete is participating.

Rippeteo: I believe it is imperative to emphasize core strength through the use of classic barbell exercises executed over the full range of motion using sets, reps,
The key factor in reducing injury would be proper instruction. Though I am sure we have all seen people do things wrong and still not get hurt, it will become more of an issue when they are training at higher levels of intensity. First, the strength and conditioning professional should be aware of the maturity levels of the youths they are training. Mental and skeletal maturity can be investigated through various physical, orthopedic, and diagnostic procedures. Something as simple as height, weight, and age nomograms can be useful. If androgen levels are a component to increasing cross-sectional area of muscles, then a program that concentrates on “hypertrophy” may be improper use of conditioning and may lead to overuse. In the case of prepubescent trainees, it might be especially beneficial to train toward a model that will provide maximal neuromuscular adaptation (25, 27). Fractures and dislocations are the least reported injuries in weight training, whereas soft-tissue injuries are the highest (21). Even among competitive weightlifters and powerlifters, the most common injury tends to be of the low back, shoulders, and knees (4, 28).

I believe there is a certain expectation to see injuries in any sport as the level of ability reaches the maximum. Although we have seen a decline in injury among youth populations, the majority of those injuries occurred at home or in unsupervised situations (21). Probably, of equal importance, if not more than proper instruction, may be the supervision of youths while resistance training. When performed properly and under supervision, risk of injury will be greatly reduced.

Question 3: Based on the Scientific Evidence, Can You Comment on the Ability of Youth Populations to Enhance or to Develop Muscular Strength?

Burgener: I really do not keep up on the scientific literature that much because I do what works for me. I may read articles regarding strength and conditioning, but I am a practical person, and I use what has been successful in the past. Now having said that, I have found that kids do make strength gains, but most of the gains using the Olympic-related lifts are neuromuscular gains. Once they have learned how to do a particular exercise, they perfect the movement patterns and make gains. The same goes for the squat and pulls. I find some hypertrophy in my 10-year-old daughter when I emphasize the squat and particular body building exercises.

Faigenbaum: Although the potential for adolescents to increase their muscular strength by resistance training is well established, the traditional belief was that training-induced gains during preadolescence were not possible because of insufficient levels of circulating androgens. However, 2 meta-analyses on preadolescent resistance training (as well as clinical observations from physicians, therapists, and trainers) provide compelling evidence that well-designed strength training programs can enhance the strength of preadolescents beyond what is normally the result of growth and maturation (6, 10). On average, strength gains of 30–40% have been observed in untrained children after short-term (8–12 weeks) resistance training programs (2).

Kilgore: Weight training has been erringly portrayed as ineffective in improving strength because hormonal response is largely absent in preadolescents. Studies that demonstrated a lack of strength increase were inadequate in magnitude of training load, training volume, duration, or did not use the simple principle of progression (1, 6, 9, 11, 23, 27). Research points that the loads, volumes, and durations similar to those commonly used in the training of competitive weightlifters are effective in increasing strength in children. A program’s ability to increase strength appears to be more closely related to the intensity of training than the volume (duration) of training. High-intensity programs have been shown to increase strength in preadolescents in 6 weeks or less (12–14, 29).

This particular issue is a razor’s edge. Conservatism in programming, as evidenced by the noneffective programs alluded to earlier, does not meet the needs and desires of healthy athletic populations. Aggressive athletic programs often run counter to the recommendations from the medical community but are effective in...
improving performance. The strength and conditioning professional is rapidly becoming limited in his or her ability to manage legal risk, given 2 items: (a) individuals under the age of 18 cannot sign an informed consent or waiver of liability that will protect the strength and conditioning professional in case of legal action (neither will the signature of their parents or guardian), and (b) authoritative guidelines are becoming more restrictive because they pertain to child participation. For example, the American Academy of Pediatrics recommends that those under the age of 18 avoid both high-intensity–low-volume and high-volume–low-intensity training. This leaves a very restricted area in which to work, one that may not be effective in developing a great deal of strength in participants.

