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AUSTRALIAN STRENGTH AND CONDITIONING ASSOCIATION

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RESISTANCE TRAINING FOR CHILDREN AND YOUTH
A POSITION STAND FROM THE AUSTRALIAN STRENGTH AND CONDITIONING ASSOCIATION (ASCA)

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1.0. INTRODUCTION TO RESISTANCE TRAINING FOR CHILDREN AND YOUTH

The use of resistance training by children (6-12 years) and youth (13 – 18 years) has been an area of controversy for the past 30 years. Much research has been directed to this area during this time and several prestigious organisations such the American Academy of Pediatrics (AAP); the US National Strength and Conditioning Association (NSCA), and the British Association of Exercise and Sport Sciences (BASES) have developed Policy Documents or Position Stands to summarise the research performed in the area and provide guidance for coaches, parents and teachers (AAP 2001; NSCA 1996; BASES 2004). Most recently several highly-respected institutions have endorsed the "Position statement on youth resistance training: the 2014 International Consensus" (Lloyd et al., 2013). These Position Stands are remarkably thorough scientific documents, for example the NSCA Position Stand references 145 publications; while the BASES Position Stand was developed by a group of experts consisting of orthopaedic clinicians, physical educators, sociologists, exercise physiologists, psychologists and biomechanists. However, the practical recommendations that were developed in these documents are typically very general and do not provide a great deal of specific guidance for the coach, parent, athlete or teacher. For example, in the AAP 2001 Policy Document one of the main recommendations is:

"A general strengthening program should address all major muscle groups and exercise through the complete range of motion." (AAP 2001 p 1471).

In the more recent 2014 International Consensus Position Stand one of the main proposed recommendations was:

"Resistance training prescription should be based according to training age, motor skill competency, technical proficiency and existing strength levels. Qualified professionals should also consider the biological age and psychosocial maturity level of the child or adolescent." (Lloyd et al. p 8).

While such advice is undoubtedly correct, these types of general statements provide little real clarity or specific guidance for the coach in developing a comprehensive resistance training program for children and youth. The purpose of the Australian Strength and Conditioning Association (ASCA) Position Stand was to develop a document that provides for as much clarity and guidance as possible to assist coaches in designing resistance training programs for children and youth at various stages throughout their development. Hence this document develops several age-related sample programs, proposes age and function specific progressions in training, and describes the actual first hand experiences of highly trained athletes who have performed intense resistance training during their youth. The Position Stand is divided into 7 sections dealing with each aspect of the long-term athlete development process including:

1. The appropriate age to commence training – how young is too young?
2. Training intensity – how heavy is too heavy?
3. Program design for the 6-9; 9-12; 12-15; and 15-18 years of age groups including model programs and recommended muscular function prerequisites prior to progression to more advanced programs.
4. Injuries, how they are caused, appropriate lifting technique and injury prevention strategies.
5. Legal cases involving weight training and children.
6. Nutrition and recovery strategies to enhance training effectiveness in children and youth.
7. Overall summary of the ASCA recommendations.

Hence this Position Stand develops very specific recommendations to serve as examples. However, it is acknowledged that all cases are individual and hence while very specific recommendations are given, individual variation for any specific individual will be required by the strength and conditioning coach (SCC) who is dealing with that specific child. The ASCA Position Stand is largely based on the results of published research with the addition of the real world first hand training experiences that have been reported by the ASCA membership and members of the ASCA Advisory Panel.

2.0. THE APPROPRIATE AGE TO COMMENCE RESISTANCE TRAINING

2.1. How young is too young?

One question that is often asked of the ASCA is how young can a boy or girl start performing resistance training? One of the most comprehensive long-term research studies on children performing resistance training was conducted in Israel by Sadres and colleagues (2001). These researchers studied the effects of progressive resistance training on 27 boys aged between 9 and 10 years (mean 9.2 $\pm$ 0.3 yrs.) over 2 school years (21 months, including 18 months of supervised training with 3 months of holidays in between the school years where no supervised training was performed) and compared the effects against a control group of 22 similar boys who did not perform resistance training but participated in standard physical education classes including track and field, basic gymnastics and ball games (e.g. soccer, basketball etc.). Each group performed their activities twice per week for approximately 1 hour per session. The resistance training was designed and instructed by a weightlifting coach and consisted of classic weight lifting exercises such as clean pulls, jerk, clean, squats, dead lift, snatch and snatch pulls as well as a few isolated exercises involving leg and arm flexion and extensions in addition to abdominal exercises and back extensions. Each resistance training session consisted of 150 repetitions per session using between 3 to 6 exercises for 5 to 30 repetitions of 1 to 4 sets per exercise. In the first school year (9 months) the load varied from 30 to 70% of maximum with a mean of 50%; while in the second school year the intensity was increased from 50 to 70% of maximum with a mean of 60% maximum. The resistance trained group recorded similar increases in body height and weight to that achieved by the control group over the 21-month period. However, the increases achieved in strength were significantly greater and were of the order of a about a 1% increase in strength per week.

Only one injury was reported during the 21-month study and was described as follows:

"… on one occasion the bar slid and fell on the thighs of one of the subjects following a lift (clean). The child complained of transient non-specific pain in the anterior thigh and sat out for about 5 min. He returned to train within the same session when the pain was resolved and had no further complications. Therefore, it was felt that no additional medical evaluation was required. The calculated injury rate was 0.055/100 participant-hours." (Sadres et al., 2002 p 363).

An important feature of this study was the high degree of expert supervision, and logical progressions that were provided throughout the training period. To commence the program the initial load consisted of a broom stick for the first month, followed by an 8-kg bar for the following month in order to learn the proper technique and safety procedures. The study clearly demonstrated that advanced resistance training can be safely and effectively employed in 9-year-old boys.

In specifically addressing the question of how young is too young, researchers Falk and Mor (1996) reported positive results from resistance and martial arts training in 6-8-year-old boys. Faigenbaum et al. (2003) conducted a study with 32 girls and 64 boys between the ages of 6-12 years that demonstrated that 1 RM (repetition maximum) testing using child-sized weight machines was safe and effective. Avery Faigenbaum from the University of Massachusetts in Boston is perhaps the most prolific researcher in this area. In a review paper entitled: "Resistance training for Adolescent Athletes" he stated:

"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 direction and should genuinely appreciate the potential benefits and risks associated with youth strength training." (Faigenbaum, 2002 p 32).

2.2. Position of the ASCA on appropriate training age

If a child is ready to participate in organised 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 organised resistance training program at about this time. However, the actual age will vary from child to child and will be largely based on their capacity to follow clear directions. However, many 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 etc. 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**.

3.0. TRAINING INTENSITY

3.1. How heavy is too heavy?

Perhaps the most controversial questions pertaining to resistance training for children are how heavy is too heavy, what is an appropriate training load, and what type of exercises and loadings are appropriate at various stages of childhood? The Policy Statement from the AAP is quite clear on this topic and recommends:

"Preadolescence and adolescence should avoid competitive weight lifting, power lifting, body building and maximal lifts until they reach physical and skeletal maturity." (AAP 2001 p 1471)

The policy statement goes on to suggest that:

"Progressive resistance exercise requires the successive completion of 8 to 15 repetitions in good form before increasing weight or resistance" (AAP 2001, p 1471).

The Position Stand from the NSCA is a little more tolerant to the performance of maximal lifts. In their Position Stand it is stated that:

"The examination of the relative safety of supervised 1-RM testing in laboratory settings performed only to evaluate training-induced changes in muscular strength should be supported philosophically. Most of the forces that children are exposed to in sports and recreational activities are likely to be greater in both duration and magnitude of exposure than competently supervised and properly performed maximal strength tests. Conversely, under no circumstances should children be subjected to unsupervised and poorly performed 1-RM testing (e.g., inadequate progression of loading and poor lifting technique) or chronic maximum resistance training (e.g., weightlifting training without periodization), due to the real risk of injury" (NSCA 1996 p 65-66).

Nevertheless, the NSCA overall recommendations suggested that:

"Depending on the goal of the training program (i.e., strength or local muscular endurance), 1 to 3 sets of 6 to 15 reps performed on 2 or 3 nonconsecutive days a week is recommended." (NCSA 1996 p 71).

The American College of Sports Medicine (ACSM) in a Current Comment paper entitled "Youth Strength Training" stated:

"Strength training with maximal weights is not recommended because of the potential for possible injuries related to the long bones, growth plates, and back." (Faigenbaum & Micheli, 1998 p 2).

3.1.1. Maximal lifts in youth athletes

Despite these recommendations for youth to avoid the performance of maximal lifts, the Australian Powerlifting and Weightlifting Federations continue to sanction maximal 1 RM sporting competitions for youth. For example, the Australian Powerlifting Federation has current records for boys and girls for the 14 to 18 age groups (sub-junior class) with some of the boys performing squats and deadlifts in excess of 250 kg, while one of the girls performed 150 kg in the squat and 155 kg in the deadlift (see www.powerliftingaustralia.homestead.com for details). The federation also has school bench press records for various age categories including under 14, under 15 and under 16 age categories for both boys and girls' divisions, with one of the under 14 boys lifting 85 kg and one of the under 14 girls lifting a whopping 75 kg bench press. Similarly, the Australian Weightlifting Federation has current records for both boys and girls in the under 16 and under 18 age classes, with some of the under 16 boys performing the clean and jerk lift with 150 kg, while one of the under 16 girls performed the clean and jerk with 92 kg (see www.awf.com.au for details).

The International Olympic Committee (IOC) commenced the Youth Olympic Games (YOG) in Singapore in August 2010 and included the sport of weightlifting, with all weightlifting athletes required to be aged between 16 to 17 years of age. For the 2nd YOG held in Nanjing, August 2014, the age ranges were dropped by one year so that all weightlifting athletes were required to be between 15 to 17 years of age. The main qualification competition for weightlifting for the 2nd YOG 2014 was the International Weightlifting Federation (IWF) World Youth Championships held in Tashkent, Uzbekistan from 7-13th April 2013. At this competition, athletes eligible to complete in the YOG Nanjing 2014 would have been between 13 to 16 years of age. In this qualification, competition a young 13-year-old Chinese girl named Ms Linglong Yu won the 48-kg class with a 81 kg Snatch and 92 kg Clean and Jerk lift producing a winning total of 173 kg. This 13-year-old girl lifted almost 2 times her own bodyweight above her head. Does anyone think this is a good idea? Does anyone think this remarkably talented young girl will still be an elite weightlifting athlete when she reaches her physiological peak in her 20's? It will be interesting to follow her progress over time. It is also interesting to consider exactly when a 13 year old girl capable of lifting such heavy weights started heavy training in preparation for this competition? There were over 400 youth athletes competing in the YOG weightlifting qualification competition in April 2013 in Tashkent. There has never been anything like this participation rate in elite youth weightlifting before. It is going to be interesting to see how it turns out. The real-world mass participation experiment of youth engaging in heavy weightlifting has only just begun and it will be interesting to see how these 400 young elite weightlifting athletes are going 10 to 20 years into the future.

Wilson (2014) tracked the progress of the 33-medal winning weightlifting athletes who competed in the 1st Youth Olympic Games (YOG) held in Singapore in August 2010. Each lifters performance in IWF competitions was recorded for the 3-year period from the YOG 2010 through to the end of 2013. The number of these elite teenage weightlifters who compete in IWF events progressively decreased over time, such that only 48% (16/33) competed in an IWF international competition in 2013; a dropout rate of 52%. Five (15%) of the medal winning weightlifting athletes never competed in an IWF competition after 2010. In assessing the progress of the athletes, only 48% (16/33) of these teenage medal winning weightlifters improved by more than 10% above their YOG 2010 performance over the following 3 years of competition. On the basis of the high youth drop-out rate and wide-spread performance stagnation that was evident from these medal winning youth athletes, Wilson (2014) proposed:

"It is recommended that the IWF seriously consider changing the weightlifting event at the YOG to a repetitions based competition involving the athletes performing as many lifts as possible with a moderate load (i.e. the athletes bodyweight) in a 20 s period, rather than the 1 maximal lift format that is currently used. It is also recommended that the minimum age requirement for the sport of weightlifting for the Rio Olympic Games 2016 be increased from 14 to 18 years of age to enhance the long-term development of weightlifting athletes, and limit the high rates of athlete dropout and early stagnation experienced by many elite teenage weightlifting athletes." (Wilson, 2014 p 9).

It will be interesting to continue to follow the long-term athlete development of the weightlifting athletes who competed in the 1st and 2nd Youth Olympic Games and see how many of them are still active athletes in the Rio Olympic Games 2016 and Tokyo Olympic Games 2020. In the 1st Youth Olympic Games held in Singapore in August 2010 the weightlifting athletes were required to be between 16 and 17 years of age. Hence at the Rio Olympic Games, August 2016, these same athletes will be between 22 and 23 years of age and should be in the prime physical condition of their lives. It will be interesting to see how much they have improved over this 6-year period and whether lifting such heavy maximal weights in their youth has hindered their future development?

Another way to examine what happens to youth when repeatedly lifting maximal loads is to consider the effects of the sports of Powerlifting and Weightlifting. Byrd et al. (2003) examined the performance and rate of injury in 3 female and 8 male elite junior weightlifters who were training at the USA Weightlifting Development Centre in Louisiana for several years. At the commencement of the program the athletes mean ages were around 13 years of age with the youngest competitor a 9-year-old male. In their first competition, their maximal clean and jerk lifts were on average around 35-kg progressing up to about 85-kg after several years of consistent training using loads that varied from 3 sets of 10 at 60-75% maximum during the general training phase up to 5 sets of 3 reps at 75-90% of maximum during the competition phase. The 9-year-old boy clean and jerked 25 kg in his first competition and after 2 years of consistent training completed a 45-kg lift at 11 years of age. During the competitions maximal loads would be attempted. Byrd et al. (2003) reported that throughout the duration of the study:

"There were 534 lifts in competition, not counting fairly heavy lifts during warm-up, with no injuries that required medical attention and no loss of training time for this population. In addition, for this population there were no injuries in training that required medical attention or that resulted in loss of training time." (Byrd et al., 2003 p 139).

One very important consideration that needs to be considered from this study was the precise nature of the training performed and the high level of expert supervision that was available to the athletes. Technique was the priority with children commencing with wooden sticks and no resistance work was done until there was a clear understanding and progress in technique. The children were steadily progressed in their training with the plan of having each child ready to compete in a local weightlifting event after about two to three months of consistent training.

Similar results have also been reported by Rielly et al. (2002) (cited in Byrd et al. 2003) who followed 20 slightly older weightlifters (mean age 14.6 $\pm$ 1.9 years) for their final 8 weeks of preparation for the US National Junior Weightlifting Championships and reported only 0.9 injuries per 1000 hours of participation. A similar value of 0.8 was reported for weightlifters by Risser et al. (1990). However, the sport of Powerlifting has been reported to have a much higher injury rate of 13.8, with muscle strain to the lower back being the most common reported injury (Brown and Kimball, 1983). The higher incidence of injury in the sport of Powerlifting may well be due to the heavier weights lifted in this sport in comparison to Weightlifting as well as the lack of qualified coaching in the sport of Powerlifting in comparison to Weightlifting. Many individuals can perform the squat, bench press and deadlift exercises with little or no coaching and the technique used in the lifts, especially maximal squats and deadlifts, can be very poor. However, the highly technical nature of the clean and jerk and snatch lifts means that the vast majority of weightlifters have competent coaches to assist them in their training. Of the 98 injuries sustained by the adolescent power lifters in the survey conducted by Brown and Kimball (1983) 50% were to the lower back, 18% to the upper extremity, 17% to the lower extremity and 14% to the trunk. This injury rate value of 13.8 is much higher than that reported for other youth sports.

The Centre for Disease Control (CDC) in the US commissioned a study of the injury rate in high school sport and reported:

"An estimated 1,442,533 injuries occurred among U.S. high school student athletes participating in practices or competitions for the nine sports studied. The overall (i.e., practice and competition) injury rate in all sports combined was 2.44 injuries per 1,000 athlete exposures. Football had the highest injury rate (4.36 injuries per 1,000 athlete exposures) followed by wrestling (2.50), boys' (2.43) and girls' (2.36) soccer, and girls' basketball (2.01). Boys' basketball, volleyball, baseball, and softball each had injury rates of less than 2.0 injuries per 1,000 athlete exposures. In each sport, the injury rate was higher in competition than practice settings." (CDC 2006).

3.1.2. Training with maximal lifts: Anecdotal experience

Published scientific research is generally the gold standard by which information is accepted as legitimate within our society. However, in addition to this data it is also useful to consider the actual first hand experiences of athletes and coaches who have trained intensely with weights throughout their youth and who are prepared to reflect upon their experiences in later life. Such information may well reveal factors that were not present during the early lifting years but emerged later in life. The membership of the ASCA were contacted and asked to briefly relate their first-hand experiences on this matter and one particularly interesting account is summarized below.

Personal Testimony from Dr Greg Wilson
Power lifter Greg Wilson commenced intense weight training at 13 years of age and competed in his first junior (under 20) national Powerlifting championships in 1981 in the 67.5 kg weight class winning the division with a 165-kg squat, 105 kg bench press and a 195-kg deadlift at 15 years of age. Two years later with consistent heavy training in 1983, Greg again won the junior (under 20) National Powerlifting championships in the 90-kg weight class lifting a 235-kg squat, 152.5 kg bench press and 260 kg deadlift at 17 years of age. Later that year Greg herniated his lower spine while deadlifting. The back injury settled down and Greg continued to compete throughout his teenage years, and represented Australia at the world open powerlifting championships in 1987 in Norway placing 5th in the 110-kg class; 3rd in the world junior (under 23) championships held in Luxemburg in 1988 in the 125-kg class; and 2nd in the world junior (under 23) powerlifting championships held in Sweden in the 110-kg class in 1989. He finished his lifting career at the 1990 WA State Powerlifting Championships with a 320-kg squat; 225 kg bench press and 320 kg deadlift in the 110-kg weight class. At this stage, at the age of 24, Greg's body was so riddled with injuries that he no longer competed. Now in his 50's Greg still trains with weights and often has soreness in his lower back, elbows, and knees. He remembers his Powerlifting days with fondness but wishes, with the benefit of hindsight, that he commenced competing in Powerlifting once he had reached skeletal maturity at the age of about 18 years, rather than at 13 years of age. Greg still feels that it is a good idea to train with weights at 13 years of age. but would have been better to do body building type training with lighter weights (60-80% maximum) for more repetitions (6-12) and avoided maximal lifts, especially for the squats and deadlifts. Greg feels such an approach may have avoided many of the injuries that he endured, enabled him to compete for longer in Powerlifting, but still allowed him the benefits of training during the adolescent growth spurt from 15 to 17 years when he experienced the best gains in size and strength throughout his lifting career. Greg also feels that he should have spent more time performing flexibility work during his youth as his body is quite stiff now and is relatively unresponsive to flexibility training at this later time.

