Review on Identifying the Causes and Frequency of Weight-training Injuries and their Prevention Strategies

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Abstract

Introduction: The purpose of this study was to investigate the causes and frequency of weight-training Injuries. **Methods:** To conduct this research, background research was performed using search engines from 1980 to 2018. In the next step, after excluding unrelated articles, articles containing information on weight-training injury and prevention of sports injuries were selected. **Results:** The results revealed that men are more injured than women. The major location of injuries in weight training was the upper part of trunk (25.1%), the lower part of trunk (21%), hands (17.9%), legs (12.7%), and head (11.9%). Furthermore, the major types of injury were sprain and strain (47.2%). In addition, most injuries from weight training occurred in ages 14-18 and 23-30 in hands and upper body respectively. Strain and sprain were the most common injuries for 13-34. The injury was different in women; most injuries in women occurred from the ankle down and trunk. Movements causing injuries included deadlift, squat, chest press, and overhead press. **Conclusions:** Injury occurred less in women compared with men in strength training. Lower body was injured more than the upper body in women. Injury in those with 14-18 years old results from lack of knowledge about the use of machines and fall of weights on limbs. On the other hand, those with 23-30 years of age tend to use heavier weights which can lead to ligaments injuries. It is recommended that sports coaches teach correct and risky exercises to athletes for injury prevention.

Keywords: Epidemiology, Resistance training, Weight training, Injury prevention, Sports injury

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Introduction

Resistance training is becoming popular for both professional athletes and teenagers. (1) It could be done with free weights (no external support), resistance machines, and other sports facilities. Resistance training is used in different sports fields such as bodybuilding, fitness, physique, Olympics weightlifting, strongest men, powerlifting, CrossFit, and sports specific strength and conditioning. This type of training, especially use of weights, could cause muscular and skeletal injuries such as fractions, dislocation, spondylosis, hernia, and meniscus (2).

Many people participate in weightlifting, strength training, and bodybuilding and nowadays musculoskeletal injuries have become an important problem. (2) Injuries related to weight training are of two kinds: the first which is more common occurs while moving weights when too much pressure is on the muscle and causes injury. The second is weight room accidents when participants are struck by falling weights or trip over equipment on the floor (1, 2).

Becoming familiar with exercises done by athletes who become seriously injured with weights could help doctors in taking accurate history (1). The mechanism and cause of injury depend on the method of exercise though many injuries are similar (1). Preventing injury is a goal of primary care. The first step of prevention is awareness and gaining enough knowledge about prevalence and causes of injury in an exercise. Information on weight injuries is