**Lavalle:** When looking at the literature, it appears that children are capable of voluntary strength gains beyond those normally associated with growth (1, 4). It appears that youth programs should be based on lighter loads (>6RM) and must be undertaken for longer durations (10–20 weeks) to observe training adaptations (4).

**Nitka:** Studies suggested that strength gains contributing to improved force production among the youth population are caused by neural and not by hormonal factors (1, 3). Some of the possible factors that may be related to improved force production in youth populations may be a result of (1):
- Increased neural drive to the muscle.
- Increased synchronization of the motor units.
- Increased activation of the contractile apparatus.
- Inhibition of the protective mechanisms of the muscle.

**Rippetoe:** I am aware of several early studies that seemed to indicate that resistance training was ineffective in youth populations (1, 2, 4–7). Because this has definitely not been my experience, I would have to assume that these studies had a flaw in their methodology. This is a common problem in some areas of research, when that which is being investigated is subjected to the restraint imposed by earlier assumptions.

It has been my experience that prepubertal male youth populations gain strength at about the same rate as do female populations, with the same variations allowed for differences in individual athletic ability, and that postpubertal male youth populations gain strength rapidly. These gains, most likely, are commensurate with the development of the endocrine system (3). The literature may or may not reflect these observations, but I believe that they are accurate.

**Proulx:** It has been well documented that youth populations can enhance or develop strength (2, 10, 13, 14, 22). The controversy is whether the gains seem to be from hypertrophy or neuromuscular adaptations, which may dictate how the youth populations should train. I believe the consensus gathers around the neuromuscular adaptations, at least for the prepubescent (25, 27). Part of the controversy lies in explaining the increase in cross-sectional area due to growth and concurrent resistance training. We know that children show an increase in size and shape as a result of growth and development, so the argument that children cannot increase in lean body mass beyond normal growth can be attributed to the lack of growth hormone or androgen levels, as compared with adults, especially males. So beyond that point, studies have shown that in comparison to cross-sectional area by computed tomography scan (27) and body composition measurements (30), even after 20 weeks and 1 year, respectively, strength gains were not only independent but there were no significant changes in fat-free mass.

However, in a diseased state, it may be possible that gains in strength may result, in part, from increases in lean body mass (6, 32). After severe burn injuries, there is continued catabolism of the damaged tissue, including muscle tissue. It has been reported by Suman et al. (32) that in children with severe burns, a program that included strength training as part of their rehabilitation significantly increased strength as well as lean body mass when compared with children who did not receive exercise in addition to the normal rehabilitation program.

**Burgener:** In over 25 years of experience, I have used a program that is based on what I call YES to the 4th power. YES 1: exercises performed standing up, with feet on the ground. YES 2: exercises that are free-weight exercises. YES 3: exercises that are multijointed and multimuscle groups. YES 4: if I am an athlete, exercises that are explosive. These 4 aspects are used between 70 and 75% of the time, thereby allowing the use of other exercises as well. Using this protocol, I emphasize the aspect of injury prevention and enhancement of performance. In my opinion, YES to the 4th power empha-
The potential for youth resistance training extend far beyond an increase in muscular strength and include many other health-related and fitness-related benefits. Data suggest that regular participation in a youth resistance training program may have a positive influence on motor performance skills (e.g., sprint speed and jumping ability), body composition, bone mineral density (BMD), and selected psychosocial parameters (1). Furthermore, because the musculoskeletal system of aspiring young athletes may be ill prepared to handle the duration and magnitude of forces that develop during practice and game situations, resistance training may be able to decrease the risk of sports-related injuries (11). Although there are many mechanisms to reduce sports-related injuries (e.g., coaching, education, and proper equipment), participation in a pre-season conditioning program that includes strength, aerobic, flexibility, and agility exercises merits consideration (8).

Resistance training also may be beneficial for overweight youngsters. Although aerobic exercise is often prescribed for decreasing body fat, several studies on resistance training have reported a decrease in fatness (as measured by skinfolds) among young participants (1). In fact, resistance training of moderate intensity has proven to be an important component of a multidisciplinary outpatient treatment program for obese children (12). Observations from our youth strength training center suggest that overweight children and teenagers enjoy resistance training because it is not aerobically taxing and it provides them with an opportunity to experience success and feel good about their performances.