Greg has been coaching elite weightlifters in Indonesia for the past 9 years (since 2007) and has regularly trained the national team athletes both for the Youth Olympic Games in 2010 and 2014 and the Beijing 2008, London 2012 and Rio 2016 Olympic Games. Including personally training the multiple Olympic medal winning athletes Eko Yuli Irawan (56 and 62 kg class), Triyatno (62 and 69 kg class) and the Youth Olympic medal winning athlete Dewi Safritri (53 kg class). In reflecting on his own personal experiences as an athlete, and as a coach, Greg recommends the following policies be adopted by national and international weight and power lifting organisations to optimize with long term development of weight and power lifting athletes:

1. For children (6 to 12 years and over 50-year-old athletes): Competitions should only involve bodyweight exercises such as dips, chin ups, inclined sit up, one legged squats, hand stand walk etc. Competitive formats should be like a heptathlon, decathlon or cross-fit competition where various points are awarded for various performances and are totaled at the end. However, no weightlifting or powerlifting movements should be included at this stage and no additional loads included.
2. For youth (13 to 17 years and over 40-year-old athletes): Competitions should include some bodyweight exercises such as hand stand push-ups, chin ups etc. but also include the various Olympic (clean and jerk, snatch) and powerlifts (squat, bench press and deadlift). However, maximal lifts should be avoided and the loads limited to a load that can be performed for at least 6 repetitions. As outlined above, a point system should be developed as used in heptathlon, decathlon or cross-fit competitions. Hence the competition in the Youth Olympic Games and associated qualification and preparation events (e.g. National youth championships etc.) should look much more like a cross-fit competition rather than a standard Olympic weightlifting competition.
3. 18 to 40 years: Athletes should be encouraged to compete in standard Weightlifting and Powerlifting competitions. The minimum age limit for participation in the sport of Weightlifting for National Championships, Regional Championships, the Olympic Games, Olympic qualification competitions and World Championships etc. should be 18 years of age.

3.2. Safely estimating maximal strength

It is the position of the ASCA that young and less experienced, school-aged resistance trainers can have their strength capabilities assessed by performing testing with lighter resistances and performing a "repetitions till fatigue" (RTF) test, from which 1-RM (or any RM up to 20 RM) can be extrapolated with reasonable accuracy (Baker, 2004). The RTF protocol involves performing the maximum number of repetitions of a specified exercise until the exercise can no longer be performed with sound technique. This testing may take place after a certain period has been used to develop sound technique (e.g., 1-4 weeks) but also should only take place if the younger athlete displays sound physical characteristics as proposed by Giles (2006). For example, it would seem futile to assess "squat strength" with any extra barbell resistance in a young athlete who does not possess adequate neuromuscular control in an unloaded version of the exercise.

The RTF testing procedure allows a coach to assess strength by using a standard light resistance (e.g., 40 kg for the bench press for males and 15 kg for females) that all or most athletes use and their individual strength scores are extrapolated based upon how many repetitions are performed with that resistance. If for example, one athlete lifted 40 kg for 9 repetitions then their estimated 1-RM would be 40 x conversion factor of 1.22 = 48.8 kg (see Table 1). If another athlete lifted 40 kg for 12 repetitions, then their 1-RM would be 52.4 kg (40 kg x conversion factor of 1.31 = 52.4 kg) (see Table I for corresponding conversion factors for different repetitions).

When implementing these tests, technique should be emphasized at all times and the test terminated when the athlete cannot maintain proper technique. The table that younger athletes use is different to that for experienced resistance trainers, as younger athletes do not possess the same intramuscular control as more experienced athletes and accordingly, this lack of coordination means they cannot perform well with heavier resistances. Accordingly, for younger athletes, a resistance should be chosen that allows at least eight repetitions, so that emphasis is placed on technique development.

It has been proposed that this type of testing suits younger and school-age athletes because it is more time efficient de-emphasizes the use of heavy weights and the risks accompanying their use for athletes not experienced in heavy lifting, while still allowing for the generation of data concerning athletes' capabilities in key exercises (e.g., Chin-ups, bench press, squat) (Baker, 2004). The extrapolated RM scores can be used to individually determine if each young athlete is lifting resistances appropriate to their strength and neuromuscular control capabilities.

Table I - Guide for determining 1-RM from varying repetitions.

% 1-RM	100	96	94	92	90	88	86	84	82	80
Reps	1	2	3	4	5	6	7	8	9	10
CF	1.0	1.04	1.06	10.8	1.11	1.13	1.16	1.19	1.22	1.25
% 1-RM	78	76	74	72	70	68	66	64	62	60
Reps	11	12	13	14	15	16	17	18	19	20
CF	1.28	1.31	1.35	1.39	1.43	1.47	1.52	1.56	1.61	1.64

Guide for determining 1-RM from varying repetitions performed to maximum effort in novice and younger less experienced resistance trainers performing standard strength exercises. An estimate of 1-RM is made when the weight lifted is multiplied by the conversion factor according to the number of repetitions that were performed with that weight (Table developed by Dr. Dan Baker). Abbreviations: **% 1-RM** = percentage of one-repetition maximum; **Reps** = repetitions; **CF** = conversion factor.

3.3. Position of the ASCA on training intensity

There is an abundance of evidence to suggest that when appropriately performed resistance training is a safe and effective exercise to be engaged by children and youth. However, it would seem prudent for all children and most youth to avoid the performance of maximal lifts, especially maximal deadlifting. It is the Position of the ASCA that the following training loading intensities and exercise selection strategies be adopted when training children and youth:

- *Level 1: 6-9 years of age:* modification of body weight exercises and light resistance (brooms and bands etc.) work only for relatively high repetitions e.g. 15+ reps;
- *Level 2: 9-12 years of age:* 10-15 RM; (maximal loading approximately 60% maximum) using predominantly simple free weight exercises and machine exercises where the machine is an appropriate size for the child.
- *Level 3: 12-15 years of age:* 8-15 RM; (maximal loading approximately 70% maximum) using progressively more free weight exercises but avoiding 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.
- *Level 4: 15-18 years of age:* 6-15 RM; (maximal loading approximately 80% maximum) progressively moving towards an advanced adult program involving split routines, where appropriate, and complex multi-joint movements, provided sound technique has been developed under competent coaching by a coach with at least Level 2 ASCA strength and conditioning accreditation.

The various levels and suggested age brackets will be discussed in more detail in the following section. The above maximal loading percentages relate to strength-based exercises (e.g., bench press) and not to velocity specific exercises such as medicine ball throws where higher percentages may apply. The ASCA **does not advocate the use of one-repetition maximum (1-RM) testing** to determine appropriate training loads or to monitor progression in training for Levels 1-3. Instead the repetitions maximum (RM) method is recommended. For example, with Level

3, 12-15 years of age, the appropriate training load is between 8 to 15 RM. If the individual can perform 15 repetitions using good form with a given load then that load may be increased on subsequent sets. However, if the individual cannot perform 8 repetitions with good form then a lower load is recommended for subsequent sets. One-repetition maximum testing may be appropriate in certain instances where elite young athletes (e.g., swimmers) have a well-developed training background with competent coaching.

4.0. PROGRAM DESIGN AND PROGRESSION

In this section several sample programs will be presented and specific training recommendations be made for various age groups. This has been done to provide the reader with some clear direction in the development of youth resistance training programs. However, it is understood that each athlete is an individual and hence the reader should not necessarily simply use the programs exactly as written but see them as models to be modified, within sensible parameters, to the specific requirements of the individual athlete(s).

4.1. Research studies

Prior to developing specific resistance training programs for youth at various ages, it is useful to examine the effectiveness of the programs employed by researchers when studying youth resistance training. For example, Tsolakis and colleagues (2004) from the University of Athens examined the effects of a 2-month upper body resistance training program on nine 11-13-year-old untrained boys. Over the 2 month period the subjects trained 3 times per week on non-consecutive days performing 6 upper body exercises for 3 sets of 10 RM with a 1 minute rest period between repeated sets and 3 minutes' rest between exercises. The 6 exercises were all performed using variable resistance machines and consisted of supine bench press, wide grip cable pull-downs, biceps curl, triceps extension, seated row and overhead press. Total training time was approximately 1 hour per session and each subject had their 10-RM maximums re-evaluated every 15 days to adjust training loads. No injuries were reported from the training and a few subjects complained of delayed muscle soreness after the initial 3 sessions of training. The training resulted in a 17.5% increase in isometric strength, and 124% increase in resting testosterone levels as measured in blood tests. These increases were significantly greater than that achieved by an age matched control group who did not participate in resistance training.

4.2. Long Term Athlete Development (LTAD)

In designing resistance programs for children the ASCA has been strongly influenced by the work performed by Dr Istvan Balyi (see Balyi, 1999) and Mr. Kelvin Giles on long term athlete development. This work has developed a coherent structured plan for the progressive development of young athletes throughout their maturation process to maximize their sporting abilities while avoiding injury and burn out. Kelvin Giles was the key note presenter at the 2006 ASCA National Conference held on the Gold Coast and presented this topic and his work has been adopted in the development of the Level 2 coaching accreditation course materials for the ASCA.

In essence the process of long term athlete development follows a series of age and function related progressions whereby child athletes perform progressively more complex and intense training as they age and become capable. The ASCA proposes the following stages in the resistance training for children and youth:

- Level 1: 6-9 years of age
- Level 2: 9-12 years of age
- Level 3: 12-15 years of age
- Level 4: 15-18 years of age

The overlap in age between the 4 levels (i.e., a 9-year-old may be in Level 1 or Level 2) reflects the fact that different children will mature at different rates and thus may well progress at various times. Further, in addition to chronological age, the progression between levels is also muscular function dependent. For example, prior to progressing onto Level 2: 9-12 years of age the athlete should be at least 9 years of age and able to:

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 pushups 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.

Hence an 11-year-old just starting out with resistance training would be encouraged to commence in the 6-9 years old category i.e. Level 1 using modified body weight and light resistance exercises only until they can perform the above exercises and then progress to the 9-12-year-old category i.e. Level 2 when this has been achieved. In this way the various categories are age related but also muscular function dependent, with the main emphasis of the training period being the achievement of the set physical competencies for that chronological age group. However, an 8-year-old child who can fulfill all the above functional tests would still be encouraged to continue to perform body weight and light resistance training only until they turn 9 and then progress to Level 2.

Prior to commencing Level 3: 12-15 years of age the athlete should be at least 12 years of age and able to:

1. Satisfy the requirements for Level 2.
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 pull ups with legs out straight using an 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.

Prior to commencing Level 4: 15-18 years of age the athlete should be at least 15 years of age and able to:

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 5 well controlled Nordic hamstring exercise repetitions.
5. Perform 10 well controlled parallel bar dips for boys and 10 bench dips for girls with legs out straight.
6. Perform 10 well controlled chin ups for boys and a 30-s arm hang at 90 degree elbow angle for girls (underhand grip).
7. 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.

The above muscular function performance criteria are based on a “normal” standard sized individual. It is recognized that certain individuals in sports such as basketball or rowing often are exceptionally tall or heavy and thus these individuals may have difficulty performing some of the task (e.g., 10 chin ups) due to their size and in such cases a modified performance criterion would be appropriate.

The ASCA recognizes that resistance training programs are implemented for achieving different outcomes such as improvements in:

1. Body and limb control and joint stability
2. Hypertrophy of muscle and general strength
3. Maximal strength
4. Power and
5. Strength-endurance

It is the ASCA position that children and youth in the first 3 stages (i.e., Levels 1-3) benefit most from programs that improve body/limb control and joint stability. These programs would also inadvertently improve other outcomes (e.g., strength-endurance, general strength) without specific training for those outcomes. With a solid foundation of training emphasizing body/limb/joint control and stability and technical mastery during resistance exercises, athletes entering the fourth stage (i.e. Level 4) may more safely embrace training aimed at improving other resistance training outcomes. Consequently, the sample programs and guidelines provided heavily emphasize this philosophy of LTAD.

4.3. Model Programs

In this section a number of model programs for Levels 1, 2, 3 and 4 will be outlined. It is not intended that these programs be the only programs allowable for children or youth to use and modifications to the programs will be required depending upon the individual characteristics of the children, training goals, available equipment, training time etc. However, model program are developed to serve as useful examples from which individual specific training programs may be developed and employed. It is the position of the ASCA that all programs performed by children must be strictly coached by an adult(s) and that the adult be accredited with at least a Level 1 ASCA Strength and Conditioning coaching accreditation. To coach youth in level 3 and 4 in the more complex lifts, a coaching accreditation of at least a ASCA Level 2 would be required with a preference for such coaches to be moving towards the ASCA Pro Structure. Further, when supervising groups of children the ratio of coaches to children is recommended to be 1 coach for every 10 children and that the children receive comprehensive instruction on relevant safety issues prior to the commencement of training.

4.3.1. Level 1: 6-9 years

As previously outlined Level 1 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. Appropriate programs involve modified body weight type exercises and light resistance work performed for relatively high repetitions eg 15+ reps. The goal over this period is to have the children become accustomed 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. The specific muscular function goals during this period are:

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.

A beginning program would comprise a basic 3 day per week circuit type whole body program performed on alternate days (i.e. Monday, Wednesday and Friday) of the following exercises:

Basic warm up and stretch (5-minute jog or cycle etc. plus 2-3 minutes of light stretching)

1. Step ups (both left and right legs) (quadriceps, hamstring and gluteal muscles) – 20 to 30 cm step or chair
2. Push-ups (pectorals, deltoid and triceps brachia muscles) - off knees initially progressing onto toes as strength increases.
3. Star jumps (quadriceps, adductors, gluteal muscles).
4. Abdominal crunches (abdominals and hip flexors) – as strength increases progress towards bent legged sit ups.
5. Chair dips (triceps brachia muscle) – initially have legs close to the chair and use the legs and arms to raise the body. As strength increases progressively move legs further away from the chair.
6. 90-degree wall sit (quadriceps and gluteal muscles).
7. Reverse back extensions (lower back, gluteal and hamstring muscles) – lying face down with torso over table or bench and lift legs to level of hips hold top position for 1-2 s and repeat.
8. Hover (abdominal, hip flexor and lower back muscles) – initially off knees progressing to toes.

Cool down and stretch – (5 min jog or cycle etc. and 5 minutes of stretching)

Progression:

Week 1: Perform 20 s of each exercise for as many controlled repetitions as possible followed by 40 s rest and then move onto the next exercise. Perform 1 circuit – total workout time approximately 25 minutes (including warm up and cool down). Once this circuit is comfortably achieved by the athlete progress onto stage 2.

Stage 2: Perform 30 s of each exercise for as many controlled repetitions as possible followed by 40 s rest and then move onto the next exercise. Perform 1 circuit – total workout time approximately 27 minutes (including warm up and cool down). Once this circuit is comfortably achieved by the athlete progress onto stage 3

Stage 3: Perform the same as stage 2 but repeat the circuit 2 times – total workout time approximately 38 minutes. Once this circuit is comfortably achieved by the athlete progress onto stage 4.

Stage 4: Perform 2 circuits but increase exercise time to 40 s per exercise with 50 s recovery – total workout time approximately 40 minutes. Once this circuit is comfortably achieved by the athlete progress onto stage 5.

Stage 5: Perform 2 circuits but increase exercise time to 50 s per exercise with 50 s recovery - total workout time approximately 43 minutes. Once this circuit is comfortably achieved by the athlete progress onto stage 6.

Stage 6: Perform 2 circuits but increase exercise time to 60 s per exercise with 60 s recovery - total workout time approximately 47 minutes.

At this stage the athlete can keep the same circuit but try and increase the intensity of some of the exercises. For example, some options include:

- Increasing the step height for the step ups
- Push-ups off toes rather than knees
- Progress from crunches to bent legged sit ups

- Chair dips performed with legs progressively further from the chair
- Hover off toes rather than off knees

Increase the intensity progressively by gradually including these changes. For example, initially the first 30 s of the hover may be performed off the toes with the remaining time off the knees etc. Conversely, there may be some particularly heavy children who are unable to perform 20 s of push-ups off their knees and for these children modifications such as the performance of push up off a wall or bench will be initially more appropriate.

Over time, with continued adaptation, additional exercises may be added or substituted such as:

- Lying pull ups performed from under a small table or off a low bar (e.g., smith machine bar)
- Isolated DB exercises such as DB arm curls, triceps kickback, lateral raises
- Lunges
- DB Squats
- Normal back extensions instead of reverse back extension

However, in all cases **workouts should be limited to 3 whole body routines per week performed on alternate days for a duration not exceeding 1 hour in total**. Hence towards the end of the Level 1 period a typical program may involve the following exercises:

Basic warm-up and stretch – 5 minutes

1. Step Ups (both left and right legs) (quadriceps, hamstring and gluteal muscles)
2. Push Ups (off toes) (pectorals, deltoid and triceps brachia muscles)
3. Star Jumps (quadriceps, adductors, gluteal muscles)
4. Sit Ups (abdominal and hip flexor muscles)
5. Lunges (both left and right legs) (quadriceps, hamstring, gluteal muscles)
6. Pull Ups (upper back and biceps)
7. Standing Squats with light (2-3 kg) DB (quadriceps and gluteal muscles)
8. Chair Dips (triceps brachia muscle)
9. Back Extensions (lower back, gluteal and hamstring muscles)
10. Hover (abdominal, hip flexor and lower back muscles)

Cool down and stretch – 10 minutes

60 s work and 60 s rest for 2 circuits – total workout time approximately 60 minutes.

There are many variations that could be done to the above program. The use of time rather than a prescribed repetition number has been employed as it is often easier to co-ordinate and focus children, especially when in a small group, to a time of exercise rather than a repetition number and have them focus on performing controlled repetitions rather than rush to get to a particular repetition number. Further, the above programs have been developed with minimal equipment requirements so that they may be adopted by the greatest number of children who may not have access to specialized resistance training equipment and can perform the exercises from home, at a local park or sporting club in the school class room.

4.3.2. Level 2: 9-12 years

At level 2 the programs begin to incorporate some free weights and machine weight exercises as well as body weight activities. Again, it is essential that the programs adopted be strictly supervised by an adult with at least a Level 1 ASCA Strength and Conditioning accreditation and the machines used be an appropriate size for the children. A beginning program for level 2 would comprise a basic 3 day per week whole body program performed on alternate days (i.e., Monday, Wednesday and Friday) of the following exercises:

Basic warm up and stretch (5-minute jog or cycle plus 2-3 minutes of light stretching)

1. Lunges (initially using body weight but progressing to include light dumbbells when appropriate)
2. Machine Leg Press
3. Barbell Bench Press
4. Wide Grip Lat Pulldown to the Front
5. Dumbbell Row
6. Back Extensions
7. Triceps Pushdown
8. Dumbbell Arm Curl
9. Hanging Knee Raises

Cool down and stretch – 10 minutes

The repetition range is between 10 to 15-RM with a maximal loading of 60% of the 1-RM. Initially the program should commence with 1 set of each exercise with 1-2 minutes' rest between sets, progressively building up to 3 repeated sets as the child advances and can readily tolerate the increased training volume.

The goal of the program is to progressively develop the physical capacities of the children to be capable of achieving the following list of physical competencies at the age of 12:

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 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.

4.3.3. Level 3: 12-15 years

At level 3 the programs 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 the programs adopted be strictly supervised by an adult with at least a Level 1 ASCA Strength and Conditioning accreditation and the equipment used be an appropriate size for the children.

A beginning program for level 3 would comprise a basic 3 day per week whole body program performed on alternate days (i.e., Monday, Wednesday and Friday) of the following exercises:

Basic warm up and stretch (5-minute jog or cycle etc. plus 2-3 minutes of light stretching)

1. Front barbell squats
2. Step ups holding dumbbells
3. Barbell bench press
4. Chin ups – initially using a close grip and restricted range of motion but progressing to a full range of motion as strength develops
5. Back extensions – with a 2-s pause at top
6. Hanging leg raises or Inclined sit ups
7. DB seated overhead press
8. Parallel bar dips or Bench dips if not sufficiently strong to perform 8 repetitions.
9. Hover – Circuit: 60 s 2 arms to front and 30 s 1 arm each side
10. Barbell Arm Curls

Cool down and stretch – 10 minutes

The repetition range is between 8 to 15-RM with a maximal loading of 70% of the 1-RM. Initially the program should commence with 2 sets of each exercise with 1-2 minutes' rest between sets, progressively building up to 4 repeated sets as the youth advances and can readily tolerate the increased training volume. Towards the end of level 3 the youth may start employing pyramid loading where the loading can be increased on subsequent sets with a lighter drop set employed for the final set.

