

Strength & Conditioning in Development Programs

Introduction

Strength and Conditioning plays an integral part of all athletes' physical development within their sport. Strength and Conditioning is a multi-faceted discipline that aims to provide athletes with the physical qualities necessary to succeed in their individual sports. These qualities include core stability, strength, speed and agility, power, range of motion and endurance.

Mission Statement

"The Strength & Conditioning Department provides athletes with sound scientific, specific, and multi-dimensional, movement based programming and education to facilitate total athletic development and enhance sport specific performance".

The goals of the NOC*NSF Strength and Conditioning Department are to:

1. Assist athletes to master exercise and lifting technique.
2. To design and implement the "world leading" S&C programs across each of our Olympic Sports.
3. Provide cutting edge S&C servicing through:
 - a. The use of current technology.
 - b. Proven scientific principles.
 - c. Sound understanding of the requirements of individual sports and how Strength and Conditioning can be optimally integrated into specific sports to prepare athletes for competition.
4. Establish a clear physical development pathway for athletes entering the NOC*NSF system.
5. Ensure that programs are targeted to address the specific strengths and weaknesses of the individual athlete with the ultimate goal of preparing them for success in the international arena.
6. Provide specific injury prevention and injury rehabilitation models.

Firstly, we should address some issues that have been circulating in regards to the potential benefits or risks relating to strength training in young athletes.

Q. *What is strength training?*

A. Strength training is a simply general term used to describe the utilization of resistance to develop physical qualities such as strength, power, rate of force development and strength endurance. This type of training may involve something as simple as the body weight of the individual or other external resistances such as dumbbells, barbells, machines, bands, medicine balls etc.

Q. *How old should an athlete be to begin strength training?*

A. Provided that the athlete (child) can understand what is being asked of them, and physically ready to begin some level of sports training, they are ready to begin participating in a basic strength and conditioning program as part of their overall development. There are some general guidelines / recommendations what type / mode that young athletes should employ that will be expanded upon in later sections.

Q. *Will strength training result in excessive musculature in young athletes?*

A. Most strength gains in young athletes prior to the onset of puberty are attributed to neural adaptations which includes improvements in motor unit coordination, recruitment and firing patterns. Inter and intramuscular coordination also serves to help improve strength. In the majority of cases, excessive muscular growth does not occur because of a lack of circulating testosterone which serves to stimulate increases in muscle size.

Q. *Is strength training dangerous for young athletes?*

A. There is very little scientific research that demonstrates that a properly supervised and coached strength and conditioning program exposes a young athlete to any more risk of injury than participating in their sport alone (Hamill, B. (1994)). The injuries that do occur appear to be mainly attributed to factors such as poor technique, excessive loading, fatigued training and lack of qualified supervision. Conversely, there is a large body of evidence available demonstrating improved strength, speed and power and a reduction in injury rates amongst young athletes participating in strength and conditioning programs

Q. *When should you start performing plyometrics?*

A. From the time children start to jump, they are performing some form of plyometric activity. Children hop, skip and jump during play all the time without injury. Therefore provided that the plyometric activities are prescribed and taught in a safe and progressive manner that is appropriate for the athlete's biological and training age it can be safely concluded that the assumption that plyometrics are not the danger that some would have you believe. It is important to note that these activities should be prescribed and monitored by a suitably qualified Strength and Conditioning Coach. It is also worth noting that excessive plyometrics (either through volume or intensity), as with any type of training, can lead to serious injury.

Strength & Conditioning in Development Programs

Istvan Bayli's work on the principles of Long Term Athlete Development (LTAD) (Bayli, 1999), has provided Sports Administrators with an excellent framework around which to structure their sports. Bayli has constructed a model that respects both the chronological and biological age of the athlete. It has been separated into specific phases of development and identifies some crucial focus points on which to focus for young athletes competing in sport.

Diagram 1: The Long Term Athlete Development (LTAD) Model



LTAD consists of 7 stages.