**Faigenbaum:** The potential benefits of youth resistance training extend far beyond an increase in muscular strength and include many other health-related and fitness-related benefits. Data suggest that regular participation in a youth resistance training program may have a positive influence on motor performance skills (e.g., sprint speed and jumping ability), body composition, bone mineral density (BMD), and selected psychosocial parameters (1). Furthermore, because the musculoskeletal system of aspiring young athletes may be ill prepared to handle the duration and magnitude of forces that develop during practice and game situations, resistance training may be able to decrease the risk of sports-related injuries (11). Although there are many mechanisms to reduce sports-related injuries (e.g., coaching, education, and proper equipment), participation in a pre-season conditioning program that includes strength, aerobic, flexibility, and agility exercises merits consideration (8).

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**Kilgore:** Speaking specifically from the perspective of competitive weightlifting, the sport relies on strength, power, and skilled performance. The ability to excel in the snatch and in the clean and jerk can be largely affected by the ability of an athlete to improve power output and technical performance. Strength and power increase with proper training in children. An indication of this relationship can be seen simply by comparing strength norms for the youth population of the United States with performances of weightlifters competing at the U.S.A. Weightlifting Regional Development Center and from scientific data demonstrating increases in vertical jump (a measure of power output) after weight training in children (13, 28). These data can bring about positive effects in other sports.

The sport of weightlifting is inclusive. Because many sports select directly or indirectly for very specific physical attributes (7, 10) or compete against others regardless of body mass, weightlifting, with its multitude of weight classes, affords athletes who traditionally have few competitive outlets the opportunity for competition in a controlled, equitable environment. Any individual can experience success in weightlifting because any participant can measurably improve their performance (this is also a valid statement for recreational training and training undertaken for sports preparation). Such a sport may be more suitable for children to participate than sports where success is measured simply by victory or defeat.

**Lavalle:** A youth resistance program offers many advantages to the youth who participate in them. One benefit is a sense of accomplishment, which can aid in the development of positive self-esteem. Resistance training may also translate into improved proprioception and reaction time. These benefits may directly affect performance in other sporting activities.

**Nitka:** First and foremost, we hope that participating in our program will eliminate or minimize serious injuries during sports participation. Second, we hope that athletic performance will noticeably improve during the time youth populations train with us. Psychologically, we notice an improvement in their confidence and in their self-esteem while participating in our training program. Although we maintain a businesslike environment, we do encourage social interaction among the athletes, grades 9–12 being with each other. Our upper-classmen work with our underclassmen, modeling the work ethic that we seek. The weight room is also a safe place for athletes to interact with others who have similar goals and values. We, as a staff, monitor and discuss diet and nutrition with all our athletes on a regular basis. Lastly, we will find odd jobs for our students to do in the weight room, keeping them with us in a safe environment, until parents can pick them up.

**Rippetoe:** The adaptations to resistance training in youth populations are precisely the same as those in the general population. As
a result, youth, adult, and older adult populations enjoy the health benefits of exercise. In addition, a structured exercise program, wherein the trainee derives benefits in exact proportion to the effort invested, teaches a young person one of the most valuable of life’s lessons. This aspect of the program cannot be emphasized enough but often remains obscured in the details of sets and reps.

**Proulx:** Back to some of the concerns about resistance training—we could further dispel the risk of fracture by looking at bone density. Elite weightlifters have been shown to have increases in BMD according to the type of training they perform (5). In addition, studies indicate that weight-bearing and impact exercises including resistance training can have a positive effect on BMD (3, 12, 34). Having a lower BMD has been associated with increased fracture rates in adolescents (17, 18). The risk of a severe injury, such as a fracture, especially from a fall, is potentially decreased through resistance training. Not only has it been shown to decrease injury, it may also decrease the amount of time lost as a result of an injury (20). Resistance training may also improve one’s capability of achieving peak bone density, especially important for girls.