For youth wishing to pursue a sporting career in a strength or power based sport such as any of the rugby or football codes, track and field, swimming etc it is recommended that during this level the inclusion of some of the more complex and/or explosive exercises such as clean and press, squats, and deadlifts into the program be commenced and that competent instruction from a strength and conditioning coach with at least Level 2 accreditation be employed to instruct the athlete.

The goal of the program is to progressively develop the physical capacities of the children to be capable of achieving the following list of physical competencies at the age of 15:

1. Satisfy the requirements for Levels 1 and 2.
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 5 well controlled Nordic Hamstring exercise repetitions.
5. Perform 10 well controlled parallel bar dips for boys and 10 bench dips for girls with legs out straight.

6. Perform 10 well controlled chin ups for boys and a 30-s arm hang at 90 degree elbow angle for girls (underhand grip).
7. 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.

4.3.4. Level 4: 15-18 years

At level 4 the programs are progressively moving towards an advanced adult program involving split routines where appropriate and complex multi-joint movements provided sound technique has been developed under competent coaching by a coach with at least Level 2 ASCA strength and conditioning accreditation. The repetition range is between 6 to 15 RM with a maximal loading of 80% of the 1 RM.

A beginning program for level 4 would comprise a basic 3 day per week whole body program performed on alternate days (i.e. Monday, Wednesday and Friday) of the following exercises:

Warm up – 10 mins on bike

1. Major chest exercise (Bench press, Incline bench press or DB press)
2. Overhead shoulder press (Clean and press, Standing military press or Seated press behind neck)
3. Upper back exercise (Chins, Lat pull or DB pullover)
4. Triceps (Dips, Lying triceps extension or Triceps pushdown etc.)
5. Major leg exercise (Squat, Leg press or Hack squat)
6. Lower back exercise (Deadlift or Back extension)
7. Hanging leg raise (holding light 1-3 kg medicine ball between legs when strong enough)
8. Major bicep exercise (Standing DB curls, EZ curls or Preacher curls)
9. Inclined sit ups or Hover circuit
10. Calf raises

Cool down and Stretch – 10 mins

Should change specific exercises throughout the week:

- Monday and Friday perform Barbell Bench Press, Wed Inclined Bench Press
- Monday Clean and Press, Wednesday Standing military press, Friday Press behind neck
- Monday Chins, Wednesday DB Pullover, Friday Lat pulldown
- Monday Squat, Wednesday Leg Press, Friday Hack Squat
- Monday and Friday Deadlift, Wednesday Back Extension etc.

The repetition range is between 6 to 15-RM with a maximal loading of 80% of the 1-RM. The program should consist of 3-4 sets of each exercise with 2-3 minutes' rest between major exercise such as clean and press, squats, deadlifts and 1-2 minutes' rest between sets for more basic exercises such as back extensions, sit ups etc. The youth is encouraged to employ pyramid loading techniques where the loading can be increased on subsequent sets with a lighter drop set employed for the final set. For youth wishing to increase training intensity, muscle strength and size and move towards a split routine towards the end of Level 4, the following training recommendations are provided:

2 Way Split Routine: After 12 months on the above whole body program the individual may choose to up the intensity and volume and move to a 2-way split routine. This involves splitting the body in 2 and performing each workout 2 times per week, thus 4 workouts per week. The ASCA preferred way to achieve this is to split the body into:

Day 1: Upper Body (Chest, Shoulders, Triceps, Upper Back and Biceps): Monday and Friday.
Day 2: Lower Body (Legs, Lower Back and Stomach): Wednesday and Saturday

However, there are other methods to achieve this, for example push : pull split routines. By splitting the body in two, more exercises can be performed per session and a more intense workout per body part achieved with longer to recover prior to the next training session.

Example of 2 Way Split Routine

Monday and Friday - Upper Body (Chest, Shoulders, Triceps, Upper Back and Biceps)

Warm up – 10 mins on bike

1. Bench press
2. Inclined bench press or DB Flies
3. Standing push press
4. DB Lateral raises or Rear deltoid exercise
5. Chin Ups
6. DB Pullovers or Bench pull
7. Dips
8. Lying Triceps Extension
9. DB Twist and Turn Biceps Curls

Cool down – 10 mins stretching

- 3-4 sets of 6-15 reps with about 1-3 minutes' rest between sets.

Wednesday and Saturday - Lower Body (Legs, Lower Back and Stomach):

Warm up – 10 mins on bike

1. Squats
2. Deadlifts or Cleans
3. Leg press
4. DB lunges
5. Leg Curls
6. Back Extensions with additional loading
7. Calf Raises
8. Russian twists with medicine ball or Inclined sit ups with rotation
9. Hanging leg raises with light medicine ball between legs

Cool down – 10 mins stretching

- 3-4 sets of 6-15 reps with about 1-3 minutes' rest between sets.

At this stage the athlete should be adopting periodization techniques for the major lifts (i.e. bench press, squats, cleans etc) with their resistance training to coincide with their sporting program. For example, if the athlete was simply interested in getting basically big and strong during a 12-week off-season program the following linear periodization loading strategy may be of use:

1. 4 weeks of high volume and low intensity training performing 4 sets of 15-RM loads per exercise – followed by:
2. 4 week of moderate volume and intensity training performing 4 sets of 10-RM loads per exercise – followed by:
3. 4 weeks of low volume and high intensity training performing 4 sets of 6-RM loads per exercise.

At the end of the 12 week period the program could return to the 15 RM loads, hopefully with the athlete considerably bigger and stronger then when they commenced the 12-week program.

4.4. Sample programs from ACSA members

ASCA membership (Dr Daniel Baker, Julian Jones, Sean Burns and Roger Mandic) and professional bodies (Basketball Australia; Queensland Academy of Sport), have provided resistance training programs for youth participating in different sports and these programs have been appended to the Position Stand (Appendix 1).

5.0. INJURIES ASSOCIATED WITH RESISTANCE TRAINING: HOW THEY ARE CAUSED AND PREVENTION STRATEGIES

5.1. Prevalence, severity and types of injuries

One method to determine the prevalence, severity and types of injuries that occur when performing resistance training is from data available from the US National Electronic Injury Surveillance System (NEISS) which is a national probability sample of hospitals in the U.S. and its territories (see http://www.cpsc.gov/cgibin/NEISSQuery/Home.aspx). This web site allows an individual to enter an activity (e.g. such as Weight lifting [activity, apparel or equipment], code 3265; Exercise Equipment [excluding weightlifting and gymnastic equipment], code 3277; Exercise Activity without equipment, code 3299) for various age groups and determine the number of times individuals presented to hospital emergencies departments, the outcomes from the presentation (e.g., admitted, treated and released, deceased etc.), and the reason for the accident (e.g., weight dropped on toe, hurt back while lifting etc.). It really is a remarkable resource and available free of charge courtesy of the US government. Unfortunately, no such data is freely available for Australia. However, in considering the US data in an Australian context it is worth remembering that at the time of updating this Position Stand the US population was approximately 323 million or 13.5 times greater than the approximate 24 million Australian population.

If age is limited from 6 to 17 years for the year 2014 and 3265 entered for the product code (i.e. Weight lifting) the system records some 555 presentations at emergencies departments in the sample which is estimated to represent 19,339 presentations across the US as a whole. Of these presentations about 97% were simply seen or treated and released not requiring hospital admission. However, of the 555 presentations 8 children died, 4 were hospitalized, 5 were held for observation and 2 were treated and transferred. Approximately 27% of the injuries were sustained at school, while about 14% occurred in the home and about 19% occurred at a sport or recreational place.

In examining the region of the body most likely to be injured in the 6 to 17-year age range from such individuals presenting to hospitals from weight lifting injuries, the following regions were identified:

- Lower Trunk 2469 (13%)
- Foot 2389 (12%)
- Finger 2355 (12%)
- Toe 1906 (10%)
- Shoulder 1527 (8%)
- Head 49 of the 555 hospital presentations (9%) [population estimate not provided]

In examining the injuries that occur to different age groupings it is apparent that the amount and type of injuries that are sustained vary with different ages. In the 6-9-year age category there were 50 cases of hospital presentations in the sample from weight lifting which corresponded to a population estimate of 1,491 for the U.S. as a whole. For the 10-13-year age category there were 89 cases of hospital presentations from weight lifting which corresponded to a population estimate of 3,263 for the U.S. as a whole. For the 14-17-year age category there were 416 cases of hospital presentations from weight lifting which corresponded to a population estimate of 14,585 for the U.S. as a whole. For each hospital presentation there is a brief write up of the narrative of the cause of the injury. If the first 30 narratives are examined for each of the age categories mentioned above an indication of the dominant causes of injury for the various age groupings is revealed (see Tables II, III and IV).

Table II – First 30 case narratives of cause of hospital presentation for 6-9-year age grouping in weight lifting category from the NEISS for 2014.

Case #	Narrative provided by the NEISS
1	6-year-old male hurt thumb with dumbbell; fractured finger
2	9-year-old male with laceration to hand from weight falling on it
3	6-year-old had a 20lb weight fall on big toe; toe contusion
4	8-year-old female dropped weight on finger; finger fracture.
5	7-year-old female sibling dropped weight on patient: laceration forehead.
6	8-year-old male dropped some weights on his thumb; he pulled the pin out of the weight machine 15 pounds dropped
7	7-year-old female sibling dropped a 2.5-pound weight onto head closed head injury.
8	8-year-old female accidentally dropped 3lb weight onto foot, contusions.
9	8-year-old male was in karate class, had headgear on walked into the weight room hit face on weights now bleeding near eye. Laceration near eye.
10	8-year-old male dropped dumbbell weights on thumb; thumb laceration and fracture.
11	6-year-old female dropped a 12-pound weight on left foot at home, left foot contusion.
12	7-year-old male hit head on barbell. Head injury.
13	9-year-old male dropped 25lb weight on finger; fingertip amputation.
14	8-year-old dropped weight on ankle and sustained a contusion.
15	7-year-old male was playing with his dog & dog jumped on him, he fell onto some metal weight lifting plates sustaining a laceration to right ear.
16	7-year-old male patient reports someone drop a 5lb dumbbell on his head, dizzy.
17	6-year-old female playing in basement at babysitter's & 10lbs weight fell & hit forehead; forehead laceration.
18	7-year-old male sibling dropped a 5-pound dumbbell on forehead in their room; forehead laceration.
19	6-year-old female mashed thumb between weights; Crush injury thumb.
20	8-year-old male dropped a 5-pound dumbbell onto toe; contusion to toe.
21	6-year-old male, 5lb weight landed on finger: fractured finger.
22	9-year-old female dropped a medium sized weight on foot; foot injury.
23	7-year-old male admitted to hospital after hitting head on a dumbbell weight in garage at home.
24	9-year-old female lifting weights and hurt finger; fractured finger.
25	6-year-old female was making blanket fort when 5lb dumbbell on couch fell on her: closed head injury.
26	6-year-old male, 2 days ago, injured right index finger with a weight. Weight was slammed down on fingernail/ right index finger nail avulsion.
27	5 lb. dumbbell fell from bed hitting patient on head; forehead laceration.
28	7-year-old male 15 lbs. barbell rolled off dresser onto head; diagnosis scalp laceration.
29	Eyebrow laceration. 7-year-old male patient was engaging in gymnastics & another child dropped 2lb weight into patient's striking forehead/eyebrow.
30	7-year-old female fell off weight bench; fractured clavicle.

Abbreviations: **NEISS** = National Electronic Injury Surveillance System.

Table III – First 30 case narratives of cause of hospital presentation for 10-13-year age grouping in weight lifting category from the NEISS for 2014.

Case #	Narrative provided by the NEISS
1	12-year-old male: foot pain, tripped on dumbbell, fell down 1 step at home.
2	13-year-old male complained of pain in the upper back after lifting weights at school Diagnosis: musculoskeletal pain.
3	13-year-old male accidentally dropped 45lb weight on top of foot: contusions.
4	11-year-old male hit a weight with 2nd digit of foot; complained of pain: diagnosis contusion foot.
5	13-year-old female lifting weights and strained lower back.
6	13-year-old male complained of pain to his right wrist, injured when he was lifting weight and dropped the weight. Diagnosis: wrist sprain.
7	13-year-old male lifting weights; diagnosis forearm strain.
8	12 year old male with trauma to chest from dropping weights on himself.
9	12-year-old male with sprained chest wall from weightlifting.
10	12-year-old male was accidentally hit by a weight in school.
11	10-year-old female stubbed toe on weight lifting equipment at home; diagnosis contusion left 3rd toe.
12	10-year-old female with contusion to chin after hitting it on a weight after tripping over sister.
13	11-year-old female was picking up an exercise weight off the rack and her right hand got Stuck: diagnosis hand contusion
14	12-year-old female strained left upper arm lifting weights at school on Monday.
15	12-year-old female shopping when 40lb weight fell from a shelf landing onto toe: crushing injury.
16	11-year-old male tripped & fell, hit head on weight bench, getting nauseated & dizzy at school.
17	10-year-old male with injury to elbow after brother threw an 8 or 10-pound weight at him.
18	10-year-old female dropped a weight on finger. Diagnosis laceration.
19	12-year-old male in football conditioning, has been lifting weights, now with swollen & painful testicles; scrotal swelling.
20	13-year-old male drop weight on finger; lacerated finger.
21	13-year-old male caught finger between dumbbells; diagnosis partial amputation finger.
22	12-year-old female accidentally struck mouth against weights stack; diagnosis lip laceration
23	13-year-old male hurt during weight lifting; diagnosis sprained upper back.
24	Diagnosis head laceration; 12-year-old male, Dad left weights in the living room patient went to lay back on the floor & hit head on weight; laceration to scalp.
25	11-year-old male stubbed toe on a kettle ball weight. diagnosis toe contusion.
26	10-year-old male hit self in head lifting weights at home; diagnosis: scalp abrasion.
27	13-year-old male started weight lifting for football this week, now with chest pain.
28	12-year-old male complaining of injuring hand at school while weight lifting; diagnosis hand contusion.
29	13-year-old male lifting weights and hurt neck; diagnosis neck strain.
30	12-year-old male dropped a dumbbell onto toe; diagnosis fractured toe.

Abbreviations: **NEISS** = National Electronic Injury Surveillance System.

Table IV – First 30 case narratives of cause of hospital presentation for 14-17-year age grouping in weight lifting category from the NEISS for 2014.

Case #	Narrative provided by the NEISS
1	15-year-old male swinging a kettlebell between legs hit right knee sustaining a contusion, was at a gym.
2	16-year-old female dropped a 50-lb. weight on her finger. diagnosis: contusion finger.
3	16-year-old male weight lifting dropped weight on foot; contusion foot.
4	17-year-old strained neck when lifting weights using barbell squatting, leaned forward too much and bar came onto her neck.
5	17-year-old male developed sudden headache while lifting weights at gym; diagnosis acute headache.
6	16-year-old male at school and dropped a 45lb weight onto his left foot sustaining a contusion.
7	15-year-old female dropped weight on hand diagnosis: contusion hand.
8	16-year-old male complained of upper trunk pain due to his spotter dropping the weights on him while at school in the gym diagnosis: chest wall contusion.
9	15-year-old male felt a pop in his elbow after lifting 30 lb. weights. diagnosis: fractured elbow.
10	17-year-old male at the gym with friend lifting weights, friend dropped weight bar on finger; diagnosis: finger fracture.
11	16-year-old male complained of pain to back when lifting weights 3 days prior at the gym. Diagnosis: back sprain.
12	15-year-old male pain to right foot when 45lb weight fell on foot in gym class. Diagnosis: foot contusion.
13	17-year-old male lying on back hit frontal scalp with weight.
14	16-year-old male injured shoulder lifting weights, sprain rotator cuff.
15	17-year-old male strained elbow lifting weights at home.
16	14-year-old male crushed 5th finger with a weight while lifting weights at practice; diagnosis: finger fracture.
17	15-year-old male with 3 cm laceration, nailbed avulsion and reimplantation: Finger got caught between 2 metal weights while placing them in rack, lacerated finger.
18	17-year-old male, complained of pain in right arm that started while lifting a 50-lb. dumbbell last night; diagnosis bicep muscular strain.
19	17-year-old male was lifting weights & had to jerk to keep the weights up & is complaining of back pain; diagnosis: back pain.
20	16-year-old male foot contusion, at the gym lifting weights when someone dropped a 2lb weight on his foot.
21	17-year-old male with abdominal pain while weight lifting & working out every 1-2 days, having muscle weakness; rhabdomyolysis.
22	16-year-old female lifting weights; diagnosis: strained lower back.
23	17-year-old male hurt back lifting weights and playing soccer; diagnosis: sprained lower back.
24	15-year-old male was lifting weights and dropped a 20-pound weight onto right foot; diagnosis: contusion to foot.
25	17-year-old male patient complained of scalp laceration. He accidentally hit his head on a metal plate during his weight training class at school 2cm laceration: Diagnosis: head laceration.
26	16-year-old female states weight fell on finger; diagnosis: contusion to finger.
27	17-year-old male was weightlifting at the gym and strained wrist.
28	17-year-old male dropped 200 lb. weight on chest; diagnosis: contused chest.
29	14-year-old male lifting weights, heard pop in hip; diagnosis: strained hip.
30	15-year-old male was weight lifting in gym class & came up from a squat & felt a pull in his back; pain to lower back. Diagnosis: low back pain.

Abbreviations: **NEISS** = National Electronic Injury Surveillance System.

It is interesting to read through the reasons for the injuries. From a quick read there are quite a few very basic types of reoccurring themes e.g. dropped weight on foot, finger or toes, bumped head on bar or fell over lifting weights etc. as well as strained back, shoulder or abdomen when lifting etc. In reading through the details of individual cases it reveals that in order to significantly reduce injuries to children in the weight room that more attention to basic safety issues such as putting weights and dumbbells safely away, using collars, basic training on loading and unloading bars, appropriate handling and storing of dumbbells, bars, plates and collars, strict supervision of children in weights area etc. may well be of greater importance than instruction on lifting technique, especially for younger children (i.e. 6-13 year olds). The adherence to such basic safety issues should be particularly emphasized in the school and at home where most of these injuries occur. It should be understood that the weights area is a very dangerous location for young children, full of heavy objects that are very hard when collided with and easy to fall over, bump into and drop on little fingers and toes. Strict supervision of such areas is strongly recommended and avoidance of such areas by young children when such supervision is unavailable an absolute must. The injury data tends to suggest that most reported injuries occurred through inadequate instruction in basic lifting safety factors, poor supervision and quite often through lifting at home without any supervision. The obvious remedy to these injuries is to have the training performed under the supervision of qualified strength and conditioning professionals in a suitable training environment.

While this Position Stand is directed at children it should also be pointed out that several fatalities have occurred when adults perform weight training, particularly when training alone at home. Faigenbaum (2002) stated that:

"During a 1-year period, 11 adult men died of asphyxia caused by barbell compression of the neck or chest as they performed heavy bench presses at home without a spotter (Lombardi, 1995), and a similar accident occurred in a 9-year-old boy (George, Stakiw & Wright, 1989)." (Faigenbaum, 2002 p 34).