The first 3 encourage physical literacy and sport for all:

1. Active Start
2. FUNdamentals
3. Learning to Train

The next 3 focus on excellence:

4. Training to Train
5. Training to Compete
6. Training to Win

The final stage encourages life-long physical activity:

7. Active for Life

It is acknowledged that some sports (e.g. gymnastics, diving, & table tennis) require early specialization to ensure success in senior international competition whilst most sports can be categorized as late specialization sports. For this reason, a differentiation has been created through the early stages of development. This differentiation in early specialization sports is that it combines the FUNdamental, Learning to Train and Training to Train phases rather than the seven stage model illustrated above.

It is widely accepted that the LTAD model provides great insight into the important considerations of developing the athletic qualities in young athletes. Many “world class” sports programs have adopted these principles into their development structure, ***BUT*** the problem remains - ***How do we implement these principles in a practical manner?*** The reality is that we continue to see the following occurring:

- Athletes in S-1 / S-2 or Talent and Sub-Elite levels presenting with increasing limitations in the functional and athletic development.
- Young athletes being consistently being exposed to modifications of programs developed for mature adults without respect to their physical, biological, emotional and training age.

Even as recently as 2005, Bayli noted;

“Young developmental players under-train and over-compete”

“Adult competition schedules are imposed on young players”

“Adult training programs are imposed on young players”

“General motor skills are not learned before age 11 for females and 12 for males”

“Training is geared for outcomes and not for ‘process’ for the developmental players”

(Balyi, 2005)

From this we can deduce that either;

- There is limited knowledge and understanding of how to actually apply the principles of LTAD in a sequential, systematic manner that will allow athletes physical skills to progress in line with the technical and tactical demands of the level of competition they are involved in

OR

- Coaches of athletes in these development age groups continue to choose to **“fast track”** their athletes in a quest for results and the elusive age group championship, thereby jeopardizing the potential of the young individuals under their care.

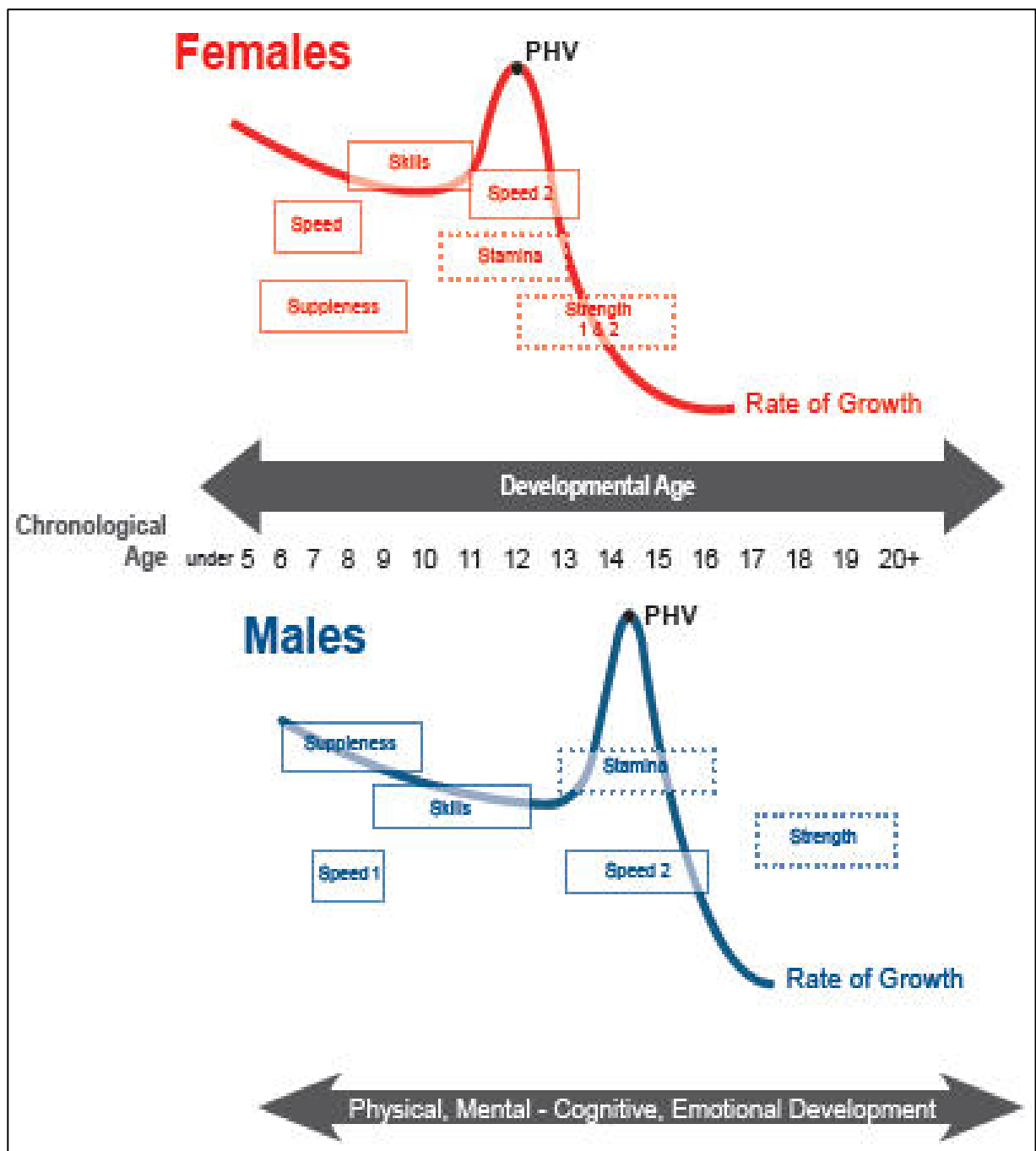
If we are to make a real and positive change in the development of our athletes and compete in the future with countries such as Australia, Great Britain, Canada who have already embarked upon this process, it is essential that we choose to prioritize the physical development of our young athletes and invest in their future and the future of sport in The Netherlands. We must prioritize the pursuit of “physical literacy” and “functional movement” as the foundation of athleticism in our development programs. This will significantly reduce the likelihood of athletes being impeded by unnecessary limitations that have been developed in earlier developmental stages when they enter the sub-elite and elite level programs. In turn, this will enhance their chances of success and give them a greater chance of being able to tolerate the higher level athletic pursuits of speed, acceleration, strength, power and endurance required to compete and succeed in the international arena.