Resistance training is now becoming a more accepted part of rehabilitation programs, if not more integral. Chronic conditions that have caused or been caused by structural abnormalities have been shown to have a positive effect on improvement in movement and gait (7, 8). Studies are confounding as to improvements in neuromuscular degeneration diseases, but it has been suggested that moderate resistance training can be performed safely for some of these conditions (1). As described earlier, improvements can be seen in overall strength and in a slow down in the effects of severe burns (6, 32).

Child obesity is a major concern in the United States in recent years. There have been studies showing improvements in decreasing fat mass through resistance training programs as well as possibly improve retention rates for obese youths (30). It has been suggested that body mass index has a greater relationship to less favorable risk status to cardiovascular disease or atherosclerotic risk factors. A reduction in body fat may also have positive psychological implications such as increased esteem and confidence. Though not specific to resistance training, sport and physical activity does appear to have a positive effect on self-esteem (23, 29, 33). If we can describe resistance training as a physical activity, then we can extrapolate this as a finding. In these same studies, academic performance was also enhanced through physical activity (23, 33).

Other health-risk factors that were improved include oxygen consumption, flexibility, and blood lipid profile (15, 30, 36). All these are considered risk factors and/or may compromise future physical activity as an adult. Because of the health benefits related to resistance, it may give children, as well as adults, a means of achieving favorable risk profiles other than performing aerobic activity.

**Question 5:** One of the Biggest Debates Among Strength Professionals is the Age at Which to Begin a Resistance Training Program. Can You Comment on What the Appropriate Age Might be to Introduce Youth to Resistance Training?

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**Burgener:** That depends on the youngster involved. I have trained all my 4 kids at a very early age. Casey, who is 19 years old, started when he was 8 years old, training very sparingly, but at 12 years of age he was a full-time weightlifter. Beau, who is 16 years old, started training when he was 7 years old, lifted in several American Weightlifting Association meets, but took to volleyball and water polo for his first 2 years in high school. However, Beau is now training full time with me at my school. Cody, who is 13 years old, is an all-sports athlete. He plays everything, but started lifting with PVC pipe at the age of 4. He is still training, but only for his sport. My daughter Sage, who is 11 years old, started lifting at 4 years of age with a PVC pipe because she wanted to compete with her brothers.

Considering that I am a strength coach it was easy for me to allow my kids to train using light resistance because I could teach them the correct technique. I never forced my children to lift weights. They all lift because they enjoy it. If a youngster wants to lift weights and you can ensure that correct technique is taught, then I believe that youngsters can lift weights. I would never force them to lift weights at a young age, but I would encourage them to lift and would make them lift correctly.

**Faigenbaum:** Although there is no minimum age requirement for participation in a youth resistance training program, all participants should have the emotional maturity to accept and follow directions and should understand the benefits and risks associated with strength training activities. As a point of reference, many 6-, 7-, and 8-year-old boys and girls have successfully participated in closely supervised youth resistance training programs (2). In
An improvement in neuromuscular coordination in children has been linked to repetitive practice of the specific skill (regardless of the skill investigated). The ages that appear to be optimal for learning movement patterns are between 9 and 12 years (24). The preponderance of data suggests that there are no valid reasons to assume that children cannot effectively begin learning weightlifting skills if taught properly during this period.

**Kilgore:** An improvement in neuromuscular coordination in children has been linked to repetitive practice of the specific skill (regardless of the skill investigated). The ages that appear to be optimal for learning movement patterns are between 9 and 12 years (24). The preponderance of data suggests that there are no valid reasons to assume that children cannot effectively begin learning weightlifting skills if taught properly during this period.

**Lavalle:** This may be an unpopular view, but I believe children can be exposed to resistance training at much younger ages than most people currently believe is possible. The current thinking is not to lift before 12–13 years of age, but if you look at our own Junior National Weightlifting team (ages 14–20 years), most started lifting when they were much younger than 12 years. They come in all shapes and sizes, both boys and girls. Despite the fact that these children not only lifted weights but also actually moved significantly heavy loads, some even world record attempts, their growth does not appear to have been stunted. This is often the case with open growth plates. As a member of the U.S.A. Weightlifting Sports Medicine Committee and as the most recent team physician for the United States Junior Weightlifting Team competing at the 2001 World Junior Weightlifting Championships in Greece, none of the athletes there related any history to me of growth plate injuries. Some may have had some minor injuries, mostly related to the overuse/overreaching type. No serious or extraordinary injuries occurred for this level of competition.