The bench press is arguably the most popular of all weight training exercises. It requires the use of competent spotters. One factor associated with serious injuries from the bench press exercise is the tendency for many experienced lifters to adopt a false grip, whereby the thumb is placed behind the bar rather than secured firmly around the bar. The use of a false grip is quite prevalent amongst experienced trainers and greatly increases the likelihood of the bar slipping out of the hands while bench pressing. The bar may be slippery due to oils produced from the sebaceous glands of the skin and also many bars may have slight bends within them caused by the use of heavy loads over time and when lifted may tend to roll slightly in the hand which may cause the bar to fall out of the hand if a false grip is being used. If the bar does come out of the hands towards the top of the lift it can fall directly onto the neck resulting in instant death. Even if a competent spotter is present there is nothing that they can do to prevent a falling bar crushing the neck or ribs as it comes out of the hand. There is simply not enough time to act and the bar develops too much momentum as it falls to effectively stop it prior to collision with the body.

Thus it is the position of the ASCA that when bench pressing or performing any other similar exercise where the bar is lifted above the body that a regular grip be adopted whereby the thumb is securely wrapped around the bar and that a false grip not be employed in any circumstance. Further, when performing the bench press it is essential that a competent spotter is used. It would be highly desirable if strength and conditioning coaches could teach the importance of the use of a spotter and the adoption of a normal grip when bench pressing to young weight trainers to avoid the adoption of a false grip or the performance of unspotted lifts.

5.2. Appropriate lifting technique to minimise lower back injuries

As children progress through to the teenage years the number of lower back injuries from weight lifting tends to increase to a greater extent and appropriate instruction in lifting technique becomes increasingly important. In the Keynote Lecture for the International Society of Biomechanics entitled "The biomechanics of low back injury: implications on current practice in industry and the clinic", Dr Stuart McGill (1997) presented a diagram of two different dead lifting techniques that clearly demonstrated that the optimal back posture while lifting is the normal lumbar curve that is present while standing erect (Figure 1). Many individuals believe that the lower back should be flat or straight while lifting. However, the lower back area has a natural inward lumbar curve and is most effective in this natural posture. McGill's (1997) research clearly demonstrated that when adopting this natural lumbar curve when lifting the musculature of the lower back and abdominals are highly activated. This serves to take much of the load off the lower back ligaments and greatly reduces the net shearing forces on the spine. When this back position is not adopted and the lifter's lower back flexes forward the musculature of the lower back and abdominals cannot effectively function and this places much higher shearing forces on the ligaments and spine, increasing the likelihood of damage to these vital structures.

Hence the need to adopt a normal curve in the lower back region while lifting is of great importance and this body posture should be mastered early in an athlete's weight training career. This body posture is often quite difficult to initially achieve when lifting and requires considerable practice and feedback from competent strength and conditioning coaches. For many individuals, it involves scooping the lower back in, pushing the backside out, keeping the chest forward, shoulders back and head slightly up. The use of mirrors and video feedback can be very useful in developing the correct posture. This normal lumbar curve posture is vital to adopt in any back supported exercise such as dead lift, squats, bent over row etc. It is important that the posture is mastered using initially light loads, but often the technique breaks down with heavier loads so one must be diligent in examining and mastering lifting technique across a range of loads and training backgrounds.

It is quite common to see experienced lifters performing heavy deadlifts with clearly poor technique involving a forwardly flexed lower back posture and for these lifters to be quite resistant to modifying the technique they have used for a long period. Often the lifter may claim that they have used the technique without any injury problems for many years so what's the problem? However, it is important to realize that most lifting injuries do not occur from a one-off lifting event. They tend to occur as a consequence of inappropriate lifting techniques and excessive training loads and practices etc. over a relatively long period of time. Over time poor technique tends to wear the back down and the lifter becomes increasingly susceptible to injury. Quite commonly the injury may occur when doing some relatively simple task around the house or at work. However, the years of incorrect lifting technique have progressively weakened the structures to the point when they may become seriously injured from a simple task such as picking up a small child, bending over to pick up a pencil etc. Thus, the need for good lifting technique is an absolute must and should be ingrained in the young athlete very early in the training process.

As a final thought from the research of McGill (1997), it is clear that strong muscular action from the abdominals and lower back muscles can significantly serve to reduce dangerous shear forces on the spine. Hence training of the vital musculature of the abdominals and lower back should be a fundamental aspect to all training programs for children and youth through all phases of the training process.

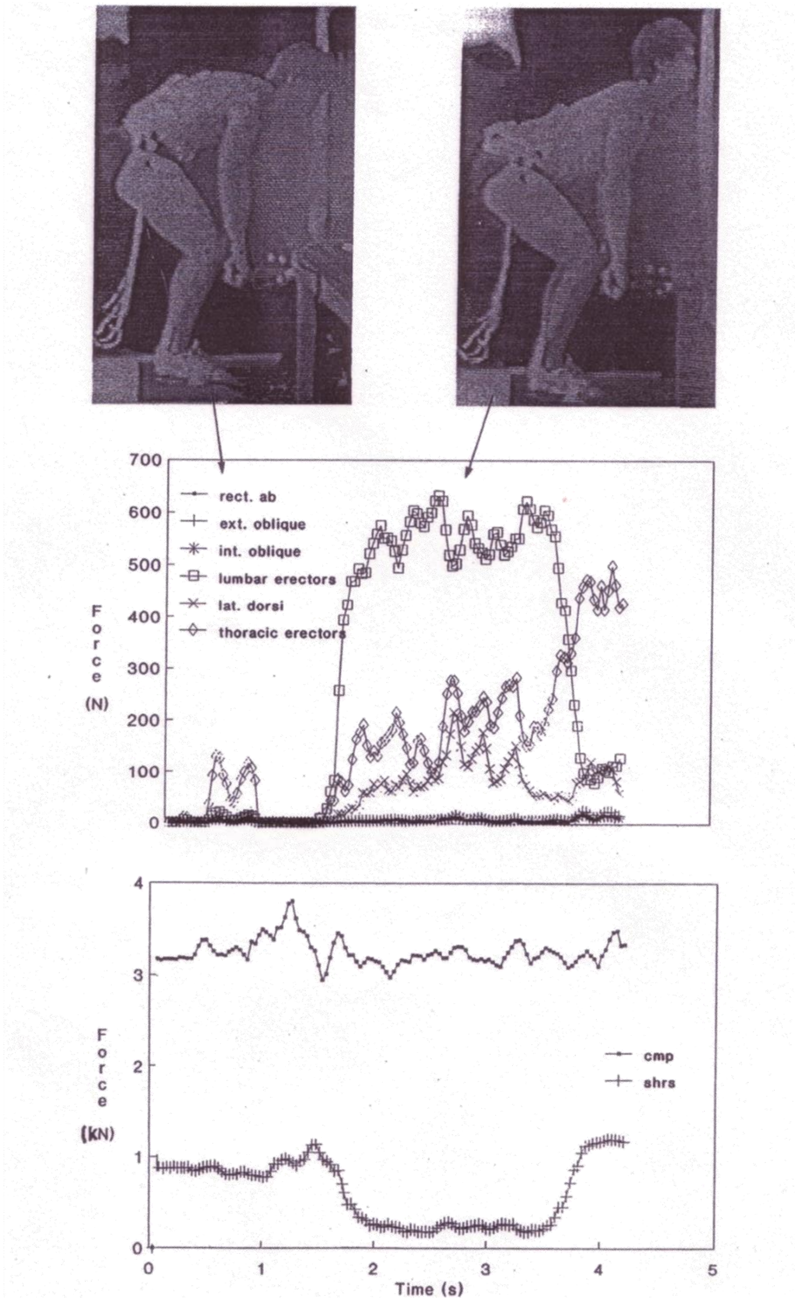

Figure 1 - Lower back posture while deadlifting using a natural lumbar curve (right figure) and a forwardly flexed spine (left figure) and their associated muscular activities and forces (from McGill 1997 p 471).

5.3. The use of resistance training to prevent sports-related injuries

When considering the injuries that do occur from resistance training one can easily forget that when performed correctly with appropriate training loadings, programs, volumes, correct technique and appropriate supervision the reality is that resistance training is a relatively safe activity. As previously outlined in section 2, in comparison to many other sports and recreational pursuits resistance training (apart from competitive powerlifting) could not be classified as particularly dangerous or claimed to have a high rate of injury. Further, when properly applied, resistance training can favorably enhance the strength of the musculo-skeletal system and has been shown to reduce the rate of sports-related injuries (Cahill and Griffin, 1978; Hejna et al., 1982; Hewett et al., 1999; Heidt et al., 2000). Each of these studies has shown that the performance of a preseason and/or in season conditioning program that included resistance training significantly reduced the incidence of sports-related injuries. The differences reported in the studies were often quite dramatic. For example, in the study by Hewett et al. (1999) a 6-week conditioning program on high school female athletes decreased the incidence of serious knee injuries from 10 in the control (non-conditioning group) to only 2 serious knee injuries in the group who had performed the 6-week conditioning program.

5.4. Legal cases involving resistance training and children

In considering the use of resistance training with children it is useful to examine legal cases that have involved children being injured in a weight room. Such cases are available from the Australian Legal Information Institute, which is a joint facility of the University of Technology Sydney and the University of New South Wales Faculties of Law (web site www.austlii.edu.au). One such case is Cullen v Tathem (2000), which was heard in the Queensland District Court, order made 30 June 2000. Andrea Cullen injured her thumb in squat machine just prior to her 17th birthday and sued the manager of the fitness centre, Ms Tathem, for failure to supervise or provide safety-warning signs. The gym was part of a squash centre requiring a $4 entry fee and was not supervised.

On January 21st 1997 Andrea Cullen decided to use the squat machine for the first time in the Willows Squash and Fitness Centre, Kitchener Street Toowoomba. The weights were lifted by a lever which moved the weights up and down and the weight was lifted by pressing the shoulders up against the shoulder pads, and the amount of the weight to be lifted depended on the adjustment of the pin in the pin bar. It is accepted that, on that day, Miss Cullen hurt her right thumb while using the squat machine. Some part of the machine fell onto the top of her thumb, breaking the bone at the end of her thumb and splitting the skin alongside the nail. There was a bruise under the nail. According to court documents the injury happened in the following manner:

"She arrived with all the weights together in their stack, but with the pin bar partly drawn out of the stack, and held up by the pin which had been inserted at about the 42-kilogram mark. That is, the machine had been left in that position by a previous user who wanted the pin at the 42-kilogram mark, but with the shoulder pads higher than they would be if the lever were resting against the top of the weight stack. She lifted the weight. Wanting to reduce the weight, she bent over, placing her right hand on the stack of weights, and her left hand on the pin. On pulling the pin out, the weight of the lever and the white-painted plate attached to it fell, crushing her thumb."

The court found in favour of Miss Cullen awarding her damages of $11,789.00. In determining liability, the court documents revealed the following information:

"That danger might have been addressed by some instruction to a beginner, or by a warning notice on the equipment. That was not done. The defendant had to take into account that not all users were familiar with all the equipment. Whether or not such instruction or warning notice would have made a difference, is a hypothetical question. The answer is that it would probably have done so. This injury was probably caused by Miss Cullen's inadvertence or thoughtlessness in pulling out the pin when she should have realised that it was holding up a considerable weight at the time. The chances are that instruction, or a written warning, would have substantially reduced the risk that she would have done such a thing. Some instruction or a warning appears to be a reasonable and manageable response to that risk. It follows that the defendant is liable to compensate Miss Cullen for her injuries."

This case is interesting in that it clearly demonstrates that children cannot be expected to have common sense in a gym setting and that they require instruction and supervision. It is perhaps a little hard to believe that anyone would actually place one hand underneath a weight stack and then use the other hand to pull the pin out that holds the weight stack up not realizing that the weight stack was going to squash the hand placed underneath it. However, this is apparently what happened and the legal system then holds Ms Tathem, the proprietor of the Squash and Fitness Centre liable for this event. Ms Tathem had a duty of care to provide instruction for Miss Cullen or at the very least a warning sign that presumably would have stated something like "Don't remove weight pins while lifting." The requirement to provide clear instruction and adequate supervision for children in a weights room is an obvious implication from this case as is the understanding that children can do silly things when in a gym and when they do these silly things the coach and/or proprietor may well be legally liable for them.

6.0. NUTRITION AND RECOVERY STRATEGIES FOR CHILDREN AND YOUTH

In this section a review of literature examines the effectiveness of recovery methods aimed at enhancing the acute and chronic training response in children and youth. Specifically, the application of recovery methods such as cold water immersion (ice baths), contrast water immersion (hot / cold water), active recovery methods, nutritional supplements and ergogenic aids will be outlined as it relates to enhancing training effectiveness.

6.1. Nutritional Strategies

Nutrition is an essential component of any training program and is especially important to the acute training responses and adaptation of children and youth. Young athletes have unique nutritional needs, as several interactions occur between nutrient intake, growth and development, optimal performance, avoidance of injury and health problems associated with nutritional deficiencies (Petrie et al. 2004). Furthermore, with a desire for improved sports performance, adolescent athletes may feel undue pressure to use nutritional supplements in the quest for performance enhancement (Metzl 1999). The following sections outline nutritional strategies aimed at enhancing training effectiveness in children and youth, as well as the use of nutritional supplements and ergogenic aids.

6.1.1. Nutritional needs of children and youth

One major concern is the ability of young athletes to avoid energy and nutrient imbalances. In reviewing energy and nutrient intakes of young athletes, Thompson (1998 p165) reported that many young athletes self-report energy, carbohydrate, and select micronutrient intakes lower than recommended dietary allowances (RDA). This may create an inadequate nutritional environment for young athletes with potential consequences including poor bone health, fatigue, limited recovery from injuries, menstrual dysfunction in female athletes, and ultimately poor performance. A paper published in the Journal of School Nursing further highlights the importance nutrition in children and adolescent athletes:

"For the child athlete, energy intake should be high enough to support growth and maturation while providing enough energy and fluids for the additional physical activity." (Cotugna, Vickery and McBee 2005 p 324).

It is well established (Thompson 1998 p 164), that physiologically, children and adolescent athletes have altered nutritional requirements compared to adults, and these include; greater protein needs for growth and development, increased use of fat as fuel during exercise, higher energy costs for selected activities (i.e., walking and running), and faster rises in core temperature. Therefore, addressing the specific nutritional needs of children and adolescent athletes is not only critical to achieving their athletic potential, but, more importantly, proper nutrition is imperative for growth, development, maturation and overall health status, and this is suggested to be a more critical determinant of energy requirements than age (Spear 2005 p. 201). Young athletes are encouraged to adopt healthy nutritional practices (Bass and Inge 2006), and especially during times of increased training, energy and macronutrient needs, complex carbohydrates and high-quality protein intake, must be met in order to maintain body weight, replenish glycogen stores, and provide adequate protein for building and repair of tissue. Fat intake should be adequate to provide the essential fatty acids and fat-soluble vitamins, as well as to help provide adequate energy for weight maintenance (ACSM/ADA/DC 2000).

6.1.2. Nutritional recommendations

Please note – As per the ASCA Scope of Practice **S&C Coaches MUST:**

- Refer to Nutrition specialists for more advanced and individualised information on dietary intervention.
- Refer to Sports medicine practitioners to diagnose and treat injuries and illnesses.

Defining Nutrient Reference Values: Nutrient reference values (NRV) comprise a series of estimates of the amount of energy and nutrients needed to meet the physiological needs of different groups of healthy people (NHMRC 2006). Three different measures are often used to express NRV, these include;

1. Absolute amount consumed in grams per day (absolute intake - g/day),
2. Amount consumed per kilogram of body weight per day (intake related to body weight g/kg/day)
3. Percentage contribution to daily energy intake based on its energy content (intake as a fraction of total energy - percent energy).

Both the intake as a fraction of total energy (percent energy) and amount consumed per kilogram of body weight per day (g/kg/day) are used to express NRV throughout this section. It is important to note that if total energy intake is inadequate, then expressing NRV by a percentage of energy intake may result in attaining sub-optimal nutrient intake. For this reason, it is suggested (Lemon, 1989 p 378) that expressing NRV per kilogram of body weight per day will ensure adequate intake is met.

Energy: There is little data published specifically relating to the effect of training on nutritional requirements of children and adolescents, with the majority of information focused on adult athletes. However, general recommendations presented by Volpe (2006 p 30) for energy intake suggest that girls and boys 7–10 years of age require between 1600 and 2400 Kcal/day. At age 10 to 12 years, girls start their growth surge; therefore, they should increase intake by approximately 200 Kcal/day to support this growth period. Boys commence this growth period around 2 years later (12–14 years of age), and should consume approximately 500 Kcal/day above their usual intake. Recommendations are listed in Table V.

Table V – Energy Recommendations for Children and Adolescents.

Group	***Age (years)***	***Energy Intake (kcal/kg/day)***
Children	7 – 10	70
Males	11 – 14	55
	15 – 18	45
Females	11 – 14	47
	15 – 18	40

Thompson, J.L. (1998). Energy balance in young athletes. International Journal of Sport Nutrition**.** 8(2):160-174.

Protein: Although protein needs are increased during the growing years (Bass and Inge 2006 p 604), limited studies support recommendations for higher protein intake in young athletes. Recommended protein intake for active children and adolescents is 0.8–1.0 g/kg/day (FAO/WHO/UNU 1985). However, according to Boisseau et al. (2007 p 27), such recommendations are based on "classic" adolescents rather than on those involved in regular training. This is an important acknowledgement, as higher protein recommendations for adults during exercise (1.2–1.7 g/kg/day) are based upon three physiological requirements, these being; (1) the need to account for gains in lean body mass; (2) the need to compensate for protein used as a fuel source during physical activity; and (3) the need for protein in muscle regeneration (Lemon 1998). Therefore, it may be appropriate, that in young athletes undertaking training, higher protein intake is necessary to meet the physiological needs and increased demands.

In addressing this issue, current research conducted by Boisseau and colleagues (2007) from the University of Poitiers in France examined protein requirements in 11 male adolescent soccer players aged 13.8 $\pm$ 0.1 years using nitrogen balance measurements with four balanced diets including different protein levels (1.4, 1.2, 1.0 and 0.8 g protein per kg BW). The athletes engaged in training and match play approximately 10–12 hours per week (at least 2 hours of training per day and a match during the weekend). The authors reported that traditional dietary protein allowances (0.8–1.0 g/kg/day) were not sufficient to meet protein requirements corresponding to growth and a high level of physical activity in adolescent athletes. They suggest that protein requirements are greater for male adolescent athletes, with an estimated average requirement (EAR) of 1.2 g/kg/day and a recommended daily allowance (RDA) of 1.4 g/kg/day. As many nutrient needs are increased with acute exercise and training (Lemon 1989 p 385), the findings reported by Boisseau et al. (2007), should not be too surprising. Collectively, these data indicate that protein requirements for children and adolescent athletes are greater than current recommendations (0.8–1.0 g/kg/day), with research indicating protein RDA ranging from 1.0–1.4 g/kg/day, with recommendations of at least 12–15% of dietary energy from protein (Lemon 1989; Petrie et al. 2004). The combination of the heavy training and increased protein intake may also influence protein turnover and perpetuate the need for greater intake by children and adolescents (Petrie et al. 2004). However, if total energy intake from a nutritionally balanced diet meets energy requirements, then protein needs should be met (Lemon 1998 p 432). Future research is required to confirm these recommendations as being adequate, particularly during intense training and competition.