“Athletes must have the physical competence to perform the technical skills and the technical skills to perform the tactical skills..... in that order!” (Movement Dynamics, 2005).

The cornerstone of the LTAD model acknowledges the fact that children develop at different rates and there are also differences in gender. Therefore the types of activities that they are exposed to through these phases should also be adjusted accordingly. Bayli has also provided some solid guidelines on “peak moments” to enhance certain physical qualities (**Diagram 2**).

A summary of the guidelines for the different phases of the LTAD model adopted from the **“Canadian Sport 4 Life Framework”** is outlined below:

Diagram 2 – Optimal Windows of Trainability (Bayli & Way, 2005)



Active Start (Age 0 – 6)

Objectives:

Learn fundamental movements and link them together into play.

Physical activity is essential for healthy child development. Among its other benefits, physical activity

- Enhances development of brain function, coordination, social skills, gross motor skills, emotions, leadership, and imagination.
- Helps children to build confidence and positive self-esteem.
- Helps to build strong bones and muscles, improves flexibility, develops good posture and balance, improves fitness, reduces stress, and improves sleep.
- Promotes healthy weight.
- Helps children learn to move skillfully and enjoy being active.

Physical activity should be fun and a part of the child's daily life, not something required. Active play is the way young children are physically active.

Organized physical activity and active play are particularly important for the healthy development of children with a disability if they are to acquire habits of lifelong activity.

Because this is a period when children rapidly outgrow their mobility aids, communities need to find effective ways — equipment swaps or rentals, for example — to ensure that all children have access to the equipment they need to be active.