**Nitka:** If asked, I would suggest that the age of 5 might be appropriate to begin resistance training. The reason I have chosen the age of 5 is because that is when most American children are beginning to participate in organized sport. Ultimately, I really would like to see more physical readiness programs for all sports before kids go out and are drilled to injury with sport-specific skills. There are windows of opportunity for the development of all locomotor movements, and we seem to narrow our training to sport-specific movements, which may lead to overuse injuries. Our youth sport coaches should be our most highly trained and experienced coaches but they are often our least knowledgeable coaches in the area of resistance training.

**Rippetoe:** It varies with the individual child, but a structured resistance training program can begin as soon as the child is mature enough to accept coaching. He/she needs to be ready to listen and to try to follow instructions out of a desire to improve as opposed to a desire to please and to see the benefit of a set of activities with long-term beneficial consequences rather than immediate rewards (3).

**Proulx:** The answer to this question is correlated with the answer regarding injuries, rates, and severity. As a sport and for conditioning, resistance and weight training are favorable physical activities. School-age soccer has the highest incidence of injury (19), and as the name suggests, it is specific to children. It is very common to see community soccer leagues, with children from kindergarten or 5 years of age playing. I have worked in soccer camps and sponsored soccer teams of young children, with complete support from the communities and the parents. Toy companies make roller and in-line skates that would fit 3-year-olds. I believe that age should be an individual concern and/or desire. Studies have shown not only that prepubescents increase in strength but also that moderate resistance training will not negatively affect growth (36, 37). Working as a ski instructor for several years, I taught 3- and 4-year-old children to ski with much success, and I do not mean that I am the best ski instructor, but their ability to perform motor skill acquisition is obvious. I believe children that are capable of learning resistance training techniques; children who are not forced into resistance training and have proper instruction and supervision should be able to participate in resistance training. There is more individuality at the younger ages, so the capabilities are as such, but this can lead to better adherence and possibly long-term effects from performing resistance training or physical activity. The risk of injury and relative training capabilities should dictate the direction of the training program, e.g., motor skill development as opposed to hypertrophy or high-intensity resistance training.

**Burgener:**
- Safety—Make sure the kids know proper protocol in the weight room, i.e., how to load the weights, how to unload the bar, how to spot, etc.
- Proper technique—Before we ever allow our kids to move up
in weight, they have to demonstrate proper technique.

- Make it fun—This is important for the young group. They should want to come to the gym. If they know their buddies are going to be there, most of them will love this socialization process and will want to participate on a regular basis.

- Video—Use a video to show them their lifting technique. They love this. If they see themselves on video, it encourages them to lift the weight using the correct technique.

- No more than 5 in a group—I have found that this relates to making it fun. If they can be with their buddies, they will enjoy the team dynamics and socialization.

I am sure there are more guidelines to follow, but these are the ones I use.

**Faigenbaum:** All strength and conditioning programs for youth should be supervised by qualified professionals who have experience in youth fitness programming and resistance training. Professionals should listen to individual concerns and should closely monitor each participant’s ability to tolerate the exercise stress. It is important to teach proper lifting techniques and help youngsters develop a more positive attitude toward resistance training activities. Even exercises such as the snatch and clean and jerk can be incorporated into a youth resistance training program, provided that the child or adolescent has successfully mastered the performance of introductory exercises and qualified instruction is available (e.g., Certified Strength and Conditioning Specialist or U.S. Weightlifting Federation Club Coach) [3].

In general, it is recommended that youth perform 1–3 sets of 6–15 repetitions on a variety of single- and multijoint exercises [2]. Data from our laboratory suggest that high repetition–moderate load training may be more beneficial than low repetition–heavy load training for children participating in an introductory program [5]. Beginning a youth resistance program with a moderate load that can be lifted for 10–15 repetitions not only allows for positive changes in muscular performance but also provides an opportunity for appropriate adjustments to be made. As participants get stronger, the training load should be increased gradually (e.g., 5–10%). However, this does not mean that every exercise session needs to be more intense that the previous one. Two to 3 nonconsecutive training sessions per week are appropriate for most children and teenagers [4].

