

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 www.cpsc.gov/library/neiss.html). This web site allows an individual to enter an activity (eg such as Weight lifting, code 3265; Exercise 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). 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 writing this Position Stand the US population was approximately 300 million or 15 times greater than the approximate 20 million Australian population.

If age is limited from 6 to 17 years for the year 2006 and 3265 entered for the product code (i.e. Weight lifting) the system records some 531 presentations at emergencies departments in the sample which is estimated to represent 18,592 presentations across the US as a whole. Of these presentations about 98% were simply seen or treated and released not requiring hospital admission. Approximately 33% of the injuries (6,093) were sustained at school, while about 26% (4,796) occurred in the home and about 14% (2,624) 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 individuals presenting to hospitals from weight lifting injuries the following regions were identified:

- Finger 3,196 (17%)
- Lower Trunk 1,930 (10%)
- Foot 1,882 (10%)
- Toe 1,386 (7%)
- Shoulder 1,323 (7%)
- Head 1,274 (7%)

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 59 cases of hospital presentations in the sample from weight lifting which corresponded to a population estimate of 1,713 for the U.S. as a whole. For the 10-13 year age category there were 68 cases of hospital presentations from weight lifting which corresponded to a population estimate of 1,994 for the U.S. as a whole. For the 14-17 year age category there were 404 cases of hospital presentations from weight lifting which corresponded to a population estimate of 14,885 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 2006.

Case #	Narrative provided by the NEISS
1	Dropped weight on finger. Diagnosis left thumb sprain.
2	2 nd toe contusion. Hit some weights at home.
3	Brother threw 2 lb weight on patient's leg at home; knee contusion.
4	Struck head on dumbbell, laceration to head.
5	Brother dropped 5-7# weight on head/scalp, laceration to head.
6	Sibling hit patient with a weight - cut to forehead. Diagnosis forehead laceration.
7	Diagnosis: Left third finger hematoma when weight fell on her at grandma's house.
8	Patient dropped a weight onto toe. Fracture toe.
9	Contusion to foot when a weight fell on foot.
10	Bumped foot against weight bench - laceration right foot.
11	8 year old male fell on weight bench, contusion/abrasion to lower trunk.
12	Lifting weights bar with 2.5 lb on each end, dropped it on face. Laceration to face.
13	Patient fractured finger when dropped a weight on it.
14	Child lifted and then dropped an 8 lb weight striking eyebrow. Diagnosis: eyebrow laceration.
15	Crush injury with fracture left great toe: dropped 45# weight on her toe last night.
16	15 lb weight fell and landed on patient's right foot. Diagnosis: contusion right foot.
17	9 year old male was playing in the basement with friends when a weight fell on head. Diagnosis: contusion to head.
18	Patient dropped a weight on her foot yesterday. Complained of pain over mid 1st toe, swelling, limping. Diagnosis: toe contusion.
19	Crushed finger between 2-3 pound weights. Fracture finger.
20	Patient hit head on weight bench. Diagnosis: laceration above right eyebrow.
21	Dropped weight bar on hand, hand contusion.
22	Fracture finger with hand weights.
23	10# weight fell on foot, contusion foot.
24	Fracture finger when weight fell on it at home.
25	Child playing with dad's weight set when dropped 50 pound weight on finger. Diagnosis: phalanx fracture, laceration.
26	Patient tripped - fell forward on a weight on the floor, scalp contusion.
27	5 lb dumbbell fell from bed hitting patient on head; forehead laceration.
28	Laceration scalp - hit with 5 lb rubber weight while playing with cousin.
29	Patient fell off a balance beam and hit forehead against a weight. Diagnosis: laceration forehead.
30	Patient slipped on steps and cut head on "weight lifting thing"; scalp laceration.

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 2006.