Active Start To-Do List

- Provide organized physical activity for at least 30 minutes a day for toddlers and at least 60 minutes a day for preschoolers.
- Provide unstructured physical activity — active play — for at least 60 minutes a day, and up to several hours per day for toddlers and preschoolers. Toddlers and preschoolers should not be sedentary for more than 60 minutes at a time except while sleeping.
- Provide physical activity every day regardless of the weather.
- Starting in infancy, provide infants, toddlers, and preschoolers with opportunities to participate in daily physical activity that promotes fitness and movement skills. Provide parents and care givers with age-appropriate information.
- Ensure that children acquire movement skills that build towards more complex movements. These skills help lay the foundation for lifelong physical activity.
- Encourage basic movement skills — they do not just happen as a child grows older, but develop depending on each child's heredity, activity experiences, and environment. For children with a disability, access to age and disability appropriate adapted equipment is an important contributor to success.
- Focus on improving basic movement skills such as running, jumping, twisting, wheeling, kicking, throwing, and catching. These motor skills are the building blocks for more complex movement.
- Design activities that help children to feel competent and comfortable participating in a variety of fun and challenging sports and activities.

- Ensure that games for young children are non-competitive and focus on participation.
- Because girls tend to be less active than boys and children with a disability less active than their peers, ensure that activities are gender-neutral and inclusive so that active living is equally valued and promoted for all children.

FUNdamentals

(Age 6 – 9 Males / 6 – 8 Females)

Objectives:

Learn all fundamental movement skills and build overall motor skills.

Skill development in the FUNdamentals stage should be well-structured, positive, and FUN!

The first window of accelerated adaptation to speed occurs at ages 6 to 8 for girls and 7 to 9 for boys. Bypassing the specialized skill development in the FUNdamentals stage is detrimental to the child's future engagement in physical activity and sport.

No periodization takes place; however, all programs are structured and monitored.

If children later decide to leave the competitive stream, the skills they acquire during the FUNdamentals stage will benefit them when they engage in recreational activities, enhancing their quality of life and health.

FUNdamentals To-Do List

- Aim for at least 30 minutes per day dedicated to physical activity.
- Include strength training exercises using primarily the child's own body weight. Provide opportunity for at least 10 – 15 minutes 1 – 2 times per week.
- Strength training can take place in a training hall or open space (e.g. training facility).
- Practice and master fundamental movement skills before sport-specific skills are introduced.
- Emphasize the overall development of the athlete's physical capacities, fundamental movement skills, and the ABC's of athleticism: Agility, Balance, Coordination, and Speed.
- Teach appropriate and correct running, wheeling, jumping, and throwing techniques using the ABC's of athletics.
- Emphasize motor development to produce athletes who have a better trainability for long-term sport specific development.
- Introduce basic flexibility exercises.
- Develop speed, power, and endurance using games.
- Encourage participation in a wide range of sports.
- Develop linear, lateral, and multi-directional speed with the duration of repetitions less than 5 seconds.
- Ensure that sporting and disability equipment are size, weight, and design appropriate and that communities explore ways to share and provide access to appropriate equipment.
- Participate once or twice a week if children have a preferred sport, so long as there is participation in many other sports 3 or 4 times per week to ensure future excellence.

Learning to Train

(Age 9 - 12 Males / 8 - 11 Females)

Objective:

Learn overall sports skills.

One of the most important periods of motor development for children is between the ages of 9 and 12. This is a window of accelerated adaptation to motor co-ordination.

Early specialization in late specialization sports can be detrimental to later stages of skill development and to refinement of the fundamental sport skills.

At this stage, children are developmentally ready to acquire the general sports skills that are the cornerstones of all athletic development.

Learning to Train To-Do List

- Further develop all fundamental movement skills and teach general, overall sports skills. Otherwise, a significant window of opportunity is lost, compromising the ability of the young player/athlete to reach full potential.
- Develop strength using exercises that incorporate the child's own body weight as well as Medicine balls and Swiss balls. Provide opportunity for 2 – 3 sessions per week of between 15 and 30 minutes in duration.
- Strength training can take place in a training hall or open space (e.g. training facility)
- Introduce hopping and bounding exercises. Also introduce squatting, lunging, pushing, pulling and bracing activities.
- Further develop endurance through games and relays.
- Further develop flexibility through exercises.
- Further develop speed by using specific activities that focus on agility, quickness, and change of direction during the warm-up.
- Identify sports the child enjoys and is predisposed towards success. Narrow the focus to 3 sports.
- Introduce single periodization noting that some sports such as swimming and tennis need to use double periodization to adequately address the sport's unique needs.
- Apply a ratio of 70 per cent training to 30 per cent competition. The 30 per cent ratio includes competition and competition-specific training. These percentages vary according to sport and individual specific needs. Athletes undertaking this type of preparation are better prepared for competition in both the short- and long-term than those who focus solely on winning.