Carbohydrate: While the benefits of high carbohydrate diets for enhancing athletic performance in adults are well documented, there is a lack of information on the carbohydrate requirements of young athletes (Bass and Inge 2006 p 605). An extensive review published by Professor Louise Burke and associates from the Australian Institute of Sport highlights the importance of carbohydrate as a critical nutrient in the performance of prolonged sub-maximal (>90 minutes) and intermittent, high-intensity exercise (Burke et al. 2001). Additionally, carbohydrates also play a role in the performance of brief high-intensity exercise. It is important to note that a significant physiological difference in children and adolescents is that they lack full development of glycolytic capacity (Petrie et al. 2004 p 622). As such, fat may play an important role in meeting the energy demands of exercise performance (Boisseau and Delamarche 2000). However, such differences in muscle enzymatic capacity for anaerobic metabolism appears to decline during the adolescent period, compared to adults. Because of the importance of carbohydrate as a substrate for high-intensity training, it is suggested (Petrie et al. 2004) that in young athletes, at least 50% of total energy intake is from carbohydrates. Burke et al. (2006) suggested that a reasonable target for carbohydrate intake by athletes, or teams with a less demanding training and competition schedule, is 5 – 7 g/kg/day. While athletes who want to maximize muscle glycogen refueling, in preparation for matches or for recovery during an intensive training schedule, a target of 7 – 10 g/kg/day may be more beneficial. Therefore, carbohydrate recommendations for young athletes are similar to those recommended for adults.

Fat: The role of dietary fat is to aid in the absorption of essential fat-soluble vitamins and carotenoids, all of which are required for health maintenance (Petrie et al. 2004). The 2003 Dietary Guidelines for Children and Adolescents in Australia (NHMRC 2003) recommend that 30% of total energy intake is from fats. Unsaturated should contribute majority of the fat-derived energy (Petrie et al. 2004), with saturated fats providing no more than 10% (NHMRC 2003).

6.1.3. Nutritional supplements and ergogenic aids

Reports indicate that the use of nutritional supplements appears to be on the increase among adolescent athletes (Bell et al. 2004; Dorsch and Bell 2005). A survey of university athletes reported that 88% used one or more nutritional supplements (Burns et al. 2004), while current or past use in high school athletes was reported by 22% of athletes and 82% thought nutritional supplements could improve their performance (Kayton et al. 2002). A recent study out of Canada examined the beliefs of adolescent athletes regarding the performance-enhancing effects of nutritional supplements. Bell and colleagues (2004) reported that most adolescent athletes believed multivitamin/mineral preparations, creatine, and protein supplements would enhance their performance, with commonly cited reasons for usage were to maintain/improve health, increase energy, build muscle, decrease body fat and to increase athletic performance (Dorsch and Bell 2005). Nutritional supplements fall into the broader category of ergogenic aids – that is, substances used to enhance athletic performance (Metzl 1999). The effects of nutritional supplement strategies (carbohydrate loading) and ergogenic aids (protein/amino acid ingestion, creatine supplementation) are presented.

Carbohydrate Loading: Carbohydrate (CHO) loading refers to nutritional strategies aimed at maximising or super-compensating muscle glycogen stores prior to competitive events of longer duration (> 90 mins) that would deplete this fuel reserve (Burke 2006). This requires an athlete deplete glycogen stores by eating a low CHO diet and exercising at maximum capacity for about three to five days before competition. Then two to three days before competition, the athlete stops exercising and eats a very high CHO diet (10-12 g/kg/day). In theory, this allows the muscles to readily accept CHO and increase the muscle glycogen; however, such a strategy raises many concerns for the competitive athlete. Spear (2005) points out that during the low CHO phase the athlete may feel fatigued and be at greater risk for injury. Furthermore, during the high CHO phase the athlete is required to reduce exercise and training, and this may cause an increase in state-anxiety. To overcome these concerns, Sherman and colleagues (1981) recommended a modified CHO-loading strategy, whereby the athlete increases CHO for two to three days before an event, while continuing light training. Following such a protocol the athlete will receive similar benefits without the negative aspects.

Although, this appears to be an effective nutritional strategy to improve performance in endurance based sports (Burke et al. 2006), to date, there are no known data published that has examined this approach in children and adolescent athletes (Bass and Inge 2006 p 606). Although CHO meals 3 to 6 hours before competition can improve performance by increasing glycogen stores, adolescent athletes are cautioned against traditional CHO loading strategies due to the severe calorie restriction that often precedes the loading phase, which can affect performance adversely (DiMeglio, 2000). It is suggested that adolescent athletes follow CHO recommendations as listed previously in this section.

Protein/Amino Acid Ingestion: As previously mentioned (Section 6.1.2), children and adolescent athletes require protein intakes ranging from 1.0–1.4 g/kg/day, with recommendations of at least 12–15% of dietary energy from protein (Lemon 1989; Petrie et al. 2004). It is noted that if total energy intake meets energy requirements, then such protein needs should be easily met (Lemon 1998 p 432). Therefore, additional protein supplementation to meet daily requirements of children and adolescent athletes is not advocated. An area that has received considerable research interest most recently, is nutrient timing (Ivy and Portman, 2004), and this may be beneficial to young athletes. Professor Kevin Tipton from the University of Birmingham has extensively studied the influence of protein/ essential amino acid ingestion around the time of exercise (Tipton et al. 1999; 2001; 2004). This research demonstrates that there is this ‘anabolic window’ that during which, ingestion of small amounts of protein/essential amino acid maximises the training response to resistance exercise, with both increased insulin and increased availability of amino acids implicated in this response (Manninen 2006). Compelling evidence recently presented by Willoughby and colleagues (2007) clearly demonstrated that 10-weeks of resistance training combined with the timed ingestion (1 hour before and after exercise) of a supplement containing a 40-g blend of whey and casein and free amino acids was more effective than a carbohydrate placebo in increasing muscle strength and mass, body composition, and increasing systemic and local indicators suggestive of skeletal muscle anabolism and hypertrophy. Given that supplement timing represents a simple but effective strategy that enhances the muscular adaptations desired from resistance training (Cribb and Hayes 2006); such supplement strategies may benefit young athletes wishing to increase lean body mass and strength.

Creatine Supplementation: Creatine supplementation first gained attention following the 1992 Barcelona Olympic Games, where British athletes competing in sprint and power events suggested their performance had benefited from creatine supplementation (Anderson, 1993). Since this time creatine has become one of the most widely used nutritional supplements, with reports indicating wide spread use by children and adolescent athletes (Kern et al. 2000). Data presented by Metzl et al. (2001) indicated that approximately 6% of middle and high school athletes supplement with creatine, and reported creatine use in every grade, from 6 to 12 (ages 10 to 18). Furthermore, 44% of Grade 12 athletes surveyed reported using creatine, and this is suggested to be approaching levels reported among collegiate athletes (Ostojic 2004). Creatine’s mechanism of action is exerted through its conversion to phosphocreatine. Therefore, the body’s ability to regenerate ATP depends on the supply of creatine and phosphocreatine, with phosphocreatine donating a phosphate group to convert ADP into ATP, bypassing the need for glycolysis for production of more ATP (Koch 2001). Creatine supplementation has been suggested as a means to "load" the muscle with creatine and increase possible storage of phosphocreatine (Bird 2003). Theoretically, this would serve to improve the ability to produce energy during explosive, high-intensity exercise bouts and/or enhance the ability to recover from intense exercise. This argument has been presented (Unnithan et al. 2001 p 527) for the use of creatine supplementation in adolescent athletes as the rate of ATP rephosphorylation via glycolysis may be reduced in this population. However, few studies have examined the effect of creatine supplementation in adolescent athletes. Grindstaff et al. (1997) reported enhanced repetitive swim sprint performance in recreational and/or national competitive swimmers aged 15.3 $\pm$ 0.6 years following creatine supplementation (21 g/day) for 9 days, and indicated that no side effects were noted.

In 2000, with numerous anecdotal reports suggesting widespread use of creatine in young athletes, the American College of Sports Medicine convened a special communications roundtable on the physiological and health effects of oral creatine supplementation (ASCM 2000). The communications of the roundtable argued against the use of creatine in pediatrics and concluded:

"Data on potential and real side effects in the pediatric (<18 yr) population is grossly inadequate from which to formulate valid conclusions as to the risk/benefit ratio of creatine supplementation. Thus, creatine supplementation is not advised for the pediatric population (i.e., <18 yr of age)." (ASCM 2000 p 712-13).

However, more recently, Ostojic (2004) had young male soccer players (16.6 ± 1.9 years) ingest a creatine-monohydrate supplement (3 x 10 g doses) or placebo for 7 days. Before and after the supplementation protocol, subjects underwent a series of soccer-specific skill tests including the dribble test, sprint-power test, endurance test, and vertical jump test. Specific dribble and power test times, along with vertical jump height, were superior in creatine versus placebo trial at post-supplementation performance. The authors concluded that:

"Although the primary finding of this investigation was that acute creatine supplementation improved specific sport performance in young soccer players, we believe that there is no clear evidence for untoward side effects of acute creatine supplementation in healthy young individuals." (Ostojic 2004 p101).

While creatine supplementation appears relatively "safe" (Poortmans and Francaux 1999; Schilling et al. 2001; Mayhew et al. 2002), there has been no critical evaluation of its health implications in children and adolescent athletes. A news release by the American Academy of Pediatrics (Rogers 2007) titled 'Creatine use by adolescents not recommended due to limited data' outlines several concerns regarding the use of creatine by adolescent athletes, these include;

1. Creatine use in adolescents has not been studied extensively and, therefore, cannot be recommended.
2. Adolescent use of creatine often is unsupervised, and adolescents may be using more than the recommended amount. The consequences of this are unknown.
3. It is speculated that if adolescents get the desired effect from using creatine, such as increasing muscle size, they may move on to testosterone and other anabolic steroids ("gateway theory").
4. The purity and safety of any nutraceutical, including creatine, cannot be assured.
5. Creatine is contraindicated in adolescents with renal disease.
6. No studies have examined the long-term use of creatine.

Therefore, at this time, **the ASCA does not advocate the use of creatine supplementation in children and suggest that adolescent athletes need clear explanations of all the benefits and risks of usage** (Table VI).

Table VI – Ergogenic aids and the potential adverse effects in adolescent athletes.

Ergogenic Aid	Potential Adverse Effects
Creatine	Muscle cramping, muscle strains, dehydration
Androstenedione	Decreased testosterone
Stimulants (amphetamines, caffeine, ephedrine, sympathomimetic amines)	Restlessness, insomnia, anxiety, tremor, palpitations, tachycardia, cardiac arrhythmia, hypertension, disruptions in thermoregulation.
Amino Acids and Protein Supplements	
Moderate (<2g/kg/dad)	None
Excessive amounts (>2g/kg/day)	Dehydration, gout, gastrointestinal upset, hepatotoxicity, renal toxicity, hypercalciuria, impaired essential amino acid absorption
Vitamin A	
Moderate amounts	None
Excessive amounts (>300% RDA)	Fatigue, irritability, increased intracranial pressure, gastrointestinal upset, hepatocellular toxicity, bone and joint pain, hypercalcemia, skin and nail abnormalities
Niacin	
Moderate amounts	None
Excessive amounts (>300% RDA)	Flushing, gastrointestinal upset, glucose intolerance, hyperuricemia
Vitamin B6	
Moderate amounts	None
Excessive amounts (>300% RDA)	Headache, nausea, sensory neuropathy, hepatocellular toxicity

http://www.eatright.org/cps/rde/xchg/ada/hs.xsl/career_3284_ENU_HTML.htm

6.2. Recovery strategies

Young athletes are often exposed to demanding training and competition schedules, which may include repeated, high-intensity exercise sessions performed on consecutive days many times per week. As such, enhancing recovery may be an important factor following training or competition. Large volumes of intense training and competition, particularly with minimal recovery time, can place great physiological demands on the musculoskeletal, nervous, immune and metabolic systems potentially causing a negative effect on subsequent exercise performance (Reilly and Ekblom, 2005). While physical demands vary between sports, in general athletes are often required to perform, recover and repeat the performance again within a 24-hour period. With consecutive bouts of high-intensity exercise often required multiple times during a weekly training and the competition micro-cycle, large volumes of intense training or competition may exert a negative effect on performance if the body does not adequately recover between sessions. Such response has been termed under-performance syndrome [UPS] (Budgett et al. 2000). In order to reduce the risk of UPS, and restore physical function, a variety of post-exercise recovery interventions are often employed by athletes to enhance recovery. It is proposed that the use of post-exercise recovery procedures ensures performance in subsequent exercise sessions (training and/or competition) is not unduly compromised by lingering muscle soreness or decrements in power, flexibility, speed or agility (Dawson et al., 2005). As such, an integral component of athletic performance may involve an effective post-exercise recovery regime, the purpose of which is to expedite the athlete's return to pre-exercise physiological states and reduce UPS.

6.2.1. Common recovery techniques

Common recovery techniques include active recovery, water immersion (contrast temperature water immersion, cold-water immersion) and compression garments. Despite their widespread use, little scientific evidence is available to support the effectiveness in facilitating optimal post-exercise recovery (Dawson et al., 2005), particularly in regard to repeated high-intensity exercise performed on consecutive days. Furthermore, no studies to date have examined the use recovery methods in children and adolescent athletes.

Active Recovery: This recovery intervention is the process by which an athlete will continue to perform sub-maximal exercise following high-intensity training or competition sessions. Historically, active recovery has been regarded as the superior method of improving performance and alleviating the symptoms associated with fatigue (Lane and Wegner, 2004). Whilst literature has shown that forms of active recovery are effective in the removal of lactic acid and superior to passive recovery on subsequent bouts of exercise lasting < 5min (Ahmaidi et al., 1996), it is yet to be determined the impact of this recovery method on performance when exercise sessions are separated by at least 24 hour. In terms of subsequent performance, the effects of active recovery has focused on consecutive bouts of exercise following a short period of recovery (15 – 20 min). However, in many sports, competitions and training sessions are separated by at least 24 hour. With this in mind, further research is required to examine the possible benefits of an active recovery in situations simulating the actual demands placed on athletes in their respective sports.

Water Immersion: The common strategies involving water immersion include cold-water immersion and contrast temperature water immersion. However, much of the current literature on the effectiveness of water immersion to improve athletic performance appears to be based on anecdotal information, with limited published research relating to exercise performance. Despite a lack of scientific evidence, it has been proposed that water immersion may cause physiological changes within the body which may improve recovery from repeated high-intensity, intermittent sprint exercise (Wilcock et al., 2006). Most notably, increased blood flow may lead to improved nutrient supply and waste transportation.

Cold Water Immersion: Cold water immersion (CWI) or cryotherapy (CT) is commonly utilised in the rehabilitation process following an acute injury and more recently, as a recovery procedure following intense exercise. CWI involves immersing a muscle group, body part or the entire body into a cold bath or whirlpool in temperatures ranging from cool (22ºC) to very cold (10ºC). CWI may also be beneficial in alleviating and treating the symptoms of delayed onset of muscle soreness (DOMS) (Cheung et al., 2003). The rationale for the effectiveness of CWI is that it contributes to the relief of pain due to decreases in the stretch-reflex response and spasticity of muscle (Meussen and Lievens, 1986). Thus, when CT or CWI is performed at the appropriate duration, frequency and temperature following muscle-damaging exercise, the inflammatory response is reduced and spasms and pain associated with the muscle injury may be alleviated.

Contrast Water Immersion: The use of hot/cold contrast water immersion (C_TWI) as a recovery procedure is rapidly growing in popularity in professional sport. Many athletes and coaches are currently utilising hot/cold water immersion as a post-exercise strategy with the intention of enhancing recovery and possibly performance in subsequent exercise bouts. C_TWI involves the repeated alternation of cryotherapy (CT) and thermotherapy (TT), where an interchanging stimulus of hot and cold water is applied to the immersed body part. This process is purported to create an altered local blood flow and hydrostatic pressure resulting in peripheral vasodilation and vasoconstriction. According to Calder (2001), C_TWI is thought to speed recovery by increasing the peripheral circulation, thereby removing metabolic wastes and stimulating the central nervous system (CNS), with contrast therapy increasing lactic acid clearance, reduced post-exercise edema and enhanced blood flow to the fatigued muscle. Furthermore, C_TWI may be a better recovery strategy for athletes following high-intensity exercise because the effects are gained with less exertion and higher perceptions of recovery from the athlete (Coffey et al. 2004). Despite the proposed benefits of C_TWI there is limited scientific evidence to date that substantiates the effectiveness of this recovery procedure on performance, particularly in regard to subsequent exercise bouts separated by 24 hours.

Collectively, these studies highlight, that despite limited scientific evidence suggesting that recovery techniques offer an effective recovery strategy, team sport athletes continue to incorporate these methods into their training and competition schedules. As such, further research is required to elucidate the effects of these recovery procedures following intense exercise common in team sports and examine the possible benefits associated with subsequent athletic performance as it relates to children and youth athletes.

7.0. SUMMARY OF THE ASCA POSITION STAND

It is the position of the ASCA that:

1. There is an abundance of evidence to suggest that when appropriately performed resistance training is a safe and effective exercise to be engaged by children and youth.

2. Prior to the commencement of resistance training all children should receive comprehensive instruction on gymnasium safety including use of collars, placing weights away correctly, correct handling and storage of dumbbells, barbells, collars and weights, appropriate spotting procedures, no playing around in the weights room etc.

3. Throughout their training period youth should be instructed by competent strength and conditioning coaches who can ensure correct lower back lifting technique involving the adoption of the natural lumbar curve and effective use of the abdominal and lower back muscles when lifting.

4. Strong muscular action from the abdominals and lower back muscles can significantly serve to reduce dangerous shear forces on the spine. Hence training of the vital musculature of the abdominals and lower back should be a fundamental aspect to all training programs for children and youth through all phases of the training process.

5. Technical competence in the performance of resistance training exercises is the primary focus for children and youth prior to any progression in loading or training volume.

6. All individuals should adopt a standard grip whereby the thumbs are securely wrapped around the bar during all lifts where the bar is lifted above the body such as bench press. The use of a false grip is strongly discouraged.

7. The youngest a child should commence resistance training is at 6 years of age provided they have the maturity to follow clear instructions and an appreciation of the dangers present when training.

8. When training children and youth the long term athletic development of the child needs to be of paramount concern and various logical progressions in the training cycle are required to be systematically imposed throughout the child's development which are age related but also muscular function dependent. It is the Position of the ASCA that the following training loading intensities and exercise selection strategies be adopted when training children and youth:

    - Level 1: 6-9 years of age: modification of body weight exercises and light resistance (brooms and bands etc.) work only for relatively high repetitions e.g. 15+ reps;
    - Level 2: 9-12 years of age: 10-15 RM; (maximal loading approximately 60% maximum) using predominantly simple single joint exercises with dumbbells and machine exercises where the machine is an appropriate size for the child.
    - Level 3: 12-15 years of age: 8-15 RM; (maximal loading approximately 70% maximum) using progressively more free weight exercises but avoiding 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.
    - Level 4: 15-18 years of age: 6-15 RM; (maximal loading approximately 80% maximum) progressively moving towards an advanced adult program involving split routines where appropriate and complex multi-joint movements provided sound technique has been developed under competent coaching by a coach with at least Level 2 ASCA strength and conditioning accreditation.

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9. Children and youth in the first 3 stages (i.e. Levels 1-3) benefit most from programs that improve body/limb control and joint stability. These programs would also inadvertently improve other outcomes (eg. strength-endurance, general strength) without specific training for those outcomes. With a solid foundation of training emphasizing body/limb/joint control and stability and technical mastery during resistance exercises, athletes

entering the fourth stage (i.e. Level 4) may more safely embrace training aimed at improving other resistance training outcomes such as strength and hypertrophy.

10. Resistance training can be effectively used to reduce the likelihood of the occurrence of sporting injuries by the development of the musculo-skeletal system and through reducing muscular imbalances.