Case #	Narrative provided by the NEISS
1	Patient has chest pain, was weight lifting yesterday; left without being seen.
2	Upper arm strain, lifting weights.
3	Pain to left 4th digit; smashed finger with a weight bar at school. Diagnosis: avulsed cuticle 4th left digit; hematoma.
4	Patient complained of testicular pain. Patient started lifting weights and started having pain. Diagnosis: testicular pain.
5	Finger contused, lifting weights.
6	Patient slipped and fell; landed on Dads weights; hurt back. Diagnosis: fall; contusion back.
7	Patient dropped 5 lb weight on foot; foot contusion.
8	Patient was lifting weights at school and felt a pop in his back. Diagnosis: low back pain; muscle spasm.
9	Patient dropped 10 lb weight on right index finger. Diagnosis: contusion right index finger.
10	10 year old male hit face on a weight. Laceration to face.
11	Right shoulder pain after lifting weights at school. Diagnosis: Right shoulder separation.
12	Child hit with weights in head. Internal organ injury.
13	According to mum, patient lifting weights from floor at cousins house. Diagnosis: lumbar back strain
14	Left foot pain, dropped weight on it at home. Diagnosis: contusion left foot.
15	Contusion left elbow - lifting 50 lb weights lost balance - hit elbow.
16	Patient fell off bar while doing pull ups in physical education at school. Diagnosis: right ankle sprain.
17	Patient dropped weight on foot. Diagnosis: laceration left foot.
18	Dropped 10 lb weight onto left thumb. Diagnosis: fractured thumb.
19	Patient stated he was lifting weights 2 days ago and hurt his left arm. Diagnosis: Myofascial strain left elbow.
20	Patient states weight fell onto right hand at school. Diagnosis: Laceration/contusion right middle finger.
21	Dropped 10 lb weight on finger. Contusion of finger.
22	Weight fell on finger. Diagnosis: Finger fracture.
23	Weight lifting at local gym and has ankle swelling. Diagnosis: ankle sprain.
24	Patient has been lifting weights twice per week in gym class, has lump in chest; gynecomastia.
25	Broke light bulb while lifting weights at home. Glass in eye, removal of foreign body right eye.
26	Contusion of finger after dropping heavy weight on finger.
27	Patient dropped a 45 pound dumbbell onto left foot, contusion great toe.
28	Patient smashed right finger while lifting weights. Diagnosis: right 5th finger injury.
29	Patient dropped weight on hand while lifting weights. Diagnosis: right 4th finger contusion.
30	Having abdominal pain after using weights last night, no bowel movement since, vomiting 4 times, has ileostomy bag intact; high risk abdomen, bowel obstruction.

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 2006.

Case #	Narrative provided by the NEISS
1	Contusion toe - 14 year old female complained of left great toe pain after dropping a weight on it class at school.
2	Patient was injured while lifting weights at school. Diagnosis: concussion.
3	16 year old male bench pressing at school, weight fell on chest causing contusion of upper trunk.
4	Low back pain after lifting weights. Diagnosis: low back pain.
5	Patient fell backward while lifting weights fell on outstretched arm. Forearm fracture.
6	Diagnosis - right middle finger contusion: dropped weight onto finger.
7	While lifting weights, a 50 pound weight came down on jaw. Diagnosis - left jaw contusion.
8	Lifting weights elbow pain at school left elbow tendonitis.
9	Hurt knee doing squats with weights. Diagnosis: knee injury, probable sprain.
10	Patient has been lifting weights, now has pain in his shoulder. Diagnosis: shoulder strain.
11	Patient at school doing weight lifting with legs felt a pop in knee. Diagnosis right knee strain.
12	Lower back pain after lifting weights. Diagnosis: acute low back pain.
13	Patient diagnosis muscle strain (forearm) - due to weight bearing exercise yesterday.
14	Patient lifting weights at school & heard pop; complained of chest pain/tenderness. Diagnosis: sternocleidal injury, vessel involvement unknown.
15	Diagnosis right thumb sprain: weight training, hit thumb on chair with weights in hand.
16	Injured shoulder while lifting weights. Diagnosis: left shoulder sprain.
17	Back pain after lifting weights at school. Diagnosis: thoracic strain.
18	Left shoulder pain after lifting weights. Diagnosis: shoulder strain.
19	Patient helping to take the weights off a barbell at school strained lower back.
20	Patient accidentally hit self on the mouth with a weight. Diagnosis: laceration lip.
21	Weight fell on patient's finger at school, patient with hemophilia; finger laceration.
22	Dropped 20 lb exercise weight on foot at school. Diagnosis: contusion foot.
23	Patient sprained a shoulder while weight lifting at school.
24	Patient complained of chest pain, patient did workout at gym doing squats with barbells. Diagnosis: musculoskeletal chest pain.
25	Patient lifted weights yesterday, complained of ankle pain. Diagnosis: left ankle sprain.
26	Patient's thumb was pinched in weight machine. Diagnosis: left thumb laceration 2 cm.
27	Low back pain after lifting weights. Diagnosis: acute low back pain.
28	Child hit head on weight bar. Diagnosis: internal organ injury.
29	15 year old female had 45 lb weight fall on hands. Hematoma left finger.
30	Strain lower back, patient lifting weights without instructions at home, complained of pain, tenderness, full range of motion.