Training to Train

(Age 12 - 16 Males / 11 - 15 Females)

Objectives:

Build an aerobic base, develop speed and strength towards the end of the stage, and further develop and consolidate sport specific skills.

During Training to Train, young athletes consolidate their basic sport-specific skills and tactics. This is a window of accelerated adaptation to aerobic, speed, and strength training.

Optimal aerobic trainability begins with the onset of PHV, the major growth spurt during maturation.

During competitions, athletes play to win and to do their best, but the major focus of training is on learning the basics as opposed to competing

Training to Train To-Do List

- Make aerobic training a priority after the onset of PHV while maintaining or further developing levels of skill, speed, strength, and flexibility.
- Strength training should take place for 1 – 3 sessions per week of between 45 and 60 minutes in duration. It should reinforce shoulder, knee, ankle and hip stability. Utilize body weight exercises, such as dips, chins, push up, squats, lunges etc.
- Introduce athletes to the use of free weights and complex lifts (squats, dead lifts, cleans, multidirectional lunging, pushing and pulling) with the emphasis on correct technique.
- Athletes should have access to a weight training facility
- Emphasize flexibility training given the rapid growth of bones, tendons, ligaments, and muscles.
- Consider the 2 windows of accelerated adaptation to strength training for females: the first occurs immediately after PHV and the second begins with the onset of menarche. For males, there is 1 window and it begins 12 to 18 months after PHV.

Note that both aerobic and strength trainability are dependent on the maturation levels of the athlete. For this reason, the timing of training emphasis differs depending on whether athletes are early, average, or late maturers.

- Learn to cope with the physical and mental challenges of competition.
- Optimize training and competition ratios and follow a 60:40 per cent training to competition ratio. Too much competition wastes valuable training time and conversely, not enough inhibits the practice of technical/tactical and decision-making skills.
- Use talent identification to help athletes focus on 2 sports.
- Utilize single and double periodization as the optimal framework of preparation.
- Train athletes in daily competitive situations in the form of practice matches or competitive games and drills.

Table 1: Overview of Stages of LTAD

	STAGES OF LTAD			
	ACTIVE START	FUNDamentals	Learning to Train	Training to Train
Age (years)	0 – 6	6 – 9 Males 6 – 8 Females	9 – 12 Males 8 – 11 Females	12 – 16 Males 11 – 15 Females
Optimal Windows of Trainability				
Skill	General Play Exposure to many different activities		Both	
Flexibility		Both		
Speed		Boys (7 – 9yrs) Girls (6 – 8yrs)		Boys (13 – 16yrs) Girls (11 – 15yrs)
Strength		Boys – 12 to 18 months after PHV. Girls – Immediately after Peak Height Velocity (PHV) or onset of menarche		
Endurance		Girls (Aerobic) – 12 to 15 years Boys (Aerobic) – 14 – 16 years (Onset of PHV)		
Requirements for Strength Training				
Recommended Equipment		Body weight (Primarily)	Body weight Medicine Balls from 1 – 5kg Swiss Balls	1 x Olympic Platform, 2 x Squat Racks, 4 x Olympic Barbells & Plates from 10 – 25kg Dumbbells from 2.5 to 40kg in 2.5 kg increments Pulley Machines Medicine Balls (1 – 6kg) Swiss Balls (45cm – 50cm – 55cm)
Facilities		Hall / Training Venue	Hall / Training Venue	Weight Training Facility
Sessions per week		1 -2 per week	1 – 2 per week	1 - 3 per week
Duration		10 – 15mins	15 – 30mins	30 – 45mins
Focus	General Play 30mins / day Diverse range of activities	Introduce body weight activities (e.g. lunges, squats, pushing, pulling) General body awareness	Reinforce body weight activities Introduce jumping, hopping & bounding	Introduce loaded complex and Olympic Lifts (e.g. Squats, Dead Lifts, Cleans) Reinforce shoulder, hip, knee and ankle stability and function Emphasize technique
Recommended Qualifications of Individuals Supervising Activities		Participation in courses such as Movement Dynamics (LTAD), Functional Movement Screen (FMS)	Education in Phys Education or Sports Science OR Participation in courses such as Movement Dynamics (LTAD), Functional Movement Screen (FMS)	Education in Physical Education or Sports Science Plus Accreditations through professional bodies e.g. Koninklijke Nederlandse Krachtsport en Fitnessfederatie (KNKF) Australian Strength & Conditioning Association (ASCA) United Kingdom Strength & Conditioning Association (UKSCA) National Strength & Conditioning Association (NSCA).