**Kilgore:** Make an athlete first and then make a competitor. This simply means develop the whole child first. Teach them how to move. Teaching them how to exercise, teach them how to play.

**Lavalle:**

- Go slowly.
- Focus on form, not on the weight they can move.
- Make it fun.
- Don’t make it too competitive.
- Keep supervision of youth at a premium. No adult, no lifting. Safety first.

**Nitka:** Please see answer to question 2.

**Rippetoe:**

- Never sacrifice technique for an increase in weight lifted.
- Always attempt to increase the weight, as allowed by good form, because improvement builds interest and dedication.
- Encourage regular competitions as a part of the training program as a way to measure, acknowledge, showcase, and reward improvement.

- Make the program FUN. The younger the population, the more critical this becomes.

**Proulx:** The first and foremost concern should be to decrease the risk of injury. The strength and conditioning professional needs to account for the possibly greater time spent on instruction and supervision. They are little people, but they are not young adults. Children do not have the same cognitive abilities as do adults, so things have to be repeated much more often. There tends to be less attention span, not only to a subject matter, but also to detail about what it is they are doing.

The progression in intensity should be slower, and although the increase may be consistent, the professional needs to be aware of intensity levels, such as maintaining a level of intensity while changing other parameters (i.e., repetitions, sets, exercises, etc.). This is done to prevent overuse/soft-tissue injuries because not every system of training addresses the different rates of growth for various groups of adolescents.

Although a weight room may resemble a playground with all of the metal, racks, weights, benches, and pulleys, it is far from a playground and is potentially dangerous if not respected. It is important that the strength and conditioning professional takes the time to explain the rules and regulations of the facility. Not only do the children need to show consideration for the facility but also for each other.

Lastly, I do not believe anyone should be forced into doing something they are not comfortable with. One of the goals should be to provide motivation and an atmosphere of support. This can play a key role in making this a long-lasting activity.
**Question 7:** In Your Opinion, What Are Some of the Things that the Strength and Conditioning Professional Can do to Make a Youth Resistance Training Program Interesting to the Community, Parents, and Most of all the Youth Participants?

**Burgener:** We have local demonstrations using young lifters. My daughter, Sage, uses great techniques when lifting weights. At 11 years of age, she, in my opinion, is one of the most technically proficient lifters in my family. These demonstrations allow the parents and the community to see firsthand that kids can safely lift weights and perform resistance training exercises the correct way.

**Faigenbaum:** Strength and conditioning professionals need to educate the public on the potential health benefits associated with resistance training. Hosting youth fitness seminars, lecturing to medical and fitness organizations, and writing articles for the lay press can help provide reassurance that resistance training can be a safe and beneficial activity for boys and girls. In addition, athletes and nonathletes should be encouraged to participate regularly in resistance training activities.

In terms of making resistance training interesting and enjoyable for children and teenagers, professionals who work with youth should downplay competition between participants and wean them away from the "winning is everything" attitude. The focus of youth programs should be on intrinsic factors such as skill improvement, personal successes, and having fun. The use of individualized workout cards can help focus each child's performance on his or her own improvement. Age-specific training guidelines should be followed, and different types of resistance training equipment (e.g., child-size weight machines, free weights, and medicine balls) can be used to keep the program fresh and exciting. If coaches and teachers are viewed as caring and knowledgeable people, youth resistance training has the potential to be a pleasurable and valuable experience that can last a lifetime.

**Kilgore:** Make training fun for the children involved. If it's not fun, then the child will not stick to it.

- Make training attractive to the parties involved. If a child, a parent, or a sport coach can see the value of resistance training as it pertains to performance or potential for performance, the program can be successful. Publicize your results. Positive results are attractive to everyone involved. If the strength and conditioning professional writes programs effectively, his trainees improve, and when those results are visible, more participants will be attracted. Our program has grown from participants coming from the university and 1 high school to participants coming from the university, 6 high schools, and 2 middle schools in less than 2 years because our off-season and summer results are visible to the coaches, parents, other athletes, and the entire community.