11. All programs performed by children must be strictly coached by an adult(s) and that the adult be accredited with at least a level 1 ASCA Strength and Conditioning coaching accreditation. To coach youth in level 3 and 4 in the more complex lifts a coaching accreditation of at least ASCA Level 2 would be required with a preference for such coaches to be moving towards the ASCA Pro Structure. Further, when supervising groups of children, the ratio of coaches to children is recommended to be 1 coach for every 10 children.

12. Young and less experienced, school-aged resistance trainers can have their strength capabilities assessed by performing testing with lighter resistances and performing a "repetitions till fatigue" test, from which 1 RM can be extrapolated with reasonable accuracy. The ASCA does not advocate using 1 RM maximal lifts for this population.

13. The ASCA acknowledges that the recent development of the Youth Olympic Games has resulted in a large increase in the number of children and youth performing maximal weightlifting exercises. The ASCA is concerned about the high drop-out rate and early performance stagnation that has been observed from such young weightlifting athletes performing maximum loading and strongly advocates national and international bodies monitor the long-term performance of these young athletes and consider modifying the format of competition for such young athletes away from a 1 RM to a repetitions based format.

14. Children and youth require appropriate energy intake:

    - 7-10 years 70 kcal/kg/day
    - 11-14 years 47-55 kcal/kg/day
    - 15-18 years 40-45 kcal/kg/day

15. Macro-nutrient recommendations are:

    - Protein 1.0-1.4 g/kg/day
    - Carbohydrate 5-7 g/kg/day increased to 7-10 g/kg/day if engaged in intensive training
    - Fat 30% of total energy intake

16. Supplement timing represents a simple but effective strategy that enhances the muscular adaptations from resistance training. There is this 'anabolic window' prior to and following training that during which, ingestion of small amounts of protein/essential amino acid maximises the training response to resistance exercise. Such supplement strategies may benefit young athletes wishing to increase lean body mass and strength.

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APPENDIX 1

Example of an off-season strength program used to train rugby union players aged 15-16 developed by Roger Mandic

Phase 1: Hypertrophy (5 weeks)

Frequency: 2 times/week Volume: 2-3 sets Rest: 1.5 mins
Intensity: 10-15 reps Tempo: slow-medium

Wk. 1
Monday, Wednesday and Friday

Exercise	Sets	Reps
Squats	2-3	10-15
D/Bell Row	2-3	10-15
B/Bell Bench Press	2-3	10-15
Deadlift	2	10-15
Front Bridge	1	45 sec
Side Bridge	1	30 sec for L & R side

Wk. 2
Monday, Wednesday and Friday

Exercise	Sets	Reps
Walking Lunges	2-3	10-15
Seated Row	2-3	10-15
D/Bell Bench Press	2-3	10-15
Stiff Leg Deadlift	2	10-15
Front Bridge	1	45 sec
Side Bridge	1	30 sec for L & R side

Wk. 3
Monday, Wednesday and Friday

Exercise	Sets	Reps
Squats	2-3	10-15
Lat Pulldown	2-3	10-15
Push Ups	2-3	10-15
Deadlift	2	10-15
Front Bridge	1	1 min
Side Bridge	1	35 sec for L & R side

Wk. 4
Monday, Wednesday and Friday

Exercise	Sets	Reps
Side Lunge	2-3	10-15
Upright Row	2-3	10-15
Standing D/Bell Press	2-3	10-15
Stiff Leg Deadlift	2	10-15
Front Bridge	1	1 min
Side Bridge	1	35 sec for L & R side

Wk. 5
Monday, Wednesday and Friday

Exercise	Sets	Reps
Squats	2-3	10-15
Bent over Row	2-3	10-15
B/Bell Bench Press	2-3	10-15
Deadlift	2	10-15
Front Bridge	1	1 min 15
Side Bridge	1	40 sec for L & R side

Phase 2: Strength (2 weeks)

Frequency: 2 times/week   Volume: 2-3 sets   Rest: 2.5 mins
Intensity: 6-10 reps   Tempo: slow

Wk. 6
Monday and Friday

Exercise	Sets	Reps
1 Legged Squats	2-3	10
Dive bomber Push Ups	2-3	6-10
Chin Ups or Pull Ups	2-3	6-10
Tricep Dips	1-2	6-10
Front Bridge	1	1 min 15 sec
Side Bridge	2	40 sec for L & R side

Wk. 7 Monday and Friday

Exercise	Sets	Reps
1 Legged Squats	2-3	10
Dive bomber Push Ups	2-3	6-10
Chin Ups or Pull Ups	2-3	6-10
Tricep Dips	1-2	6-10
Front Bridge	1	1 min 30 sec
Side Bridge	2	45 sec for L & R side

Phase 3: Power (2 weeks)

Frequency: 2 times/week   Volume: 1-2 sets   Rest: 3 mins
Intensity: 4-8 reps   Tempo: explosive/fast

Wk. 8 - Lower and Upper Body Plyometrics

Monday and Friday

Exercise	Sets	Reps
Overhead Medicine Ball Backward Throw	2	8
Multiple Box-to-Box Jumps		60
Front Toss	2	6
Push Up Claps	2	8-10
Medicine Ball Push-Up and Pass	1	8-10
Power Drop	1	8-10
Front Bridge	1	1 min 30
Side Bridge	2	45 sec for L & R side

Wk. 9 Repeat week 8

APPENDIX 2

Example of an off-season strength program used to train rugby union players aged 17-18 developed by Roger Mandic

Phase 1: Hypertrophy (5 weeks)

Frequency: 3 times/week Volume: 3-4 sets Rest: 1.5 mins
Intensity: 8-12 reps Tempo: slow-medium

Wk. 1
Monday, Wednesday and Friday

Exercise	Sets	Reps
Back Squat	3	8-12
B/Bell Bent Over Row	3	8-12
B/Bell Bench Press	3	8-12
Deadlift	2	8-12
Front Bridge	1	1 min
Side Bridge	1	30 sec for L & R side

Wk. 2
Monday, Wednesday and Friday

Exercise	Sets	Reps
Front Lunge	3	8-12
Seated Row	3	8-12
D/Bell Bench Press	3	8-12
Stiff Leg Deadlift	2	8-12
Front Bridge	1	1 min
Side Bridge	1	30 sec for L & R side

Wk. 3
Monday, Wednesday and Friday

Exercise	Sets	Reps
Front Squat	3	8-12
Lat Pulldown	3	8-12
Incline Bench Press	3	8-12
Deadlift	2	8-12
Front Bridge	1	1 min 15 sec
Side Bridge	1	40 sec for L & R side

Wk. 4
Monday, Wednesday and Friday

Exercise	Sets	Reps
Side Lunge	3	8-12
Upright Row	3	8-12
Military Press	3	8-12
Stiff Leg Deadlift	2	8-12
Front Bridge	1	1 min 15 sec
Side Bridge	1	40 sec for L & R side

Wk. 5
Monday, Wednesday and Friday

Exercise	Sets	Reps
Step Ups	3	8-12
Cable Pulley Row	3	8-12
B/Bell Bench Press	3	8-12
Deadlift	2	8-12
Front Bridge	1	1 min 30 sec
Side Bridge	1	50 sec for L & R side

Phase 2: Strength (2 weeks)

Frequency: 2 times/week Volume: 2-3 sets Rest: 2.5 mins
Intensity: 6-8 reps Tempo: slow

Wk. 6
Monday and Friday

Exercise	Sets	Reps
Squat or 1 Leg Squat	2-3	6-8
Chin Ups or Pull Ups	2-3	6-8
B/Bell Bench Press	2-3	6-8
Dips	1-2	6-8
Deadlift	2	8
Front Bridge	1	1 min 30 sec
Side Bridge	2	50 sec for L & R side

Wk. 7 Monday and Friday

Exercise	Sets	Reps
Squat or 1 Leg Squat	2-3	6-8
Chin Ups or Pull Ups	2-3	6-8
B/Bell Bench Press	2-3	6-8
Dips	1-2	6-8
Deadlift	2	8
Front Bridge	1	1 min 45 sec
Side Bridge	2	1 min for L & R side

Phase 3: Power (2 weeks)

Frequency: 2 times/week Volume: 1-2 sets Rest: 3 mins
Intensity: 6-8 reps Tempo: explosive/fast

Wk. 8 - Olympic Lifts

Monday and Friday

Exercise	Sets	Reps
Hang Jump Shrugs	1-2	6
Jump Shrugs	1-2	6
Hang Pull	1-2	6
High Pull	1-2	6
Hang Clean	1-2	6
Clean	1-2	6
Push Press	1-2	6
Front Bridge	1	1 min 45 sec
Side Bridge	2	1 min for L & R side

Wk. 9 - Either repeat Wk. 1 or perform Lower and Upper Body Plyometrics

Monday and Friday

Exercise	Sets	Reps
Multiple Box-to-Box Jumps		60
Pyramiding Box Jumps		30
Front Toss	2	6
Push Up Claps	2	8-10
Medicine Ball Push-Up and Pass	2	8-10
Power Drop	1	8-10
Front Bridge	1	2 min
Side Bridge	2	1 min for L & R side

APPENDIX 3

Example of Junior Representative Rugby League program developed by Sean Burns

1 WEEK BLOCK – U/16 RUGBY LEAGUE OFF SEASON

Week 1			
EXERCISE	**SET**	**REP**	**MOVEMENT**
SESSION 1 – UNILATERAL//HIP/BACK DOMINANT			
SINGLE LEG BOSU JUMP	2	6	STABILITY LANDING
SCAPULA HOLD PUSH UP POS	2	6	HUMERAL STABILITY
LYING HIP EXTENSION	3	8	SINGLE LEG
ONE ARM ROW	4	10	FULL RANGE
MED BALL LUNGE	4	10	STATIC LUNGE
DUMBBELL BENCH PRESS	4	10	FULL RANGE
SESSION 2 – BILATERAL/CHEST/QUAD DOMINANT			
BOSU SCAPULA HOLDS	2	6	STABILITY HOLD
BAND CUBAN PRESS	2	6	ROTATOR CUFF
HORIZONTAL PULL UP	4	8	
REVERSE HYPEREXTENSION	4	10	GLUT ACTIVATION
MED BALL BOX SQUAT	3	10	
STANDING SHOULDER PRESS	3	10	SAGITTAL PLANE
SESSION 3 – UNILATERAL/HIP/BACK/DOMINANT			
BAND SCAP RETRACT/DEPRESS	2	6	GOOD QUALITY
BOSU STABILITY JUMPS	2	6	STABILITY LANDING
ONE ARM SEATED ROW	3	10	FULL RANGE
LEG CURL	3	8	CONTROL ECCENTRIC
FRONT SQUAT	3	10	NEUTRAL BACK
PUSH UP			CONTROLLED SPEED

The above program is an actual program developed by ASCA member Sean Burns for a Junior Representative Rugby League Player. The player had a limited training age of 1yr prior to this off season. He started the year weighing 70 kg and by seasons end he weighed 78 kg. Although at this age growth is expected. He also lost a considerable amount of body fat and gained lean body mass. My objective by seasons end was to have this player performing Squat Variations and Deadlift variations with consistently good technique.

By seasons end he could perform a front squat with a clean grip which set him up to be taught more complex lifts as he matured. Although he achieved the ability to complete squat, deadlift and both their variants he still performed these lifts with minimal loads. This took several months to achieve and at times progression was slow. In my experience, close supervision is the key at this age the players are very inconsistent with their technique. It's best to remain positive and don't try to solve their problems in their first session. If you over teach early they may suffer an information overload which can make any progress seem too hard for athletes this age.

The biggest room for improvement in performance can be put down to two things, diet and hydration. Diet is the biggest problem in terms in improving performance. Nine times out of ten athletes this age are dehydrated at the start of a training session, Education needs to be in place to explain why eating poor foods and no hydrating will affect their ability to play better.

With athletes this age, all the resistance, conditioning and skills training won't help the player who is having cookies and a soft drink for dinner. An information night with parents and players present to take advice from a qualified dietician is recommended. I have found that a food diary also works well with players. This age is the ideal time to ensure the young athletes understand gym conduct, always warm up, know when and how to spot their partner, how to cool down.

<u>Why these exercises?</u>

Med Ball Box Squat – Holding a med ball to the chest is an easy and safe way to get the young athletes to get used resisting weight from the front of their body as a lead into to developing their front squat. The use of a box is a great teaching tool to encourage the athlete to keep a neutral back and 'reach' back with their gluteals to find the box. This helps to teach them correct ankle, knee and hip alignment as opposed to dropping forward at the knees where the knees end up in front of the hips.

Lying Hip Extension – This exercise is a great for closed chain hamstring/gluteal development. To some degree it works the hamstring at the hip and knee and better prepares their hamstrings for heavier lifting and playing as opposed to a leg curl.

Horizontal Pull Up – This is a great exercise to gain a better understanding of where athletes this age stand in relation to midsection and lower back strength. If the player can't remain strong whilst completing a pull up because they buckle in the middle they need a lot of work so that they can remain strong from the feet all they way to their shoulder joint.

Standing Shoulder Press Sagittal Plane – This exercise performed in a split legged stance works the entire body, most of the athletes I have worked with have found that there feels to be less stress on the shoulder joint when a dumbbell is pressed in this plane.

Front Squat – A great progression to the clean variants down the track

Why this order?
Generally speaking, the majority of male athletes this age are Chest over back dominant and Quad over Hip Dominant. They may also have a tendency to be stronger in one side of their body over the other. During the preseason, I tried to iron out these problems before progressing to anything further. This was the split

SESSION 1 - UNILATERAL/HIP/BACK DOMINANT
SESSION 2 - BILATERAL/CHEST/QUAD DOMINANT
SESSION 3 - UNILATERAL/HIP/BACK DOMINANT

This unilateral. Hip and back dominance in training will begin to rectify any problems they may have had. In this athletes case we rectified this athlete's right sided superior strength over his left side in 4 weeks and Hamstring/Back improvement in 5 weeks.

Why these loads?
Athletes this age need to generally gain lean body mass. His loads were prescribed by the number of reps he could complete. If he needed to complete 4 x 10 bench he selected a weight where he could complete the 10th rep generally without to much help from his spotter. If he had to complete 4 x 8 on bench Press the next week he would know to increase his load by a small margin. I have found this to be the most efficient way to prescribe load to a large number of athletes at once.

Session Duration ?
To calculate the set loading, I worked backwards if we had those players in the gym for 35 mins I calculated how long each warm up, set/rest took then came up with a number of sets that I could realistically fit in that session. Athletes this age do not need as much stimulus to see results, their bodies are still growing so if in doubt of prescribing to much in the gym always program less to be safe.

APPENDIX 4

Example of Novice's resistance training workout by Dr Dan Baker.

Warm-up: For the warm-up section do 12 reps of every exercise (Walking lunge, walking toe-touch, walking angled lunge, O'head squats, Offset pushup, T-pushup, Band pulls, Band pulls to archer) alternating upper and lower body dynamic movement drills								
Order	**Exercise**		**Wk 1**	**Wk 2**	**Wk 3**	**Wk 4**	**Wk 5**	**Wk 6**
1a.	Bench press	Weight	22.5	25	27.5	30	32.5	35
		Sets x Reps	2 x 15	2 x 15	3 x 12	3 x 12	3 x 10	3 x 10
		Speed	311	311	211	211	201	201
		Start every	3 mins.	3 mins.	3 mins.	3 mins.	3 mins.	3 mins.
1b.	Seated rows	Weight	20	20	22.5	22.5	25	27.5
		Sets x Reps	2 x 15	2 x 15	3 x 12	3 x 12	3 x 10	3 x 10
		Speed	311	311	211	211	201	201
		Start every						
2a.	Shoulder press	Weight	15	15	17.5	17.5	20	22.5
		Sets x Reps	2 x 15	2 x 15	3 x 12	3 x 12	3 x 10	3 x 10
		Speed	311	311	211	211	201	201
		Start every	3 mins.	3 mins.	3 mins.	3 mins.	3 mins.	3 mins.
2b.	Front pull-down	Weight	20	22.5	25	27.5	30	32.5
		Sets x Reps	2 x 15	2 x 15	3 x 12	3 x 12	3 x 10	3 x 10
		Speed	311	311	211	211	201	201
		Start every						
3	Squat	Weight	20	22.5	27.5	30	35	37.5
		Sets x Reps	2 x 15	2 x 15	3 x 12	3 x 12	3 x 10	3 x10
		Speed	411	411	311	311	211	211
		Start every	2 mins.	2 mins.	2 mins.	2 mins.	2 mins.	2 mins.
4	Romanian Deadlift	Weight	20	22.5	27.5	30	35	37.5
		Sets x Reps	2 x 15	2 x 15	3 x 12	3 x 12	3 x 10	3 x10
		Speed	411	411	311	311	201	201
		Start every	2 mins.	2 mins.	2 mins.	2 mins.	2 mins.	2 mins.

Warm-up is a dynamic movement period. It should take 5 minutes maximum
.
Order - "A" and "B" exercises are super-set (30-s rest between "A" and "B") with the cycle starting every 3minutes.

Speed- refers to the lowering (eccentric), pause and lifting (concentric) time in s. Therefore 311 means 3-s to lower the weight, 1-s pause and 1-s to lift the weight. A zero in the middle (eg. 201) implies no pause between lowering and lifting.

Start every- Refers to the time for commencing the next set. If the next set is to commence every 2 minutes and the first set took 55-s, then the athlete has 65-s rest. If the second set took 60-s, then only 60-s rest is taken.

The resistance portion of the workout takes 20 minutes in Wks 1-2 and 30 minutes in wks 3 onwards, when the total sets increase from 12 to 18.

Torso/abdominal training take place at the end of the resistance portion and entail basic slow speed (eg. Crunch, Reverse Crunch) and isometric (Hover, Side Hover) exercises. 4-6 sets should suffice taking 4-5 minutes.

Workout plan: Dynamic Warmup – 5 minutes
Resistance exercises – 30 minutes
Torso/abdominal – 5 minutes

The weight listed is an example for a relatively weak beginner and will need to be individually adjusted according to the strength and sex of the athlete. The increase in weight over the 6-week period is outlined to show a logical progression over the training period.

APPENDIX 5

Developing strength training programs for "Age Group" Swimmers
Dr Anthony Giorgi, Senior S&C Coach, QLD Academy of Sport, Focus Group Leader for S&C, Swimming Australia.

Introduction

Strength training for the age group swimmer involves a number of key factors that the coach needs to address. Importantly, certain windows of opportunity present themselves that allow for the coach to not only take advantage of key physical development aspects but may allow the coach to maximise the technical development of their swimmers. The following article is one presented at the 2007 ASCTA coaches' conference.

The Key Physical Qualities

- **Flexibility**: General and Swimming Specific Range of Motion – Stroke, Streamlining, Turns.
- **Strength**: Relative, Absolute, Functional Strength
- **Stability**: Joint Integrity, Trunk Control – Static and Dynamic
- **Injury Prevention**: Combination Strength, Stability and ROM.
- **Body Awareness**: Feel, Position, Posture, Shaping, Motor Unit Recruitment, Muscle Activation (Includes overall body awareness and specific body shaping positions crucial to efficient swimming)
- **Power**: Unloaded and Loaded (essential for starts and turns)
- **General Athleticism**: Extensive Movement Vocabulary (can improve the ability to master more finite skills)

Age Based Progressions

The following table/s aim to provide a guide to when specific physical qualities can be developed and or need to be maximised - emphasised so as to ensure…

- physical qualities are maximised during crucial windows of opportunity
- physical qualities are established enabling the coach to maximise their swimmers technical development
- physical qualities take into consideration the growth stages (puberty)
- physical qualities are established reducing the likelihood of injury
- physical quality differences are accounted for in individuals/sex

Training to Train Summary: Age Based Progression for Males (10-14)

From Table 1 we can summarise the following information.