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 eg 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 areas is a very dangerous locations 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 the majority of 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 a number of 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 being placed upon it 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 can not 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 of time. 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. 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.



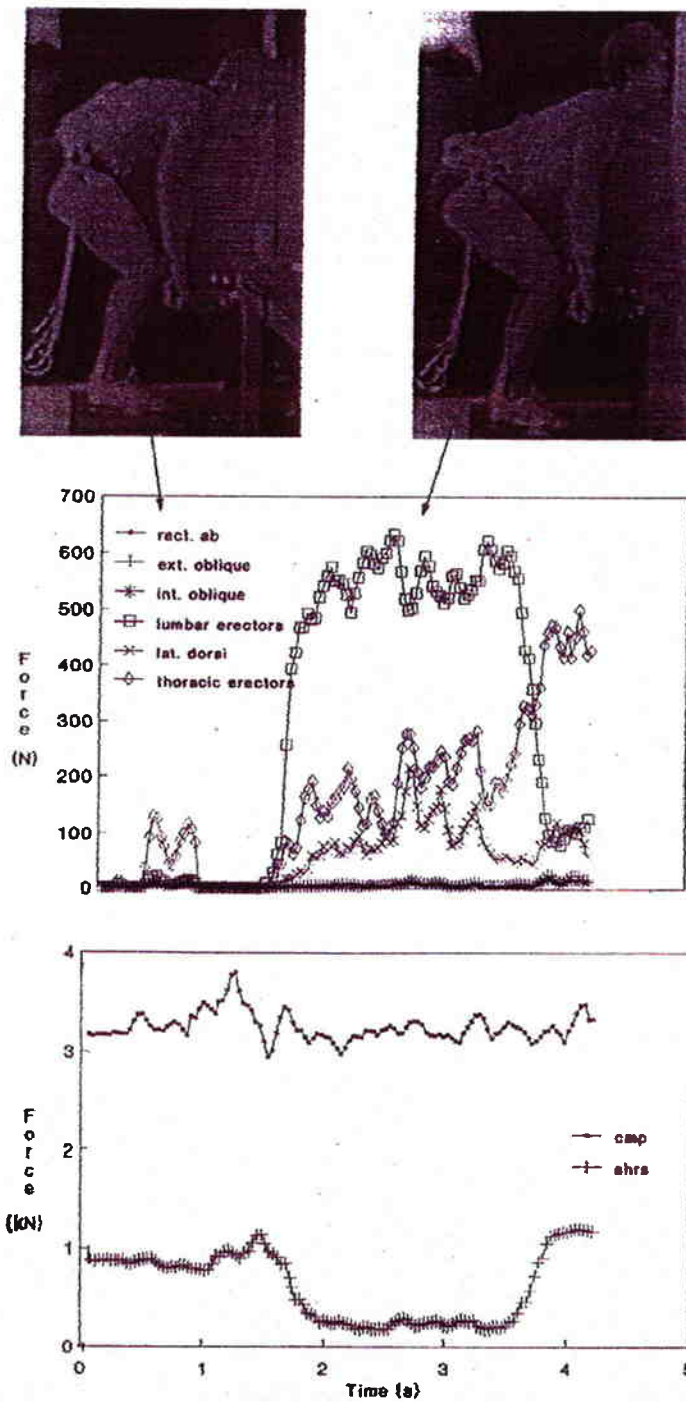


Figure 1: Lower back posture while deadlifting using a natural lumbar curve (right figure) and a forwardly flexed spine (left figure) and their associated muscular activities and forces (from McGill 1997 p 471).