- Become a true expert. There is a wealth of misinformation about resistance training available to the general population that is often perceived as the truth. Furthermore, stereotypes and misconceptions about resistance training can be found at every level of participation: athlete, coach, parent, or clinician. The strength and conditioning professional must be objective and must become well versed in all aspects of resistance training literature to educate involved parties about differences between fact and fallacy.

**Lavalle:** I prefer weightlifting (Olympic style) for youth populations because a sound lifting technique is as important as strength is for success. Some good examples of successful youth weightlifting programs I am aware of are Mike Burgener’s Team Southern Cal from Bonsall, CA, Dennis Snethen’s program from St. Joseph, MO, and Henry Meyer’s Program from Savannah, GA. All these programs target children from the poor to the well off and have produced many Olympians.

**Nitka:** If you build it, they may or may not come to your high school weight room. High school weight-training facilities in the United States are as good as or better than many small college weight rooms, but there are many personal trainers in every community who sell their program better than do most high school programs.

Do you want your athletes training at the facility down the road following someone else’s philosophy and program? Our programs begin to develop the team chemistry in our weight rooms that is necessary for a championship season. Can this chemistry be developed if the team is training in various facilities without their teammates?

If you want your athletes in your weight room it is extremely important to inform the parents of your training philosophy, what type of equipment you have, who can train, hours of operation, cost of the program, supervision ratios, and if a certified strength and conditioning specialist is on the staff. Always keep the facility clean and all equipment properly main-
tained. Make sure to continually educate yourself about the latest in athletic training and include these concepts in your program. Start educating the community, parents, and students at the middle school level about the benefits of resistance training. Lastly, attempt to make contact with each kid while he/she is training at the strength facility because this makes each athlete feel welcome and a part of the overall program.

**Rippetoe:** The competitive nature of youth populations is reinforced at all levels of formal education, with competitive sports programs being introduced in grade school. Most students and parents are comfortable with sports competition, and this aspect of resistance training should be used to its fullest advantage. The sport of weightlifting is experiencing a resurgence in popularity and is the perfect competitive outlet for strength-interested kids. The community responds favorably to a successful competitive program, and peer pressure is positively directed when kids and parents see the benefits of participation in a winning team.

**Proulx:** One of the most important things the strength and conditioning professional can do is to educate people. A major concern, I have seen, is the possibility of injury. People do not know what we know about the injury rates. I believe the first step would be to tell the public that it is safe. The research is on our side as well as the government’s side. Healthy People 2000 and now Healthy People 2010 are aimed at increasing the health status of the nation. I believe it was 2001 that this is trickling down from federal into local, and grants have been given to local communities to implement community health, one component of which is exercise. But few people know this. I asked one of my classes if they had heard of Healthy People 2010, and only 1 said they may have heard something about that.

There are several theories and reviews for promoting physical activity (11, 31, 26), and the consensus is not to promote any one sport or activity but to promote physical activity. Instructing people on the possible uses, e.g., benefits of resistance training, may provide a base for motivation and adherence.

I believe it is also important to get the support of the schools, community, and parents. This can make a successful program. It can be marketed in several ways to accomplish or attract different populations. Some examples may include marketing to the community for promoting health status, marketing to athletic programs to decrease injury and improve performance, marketing to parents as a means of weight control, improvements in psychosocial issues, and reduction in risk factors for disease.

Some people might consider getting the information that is difficult. A place to start may be community centers for youths or even town community centers. Speak to different groups, especially some that have influence in the area you would like to implement a program. Being a guest speaker is a great way to speak to large groups, such as local Rotary clubs, group organizations, and schools. Several organizations are always looking for guest speakers. As for school programs, address the topic with the athletic director and possibly set up a presentation with the coaches and physical educators.

The goal is not to just promote strength training, but to explain why resistance training is beneficial to the children of the community. This can be beneficial if a goal is to receive funds for a program. ▲

### References

**Faigenbaum**

Kilgore


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