The Role of Federations in LTAD

Federations can:

- Ensure that coach education courses incorporate basic information on the theoretical models of athlete development as well as some practical examples of how to apply these. This will ensure that coaches are armed with at least a basic knowledge of strength training and how it applies to their athletes.
- Set in place specific curriculum for the development of athletes within their federations. This will assist in the identification and achievement of specific learning / athletic outcomes related to each age group.
- Ensure that their training and competition requirements fall in line with the recommendations of the LTAD framework.
- Ensure there are adequate opportunities for coaches to have access to suitably qualified personnel to assist in the development of a physical education curriculum within their clubs (e.g. appointing a Director of Athletic Development or holding regular updating courses which are compulsory for coaches to attend).
- Ensure that athletes have a “physical competency screening” to identify what areas need to be targeted.

Web Resources & References

www.movementdynamics.com

www.gambetta.com

<http://www.canadiansportforlife.ca>

<http://www.humanmotion.nl/>

<http://www.functionalmovement.com/SITE/>

www.knkf.nl

Balyi, I. and Way, R. (1995) Long-term planning of athlete development - the training to train phase. B.C. Coach, 2 - 10.

Balyi, I., (1998) Long-term planning of athlete development, the training to train phase, FHS, The UK's Quarterly Coaching Magazine, 1, 8 - 11.

Balyi, I., (1998) Long-term planning of athlete development, the training to compete phase, FHS, The UK's Quarterly Coaching Magazine, 2, 8 - 11.

Balyi, I., Way, R., Norris, S., Cardinal, C. & Higgs, C. (2005). Canadian sport for life: Long-term athlete development resource paper V2. Vancouver, BC: Canadian Sport Centres.

Faigenbaum, A. Kraemer, W. Blimke, C. Jeffreys, I. Micheli, L. Nitka, M. and Rowland, T (2009) Youth resistance training: updated position statement paper from the national strength and conditioning association. The Journal of Strength and Conditioning Research. 0 (0), 1 – 20.

Giles, K. and Giorgi A (2003) Queensland Academy of Sport Long Term Athlete Development Manual

Giles, K. (2006) Developing Physical Competence: the cornerstone of LTAD

Giles, K., Penfold, L., and Giorgi, A., (2005) Movement Dynamics, Long Term Athlete Development: A Guide to Developing Physical Qualities in Young Athletes – An Instructional Handbook. Australia

Guy, J, Micheli, L.(2001) Strength Training for Children and Adolescents Journal of American Academy of Orthopedic Surgeons, 9 (1), 29-36

Hamill, B. (1994). Relative safety of weightlifting and weight training. Journal of Strength and Conditioning Research 8 (1), 53-57.

KNZB (2007) Meerjaren Opleidingsplan Zwemmen, Koninklijke Nederlandse Zwembond.

Pierce, K. Brewer, C. Ramsey, M. Byrd, R. Sands, W. Stone, M. E and Stone M. H, (2008) Youth resistance training UKSCA Journal - June, 9 – 23.

Riewald, S. Cinea, K. Strength Training For Young Athletes National Strength and Conditioning Association Education Department

Stone, M.H., A.C. Fry, A.C, Ritchie, M, Stoessel Ross L. and Marsit J.L, (1994) Injury potential and safety aspects of weightlifting movements. *Strength and Conditioning*, 16, 15 – 24.

Thompson, P., O'Brien, C., Rice, T (2008) Long term athlete development. Rowing Australia Coaching Conference Presentation.