- Lifting development is established. The need to teach the swimmer how to lift, how to recruit and what they are supposed to feel is paramount to getting the best from their strength training.
- Strong emphasis on relative strength. Prior to puberty the swimmer needs to develop good power to weight ratios. If this established early prior to major growth spurts the ability to maintain and improve in these areas is enhanced.
- The development of body awareness / Activation. Ensuring a variety of exercises, methods and activities to teach both activation – recruitment and thus good body awareness will ensure that all aspects of strength training are maximised. This interrelates extensively with technical development and RS.
- Stability. Forms the cornerstone to strength development – joint integrity and horizontal trunk stability (static and dynamic)
- Phases: 6-8wks / 2 x 30-60min session a wk.

Training to Compete Summary: Age Based Progression for Males (14-18)

From Table 1 we can summarise the following information.

- Introduction of external loading to maximise AS and FS. A combination of traditional/slightly modified ex. can be used to meet the swimmers needs.
- Strong focus on general ROM / a shift towards stroke specific ROM. Compromising on ROM can (will) reduce the effectiveness of additional strength loading potentially hindering development and long term performance. The need to begin prior and continue during puberty is the key to developing good mobility.
- Re-establishing a priority in body awareness. Following the major growth spurt it is essential to re-establish important body awareness skills which may have lapsed slightly during puberty. A brief period of lifting development may also need to take place to ensure lifting technique is not compromised.
- Power. The continuation of the development of Bwt power with a shift towards loaded power to maximise maximal power output.
- Phases: 3-6wks / 2-3 x 60-90min sessions a wk.

Table 1 - Age Based Progression for Males.

Age	10	11	12	13	14	15	16	17	18
	Training to Train					Training to Compete			
LD	-	**X**	**X**	**X**	x	x	**X**	**X**	**X**
GROM	x	x	x	**X**	**X**	**X**	**X**	x	x
SROM	x	x	x	x	x	X	X	X	X
RS	**X**	**X**	**X**	**X**	**X**	**X**	**X**	x	x
AS	-	-	-	-	-	-	x	**X**	**X**
FS	-	-	-	-	-	x	x	**X**	**X**
Pow1	-	x	x	**X**	**X**	**X**	**X**	x	x
Pow2	-	-	-	-	-	-	**X**	**X**	**X**
BA	**X**	**X**	**X**	**X**	x	x	x	**X**	**X**
Stab	**X**	**X**	**X**	x	x	x	**X**	**X**	**X**
IP	x	x	x	x	x	x	x	x	x

Note: x – Minor Focus; X – Major Focus
Key: AS - Absolute Strength; BA - Body Awareness; GROM – General Range of Motion; LD – Lifting Development; FS - Functional Strength; IP - Injury Prevention; Pow - Power; RS: Relative Strength; SROM - Specific Range of Motion; Stab – Stability;

Training to Train Summary: Age Based Progression for Females (10-14)

From Table 2 we can summarise the following information.

In the early stages, there are little differences between males and females. The key differences begin to become noticeable at the onset of puberty.

- Lifting development is established
- Strong emphasis on relative strength. It is extremely important that female swimmers are exposed extensively to bwt exercises prior to and during puberty so as to maximise the development of this quality.
- The development of body awareness / Activation.
- Stability. Joint integrity becomes a greater issue in females due to the presence of less musculature. Hyper-mobility and lower joint stability can result in issues with the shoulder capsule and knee which may arise in mid to late teenage years.
- Phases: 6-8wks / 2 x 30-60min session a wk.

Training to Compete Summary: Age Based Progression for Females (14-18)

From Table 2 we can summarise the following information.

- Introduction of external loading to maximise AS and FS. Due to the earlier maturation rates females can be exposed to this quality a little earlier.
- Strong focus on general ROM / a shift towards stroke specific ROM. It is important to ensure that flexibility is not overdone in females who possess sufficient levels of ROM. Excessive flexibility effects not only stroke maintenance but increases the incidence of injury.
- Re-establishing a priority in body awareness. Following the major growth spurt it is essential to re-establish important body awareness skills which may have lapsed slightly during puberty. A brief period of lifting development may also need to take place to ensure lifting technique is not compromised.
- Power. The generally lower levels in power females possess means that both bwt and loaded power need to be addressed extensively.
- Phases: 3-6wks / 2-3 x 60-90min sessions a wk.

Table 2 - Age Based Progression for Females.

Age	10	11	12	13	14	15	16	17	18
	Training to Train					Training To Compete			
LD	-	X	X	x	x	X	X	X	X
GROM	x	x	x	X	X	X	x	x	x
SROM	x	x	x	x	X	X	X	x	x
RS	X	X	X	X	X	X	X	X	X
AS	-	-	-	-	x	X	X	X	X
FS	-	-	-	-	x	x	X	X	X
Pow1	-	x	X	X	X	X	X	X	X
Pow2	-	-	-	-	-	X	X	X	X
BA	X	X	X	x	x	X	X	X	X
Stab	X	X	X	X	X	X	X	X	X
IP	x	x	x	x	x	x	x	x	x
Note: x – Minor Focus; X – Major Focus **Key:** AS - Absolute Strength; BA - Body Awareness; GROM – General Range of Motion; LD – Lifting Development; FS - Functional Strength; IP - Injury Prevention; Pow - Power; RS: Relative Strength; SROM - Specific Range of Motion; Stab - Stability									

Male's v Female's: The differences

A number of differences present themselves at different time periods during the development stages which show key differences between male and female athletes. As a consequence, it is important for the coach to be aware of these differences and ensure that programs are developed accordingly.

- **Stability** - Females can have joint capsule stability issues due to the high predisposition for more compliancy. This can lead to both technical development and strength development issues, while increasing the likelihood of injury. Males can have issues with trunk stability as a result of the overdevelopment of the rectus abdominal muscles leading to muscle recruitment and streamlining issues.
- **Range of Motion (ROM)** - Females tend to be more compliant and thus flexibility needs to be prescribed accordingly. Males on the other hand need a greater emphasis on this are and this needs to be addressed considerably prior to and during puberty.
- **Relative Strength** – the need to expose females to plenty of bwt exercises, chin ups, pushups, rope climbs prior to and during puberty is extremely important. This will allow them to respond better to the changes in COM and increases in body adipose that occur during high oestrogen surges during puberty which sees them fall behind males in terms of lean body mass development.

Using the Age Based Progression Tables

The information in the Tables 1 and 2 provide a frame work which should enable the coach / S&C coach to design a swimming dry land program that targets the specific physical qualities important for that period of their developmental progression.

Below is an example of how that information can and could be used to design the overall breakdown of how a session could be constructed.

<u>Example</u>: 11yr Old Male Swimmer (60min session)

- **Key Physical Aspects**: (see Table 1)
  - Major Focus: Lifting Development, Relative Strength, Body Awareness, Stability
  - Minor Focus: General ROM, Specific ROM, Pow1 and Injury Prevention

- **Session Breakdown**: (based on the priority of the physical aspects)
  - 5mins General ROM,
  - 5mins Injury Prevention,
  - 10mins Body Awareness,
  - 10min Lifting Development,
  - 5mins Bwt Power (Pow1),
  - 10mins Relative Strength,
  - 10mins Stability,
  - 5mins Specific ROM

Summary of Key Points

- Using an aged based progression will allow for the physical qualities required to be addressed at key time periods and in the right loads allowing for not only the maximisation of physical development but also swimming specific technical development.
- There are individual differences to consider including chronological versus physical maturation, the differences between males and females and the within sex differences such high tone verse low tone individuals.
- The early exposure to stability, flexibility and Bwt strength training cannot be understated if one wishes to both maximise performance and limit the incidence of both performance limiters and incidence of injury.

APPENDIX 6

Basketball Australia Intensive Training Centre Program: Strength, Agility & Stability Program 2004, Julian Jones.

BASKETBALL AUSTRALIA

INTENSIVE TRAINING CENTRE PROGRAM

Strength, Agility & Stability Program
1999

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INTRODUCTION

The aim of this document is to provide to you, the coach, methods that will produce a base level of strength, agility and stability for developing players. This will enable your athletes to achieve more and be better prepared, physically, for the sport of basketball. This program has been developed for the adolescent athlete who has very little, or no weight training experience.

As with the 1st and 2nd editions of this program for the Intensive Training Centre, this document is designed for the coach who will be delivering the program to the ITC players. The information contained in this guide can also be used to educate players, parents and club level coaches on the “do’s and don’ts’ of conditioning.

GUIDELINES

The guiding principle for any conditioning program is INDIVIDUALISATION. All players are different and the level of the group you are working with, dictates the rate at which this program is implemented. The coach can, therefore, implement certain sections at different times, to other ITC programs or coaches.

The strength program should be introduced first, followed by the other components. At ITC level, the majority of the players you will be dealing with have had little or no weight training experience at all. This follows then, that if a general strength base is developed as early as possible, then the athlete’s skill level and performance in training will be enhanced.

The programs contained in this document are for the beginner weight trainer and will serve them well for the first 18 months of their weight training development.

RESOURCES

The best resource available to the ITC coach is a qualified strength and conditioning coach. The best form of accreditation in this area, is those coaches accredited by the Australian Strength and Conditioning Association (ASCA), in the form of a level 1 or 2 certificate.

Julian Jones will act as central resources for the strength and conditioning program, and will be available to help identify qualified personnel for each centre. Coaches will be visiting centres each year to assist with the implementation of strength & conditioning programs and will carry out an education session in that visit.

REFERENCES

Strength Training for Young Athletes
W. Kraemer and S. Fleck. Human Kinetic Publishers. Champaign, Illinois. Available from Peak Performance Consultancy, P O Box 129 Jamison, ACT 2614.

This book is a very good reference point for a multitude of exercises. Each exercise has a descriptive and pictorial account of how the movement is performed. It contains a section on designing and implementing weight training sessions for athletes as young as 12 years of age. This book emphasises how to introduce young athletes to strength training safely with particular focus on the performance of correct exercise technique.

Strength Training for Basketball

Guidelines for ITC Players and Coaches

The aim of undertaking a strength training program for basketball players is to provide a general level of body strength to be able to perform the skills of basketball to their maximum.

Weight training will improve the player's ability to run faster, jump higher and reduce the risk of injury. Building up a good weight training base will enable the player to handle the high playing demands of an ITC program and, in the future, State and National team training loads and volumes.

Within the community, there are some misconceptions and myths associated with the performance of strength training. A number of these myths are associated with the athlete's training age or females performing strength training. The majority of these misconceptions have no scientific basis and have come from people making sweeping generalisations about why certain things happen. To provide you with the necessary information to counter these myths, an explanation of a few commonly raised issues are listed below;

Strength Training Will Make You Slow
Strength training will not make players bulky and slow. This is a result of some former players doing bodybuilding type programs that should not be used for basketball. Provided that a qualified strength and conditioning coach have set the program, the opposite is in fact true. The stronger and more powerful the athlete, the faster and more agile the player will be around the court.

Girls Will Get Big and Bulky
Strength training will not make girls put on large amounts of muscle or make the girls look masculine. Usually young girls are not strong enough in their upper body to compete with older, more physically developed athletes. Strength training will simply enable females to be able to play at their best. A simple body shape change usually occurs with girls that make them look more athletic.

Weights Will Cause Growth Plate Injuries
There is virtually no risk of overuse injuries or growth plate problems in players starting some type of training, as young as fourteen years old, providing the appropriate guidelines and techniques are followed. It is a complete misconception that players shouldn't do any 'weights' until they are sixteen or seventeen years of age. Some would argue that failure to commence strength training until later on might be detrimental to playing longevity.

Weights Will Make Me Shoot Badly
When a player initially starts a strength program, slight changes to their shot distance can occur. Once the body has adapted to doing the strength training this problem will disappear.

Girls Can't Do the Same Strength Program as Boys
This is completely untrue! Girls can do the same program as boys without any problems whatsoever. The only thing that could be different is the amount of weight that girls use as opposed to boys.

Strength Training for the Young Basketballer

The aim for the young basketballer embarking on a strength training program is to improve their general strength level and improve them for their future playing years.

When implementing a strength program with young players, the following should be the emphasis of each session;

- Correct technique
- Safety procedures
- An understanding, by the player, of why they're doing strength training and the benefits it gives them.

A major consideration when planning and implementing strength training programs for young athletes, is the different levels the athletes can be at. What may be considered appropriate for a fourteen-year-old may not be appropriate for a seventeen-year-old. The coach must be able to differentiate between training age and chronological age, and physical maturity. In this type of situation, the coach may require the assistance of a strength coach to determine the starting level of different players. We must remember the principle of progressive overload here, with the emphasis on progressive.

The program outlined in this document can be done without the use of commercial weight training facilities. All one has to do is look for heavy implements around the house such as books, bricks and containers. Once the player has developed beyond this level, then they will need a suitably equipped gymnasium.

A Program for Beginner Weight Trainers at 14-16 years of age.

In order to achieve the desired results, strength training should be undertaken 3 times per week. The program is one of total body use, meaning that all body parts are used in the one workout.

The technique of all the exercises used, should be taught to the player by a qualified strength coach. The correct breathing should also be learnt on the various exercises.

Repetition Range
The program has an emphasis of initially making the player as strong as possible. Therefore, a repetition range of six to eight should be undertaken. This should be mixed every 3 weeks by changing to ten to twelve repetitions.

E.g.
- 6-8 repetitions for 3 weeks
- 10-12 repetitions for 3 weeks

The volume of work should follow a cycle of two weeks hard, one week light. Within the "light week", it is the volume of training that decreases while the intensity of the exercises remains the same. In terms of sets and reps, it is the number of sets that decrease (usually by half) while the number of reps stays constant.

Beginner Program

Week 1-2	4 sets of 8, 8, 6, 6 with each exercise except for abdominals
Week 3	2 sets of 8, 6
Week 4-5	4 sets of 12, 12, 10, 10
Week 6	2 sets of 12, 10

This process is then repeated. All abdominal exercises should be 4 sets of 25 reps. This is a guide only and a qualified coach should be consulted once the athlete gets beyond a certain level of training.

Bodyweight Program

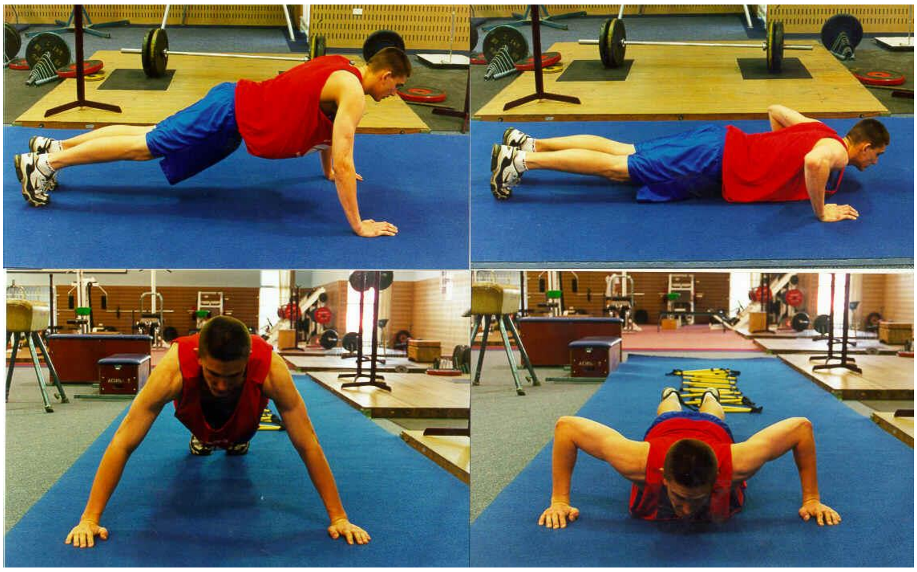
For those athletes that do not have s gym nearby for them to be able to undertake some of the strength training that is outlined in this document and many other the following bodyweight exercise program can be of benefit. All of the exercises below can be performed in your home with very little equipment needed to help. The repetitions that you would follow for this type of program would be eight to six. To start with just your body will be enough resistance, then if you cannot increase the resistance, by say holding heavy books or resting them on you body whilst doing the exercise, you can increase the number of repetitions out to twelve.

The pictures show how the exercises should be done and have a brief explanation. If you still are not sure what to do ask your coach.

Push Ups

Having the body in a horizontal position (as shown below) starts this exercise. Lower the body to the floor by allowing your arms to bend at the elbow. Control the decent of the body down to the floor. Allow only your chest to touch the floor and then push with your arms to move the body back into the starting position and have the arms return to their straight position. This exercise can be done with a wide hand placement or a narrow one. The difference being that the wider the hand placement the more work the chest does, the narrower the hand placement the more work the upper arm (tricep) does.

Points to remember with this exercise are that the arms should remain outside of the body as illustrated by the fourth picture below. For girls, it may be hard to start with the body straight and on the toes. You might have to start with your knees on the ground. Once you have done this exercise for a while you can change the feet position and hand placement position for better effect

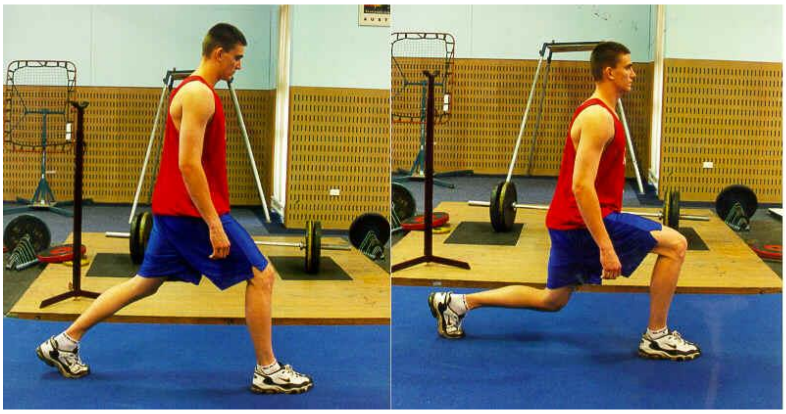


Dips

The start position for this exercise is shown below. You can find a box or bench to put your hands on. Put your feet and the rest of your body out in front of you and lower your body to the ground by bending your elbows. Make sure that you lower your body in a slow and controlled manner. Once you get to an angle of 90 degrees at the elbow joint, push with your arms to get back to the start position and straight arm position. Make sure that you do not lower your body to far as this will put unnecessary strain on the shoulder and sternum joints. Some athletes will find this exercise uncomfortable to do initially until their shoulder and sternum joints can go through the correct range of movement.

Lunges

This exercise is for the stability and strength of each leg. The reason for doing lunges is to identify and correct if one leg is stronger or does more work than the other. The start position, below left, has the body in an upright position and legs spread apart. Do not have both your front foot and back foot on the same line as this is not good for your balance. Once you have your feet in the right position lower your body by bending at the knee joint. Do not let your knee push over your toes on the front foot. Make sure that you only lower your body until there is a knee angle of 90 degrees on your front leg. Be aware that you don't let your knee of the back leg touch the floor. Push hard with your front leg to get your body back to the start position again. This will feel like you have to push backwards with your front leg.



Single Leg Squats

This exercise is for the strengthening of the upper leg whilst also making sure that the pelvis stabilises the upper body. The lowering of the body must be done in a controlled manner and the body is kept in an upright position as much as possible. The depth that you should lower your body to will depend on the flexibility of your ankle joint. To come back up from the bottom position you must use your hips to help by pushing them forward as you come up. Make sure that you do not lean to one side or have your body come out of alignment. When you lower your body make sure that your knee tracks over the big toe of your foot. This will keep you knee in the right alignment and make sure that the muscles of your upper leg are developed in the right way.

Static Hold

This is an abdominal exercise that teaches the body to be stable in four different functional lines. The body must be stable in all four planes of movement. Each position should be held for 15 seconds to begin with and then increased as you get better at holding each position. At each position the body must be held in a straight line. The arms in each position support the body, the hips are keep at the same level as the rest of the body, as illustrated by all the pictures below.

Calf Raises

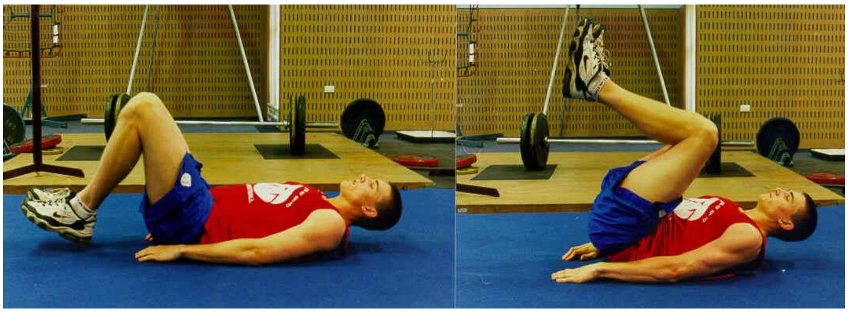
This exercise is for the lower leg and helps in the reduction of injuries to the knee. Most athletes do not have the right strength levels in this area to absorb the shock of landing. Making your calves stronger will enable you to handle more loads from the running and jumping that you do. Place the ball of your foot over the edge of a platform or a step. Lower your body as far as your ankle will let you and then lift your body by using you calves. The picture on the left shows that start position and the picture on the right the finish position.

Crunches

An abdominal exercise that can be done anywhere. Do not have your feet fixed to anything and have you legs bent at the knees. Keep your feet flat on the floor and have your hands next to your head. Do not hold the back of your head with your hands, as this will put stress on your neck. Let your abdominals do the work to pull the body up to the knees. Do not attempt to jerk your body off the ground in an effort to get up to your knees. Try to get your trunk off the floor as much as possible but let your abdominals do the work and not gain momentum with your arms.

Leg Raises

A lower abdominal exercise. The same start position as with the Crunch, but it is the legs that move and not the trunk. Keep you feet together and lift them at the same time until your hips start to lift off the ground. Keep your pelvis in its natural position, don't put your pelvis into a position that it is not used, or comfortable, in. The below pictures show the start position and finish position.



EXERCISES

1. Bench Press

Grip should be shoulder width apart. You can use a bar or dumbbells for this exercise. Lower the weight so it touches the chest at the same level as the shoulders. Push the bar back up to the starting position. The down phase should be in a controlled manner whilst the up phase should be done as quickly as possible. When working up to the bench press, push ups can be done initially with knees on the floor then working to having only feet on the floor.

2. Free Squats

Feet should be slightly wider than hip width apart. This allows a space for the hips to move when going down into the squat position. Keep feet flat on the floor. If this is difficult, a block up to 2 cm or more can be used under the heels. Bend at the hips and the knees until thighs are parallel to the floor. The chest must be kept high and the back as straight as possible. Stand up with the weight once you have gone down into the parallel position. To come up, use your hips as much as possible by pushing them forward while standing up straight.

3. Dumbbell Flys

Lie on your back on a bench that is wide enough for you to be stable on. With a dumbbell in each hand, extend your arms to a bench press starting position. Slowly lower your arms, while keeping them as straight as possible, away from your body horizontally. When the weight is parallel with your body, bring your arms back to the starting position. Having a slight bend in your elbows is recommended for this exercise.

4. Dumbbell Lateral Raises

Stand with a dumbbell in each hand. In a controlled manner, raise both arms directly out to your sides, keeping the back of your hand facing out to the side. Take the dumbbells up until your arms are at least parallel to the ground, then lower them again.

5. Bent Over Row

Hold a bar or dumbbells in your hands and bend over until your back is parallel to the floor. Pull the bar or dumbbell up until it touches your chest and then lower it in a controlled manner back to the starting position. Remember your back must be straight whilst performing this exercise.

6. Bicep Curls

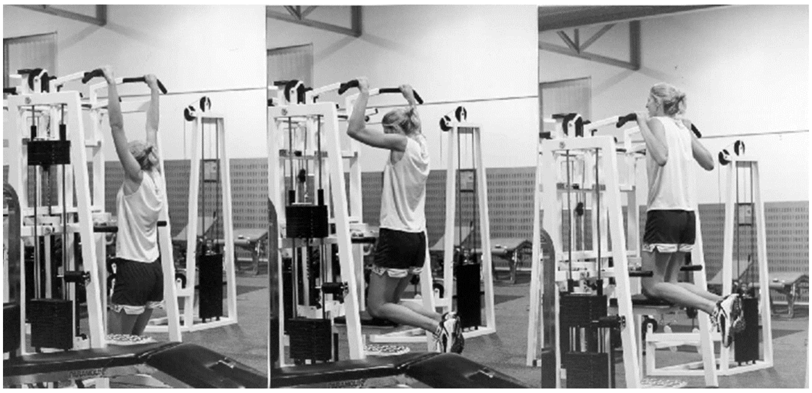
Stand upright, your back straight with a dumbbell in each hand. Keeping your elbows locked at your side, lift your forearm up so the dumbbell reaches your shoulder. Lower it to the starting position and repeat with the other hand. Do each arm alternatively, not together. Do not swing your arm up! This exercise can be done standing up or sitting down.

7. Tricep Press/Extension

Lie on a bench with your arms at full length straight up from your chest. Hold a bar with both hands or dumbbells in each hand. Lower the weight by bending your arm at the elbow joint, towards your chest. Do not let the upper arm move. Once the weight cannot lower any further, press the weight up until your arms are at full extension.

8. Chin Ups (Assisted)

Hang from a bar with your arms straight. Make sure that your feet don't touch the floor. Pull yourself up so your chin reaches the bar. If you have trouble doing this, have someone assist you by pushing up your trunk. This exercise can be done whilst kneeling on the machine (as pictured below) or standing on it. It depends on the equipment available.

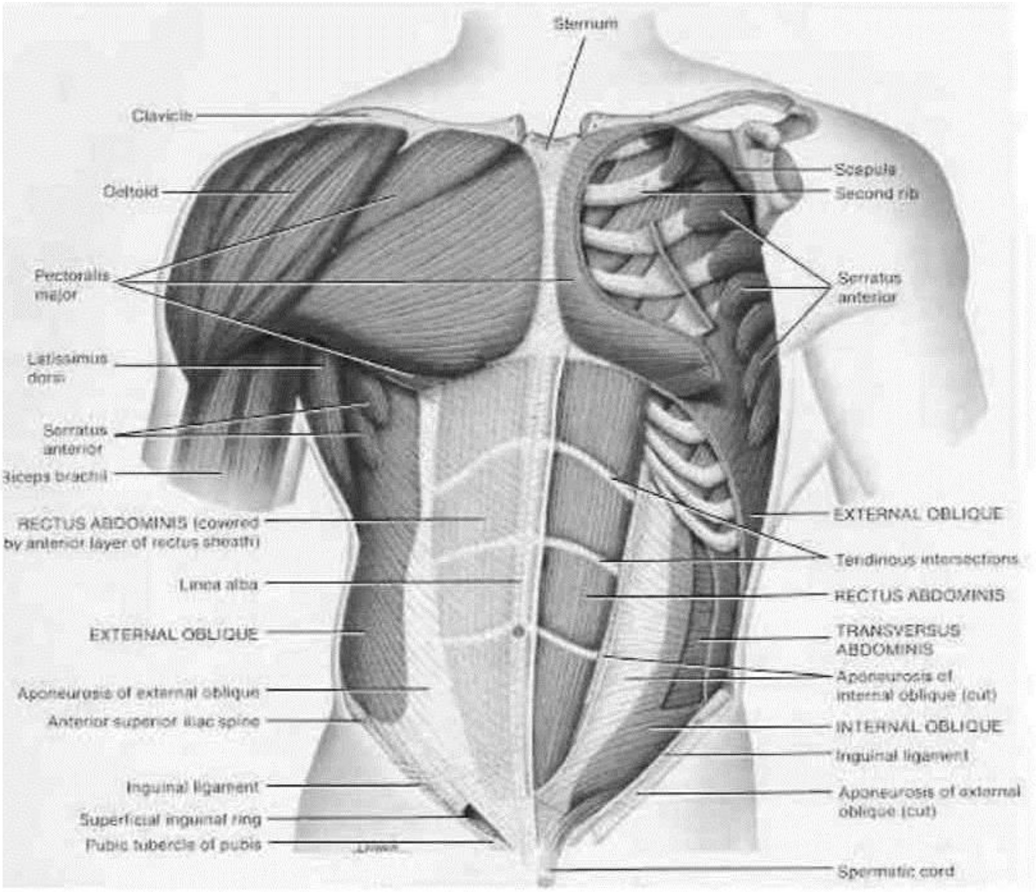


ABDOMINAL TRAINING

Core stability……..the flavour of the month in the strength and conditioning field. Being strong through the trunk is critical to developing good posture and preventing back soreness and injuries. With reference to basketballers, core strength is vital to playing longevity and playing performance. The information provided below will help you assess if your players are strong enough in the upper and lower abdominal areas and gives you some exercises that they should do.

ANATOMY

The anterior abdominal wall consists of four major muscles, the rectus abdominus, external oblique, internal oblique and transversus abdominus. The iliopsoas must also be considered because of its important effect on the lumbar spine during trunk flexion. The muscles are illustrated below;



External Oblique
- bends the trunk forward through bilateral stimulation
- main action is on the spine, posteriorly tilting the pelvis
- rotates trunk to the same side

Internal Oblique
- bends trunk forward through bilateral stimulation
- rotates trunk to the same side

Rectus Abdominus
- flees the trunk if the pelvis is fixed
- bends the trunk to the side when stimulated unilaterally
- assists in forced expiration

Transverse Abdominus
- increases intra-abdominal pressure
- creates an extension force in the flexed position

Psoas
- flexes the trunk when feet are anchored
- flexes the hip when the trunk is anchored
- if unchecked by the lower abs, causes anterior pelvic tilt and increases the lumbar lordosis

ABDOMINAL TRAINING ORDER

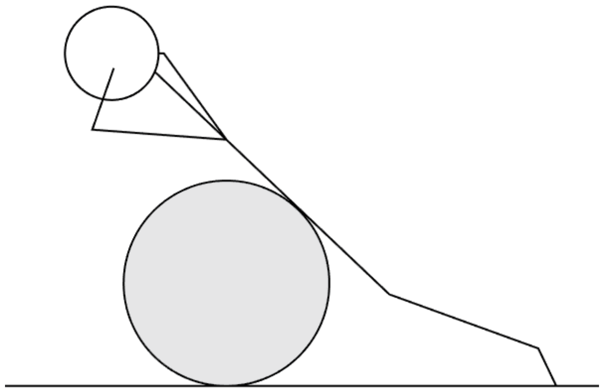
The following order of muscle groups is recommended when training the abdominal region;

- The lower abs – these exercises require maximal co-ordination and support from the upper abs.
- The obliques – these exercises also require maximal co-ordination.
- The upper abs – they involve simple movement patterns and generally are the strongest muscles in the area (Chek, 1992)

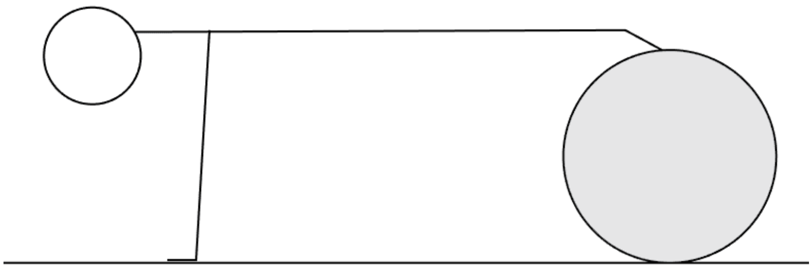
CORE STABILITY

Abdominal hollowing refers to the “drawing in” action of the abdominal wall. To do this, think about pulling your navel through to your spine. This action primarily recruits the transverse abdominus. Be careful not to suck your breath in – you should be able to breathe evenly when you perform this action. So when you are following the core stability program, concentrate on implementing this technique.

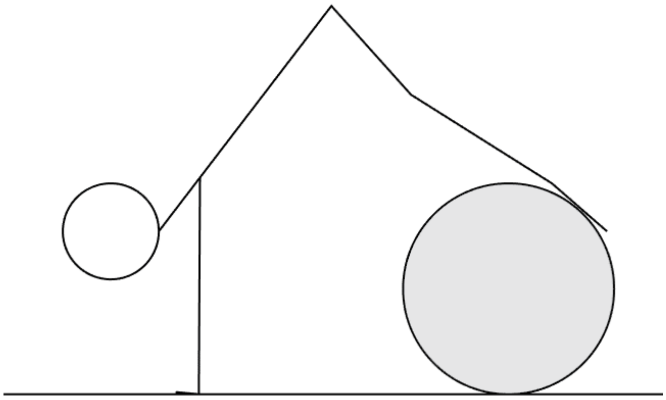
Back Extension
Lying face down on the ball, your feet are used as anchors. Bending at the waist, the athlete raises their upper body up until their body is in a straight line (see diagram) Repeat 10 times and complete 2-3 sets.



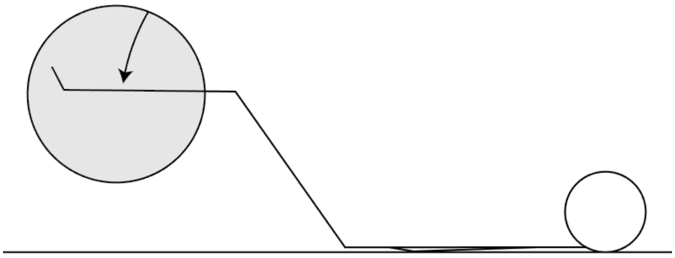
Swiss Ball Static Hold
Lying face down on the ball, walk out with your hands until you are in a “push up” position. Ensure that your back is straight and that your hips aren’t ‘sagging’. Hold this position for 30 secs.



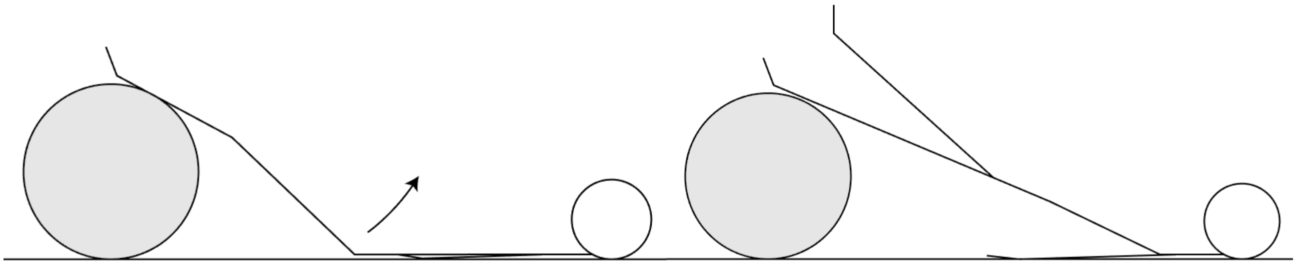
Swiss Ball Leg Tucks
Set up is the same as the static hold. Once hips are fixed, knees are tucked up towards the chest. Don’t round out your back like a cat, instead try to keep your back straight and hips in a static position. Complete 10-15 reps.



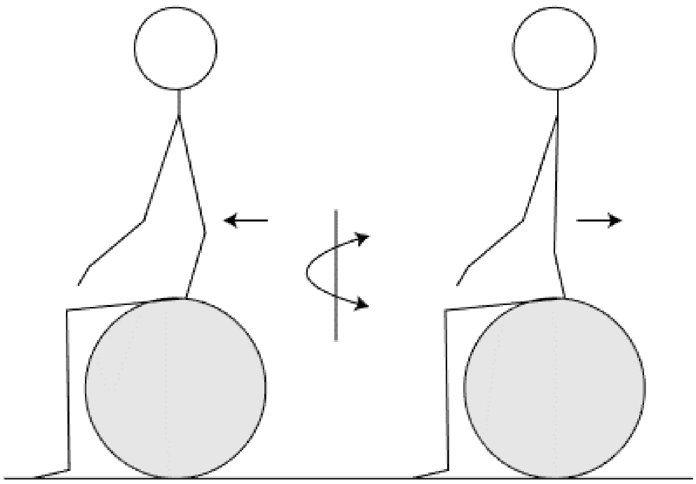
Swiss Ball Lower Abs
Using a small Swiss ball, place it between your legs. Start with the ball touching the floor, and lift your knees towards your chest. It is important that your abdominals don't 'stick out' when doing this exercise, and remember to practice the bracing. Complete 10-15 reps.



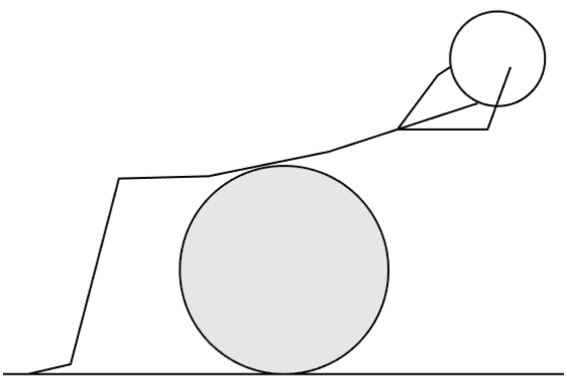
Swiss Ball Bridge
Lying on the floor, place your feet on top of the ball. Raise your hips until your body is straight. As you get better at this exercise, try not to use your arms to stabilise. Hold for 30 secs.



Swiss Ball Balance
Sitting upright on the ball, the athlete adopts a posture that braces their abdominals (see above). Slowly the athlete raises one foot off the ground, and when they feel comfortable they raise their second foot off the ground. Attempt to keep your feet off the ground for at least 30 secs.



Crunches on Swiss Ball
Can be completed either lying on top of the ball, or lying on the ground with feet on the ball (see diagram). Hands are placed behind the head, and the chin is raised up towards the roof (rather than a bend in the neck) Repeat 15 times.



AGILITY/SPEED

Being agile is the ability to change position and direction quickly; it demands a high level of balance, stability and co-ordination. The nature of basketball brings about unpredictable movements and situations that need to be reacted to quickly.

When incorporating agility/speed sessions into your program, it is important to keep three things in mind. The distances covered in each individual drill should be basketball specific. There is no point in doing 100m sprint when basketballers never cover that distance whilst playing. Secondly, you must carefully consider how much rest you will have between sets and/or reps. If your aim is to have your agility session double as a conditioning session there may be minimal rest between reps and relatively short breaks between sets. If your session is serving the purpose of purely improving body movement and efficiency, then there should be more rest between sets to allow for adequate recovery. Finally, as with any training session, there is no point in doing agility/speed sessions unless the athlete is putting in 100%.

As a coach, you are only limited by your imagination when it comes to agility drills. Below are a selection of drills commonly used by basketball coaches;

Partner sprints – Players stand at the baseline facing each other 2m apart. The player with his back to the court can turn and run to half court at any time. The other player's job is to 'tag' their opponent before they get to half court.