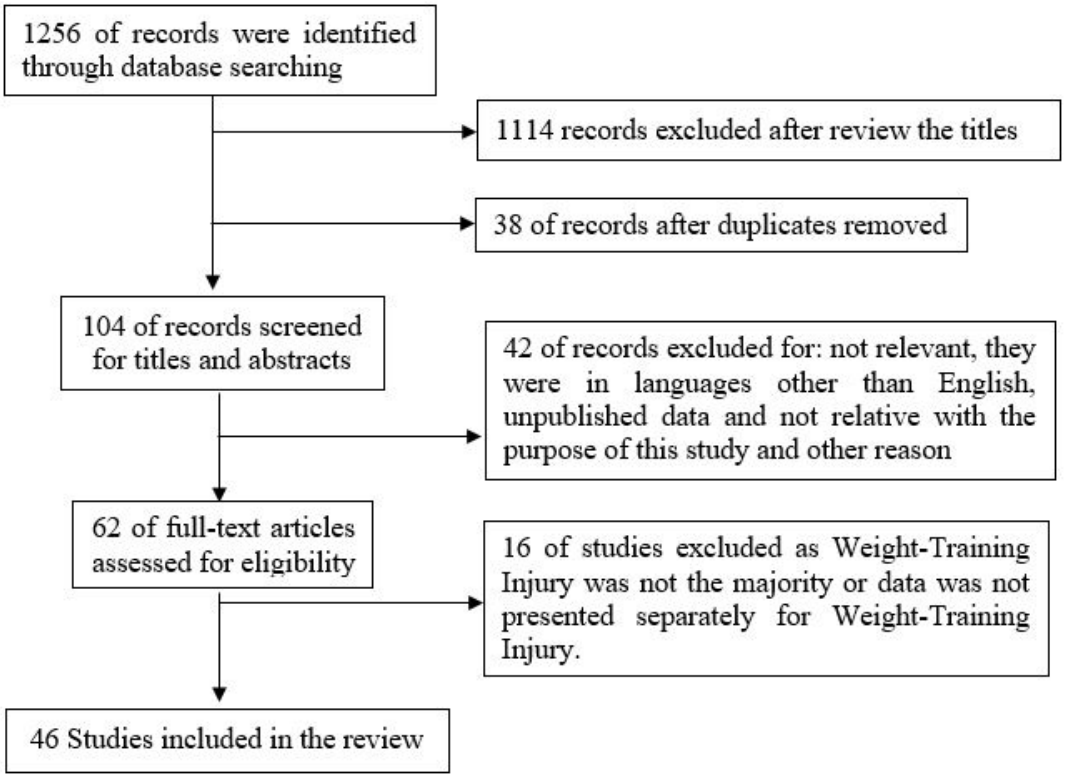

Figure 1. Flow chart of the study selection process for eligible studies in the review article

provided from emergency, orthopedics (3-6), physicians, sports coaches, and bodybuilding coaches' reports (7). Also, a better understanding of risk factors is required for gaining more information about injuries (8). Accordingly, the purpose of the present study was to determine resistance training and bodybuilding injuries that occur because of weight training.

Materials and Methods

This study was a review of studies on the causes and prevalence of bodybuilding injury and methods to prevent them. Information was collected using search through articles published within 1980-2018.

Databases used included PubMed, ISI Web of Knowledge, Scopus, Google Scholar, and ProQuest using Search query of sports injury, weight training injury, preventing sports injury. After finding the articles and eliminating unrelated items, articles with information about sports injury and their prevention were analyzed (Figure 1).

Results

The number of people participating in resistance training is progressively growing, hence the number of people at risk of injury also increases (9). Several studies have been conducted on weight training injuries in children and teenagers (11-7), adults (3, 9, 12), and athletes (9, 13, 14).

Keogh and Winwood (2016) analyzed injury in weight training and found that the most commonly injured anatomical locations included: shoulder, back, knee, elbow, wrist, and hand, with the most common types being sprains and strains (15).

Brown and Kim (1983) report that 28 of 71 athletes were injured. These 28 had 98 injuries whose cumulative frequency was 39.4%, with the mean participation of 17.1 months (7).

The study of Risser et al. in 1990 with the purpose examining weight training injuries in 354 athletes showed that 25 athletes were injured. The cause of the low injury rate was the supervision of coaches on athletes during exercises (8). Also, Zemper in 1990 did a study for four years on 297088 athletes. During this time, only 34 athletes were injured by weight training. The reason was the presence of professional coaches in

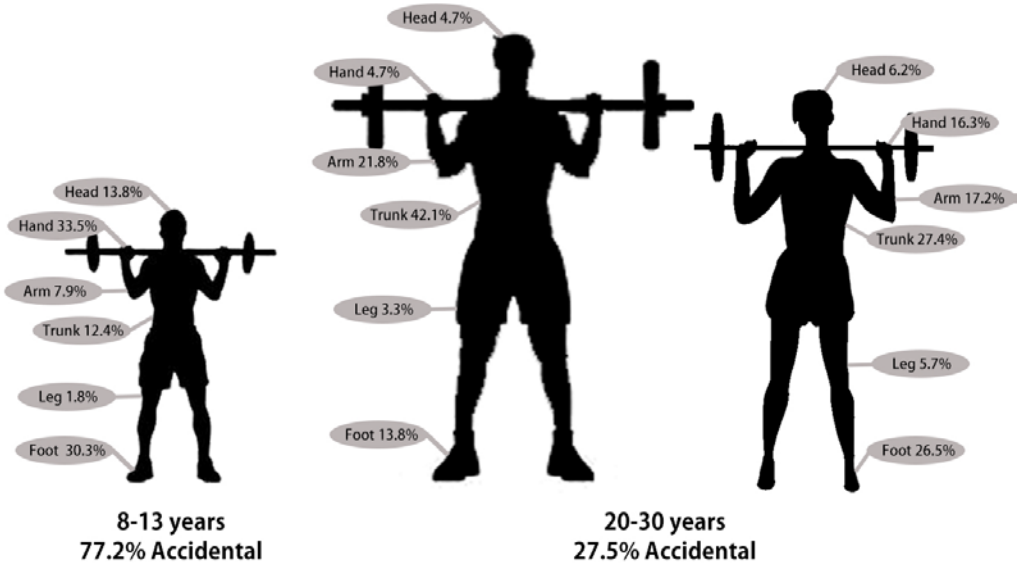

Figure 2. Injury rates by the anatomical location in children (left) and adults (men and Women on the right)

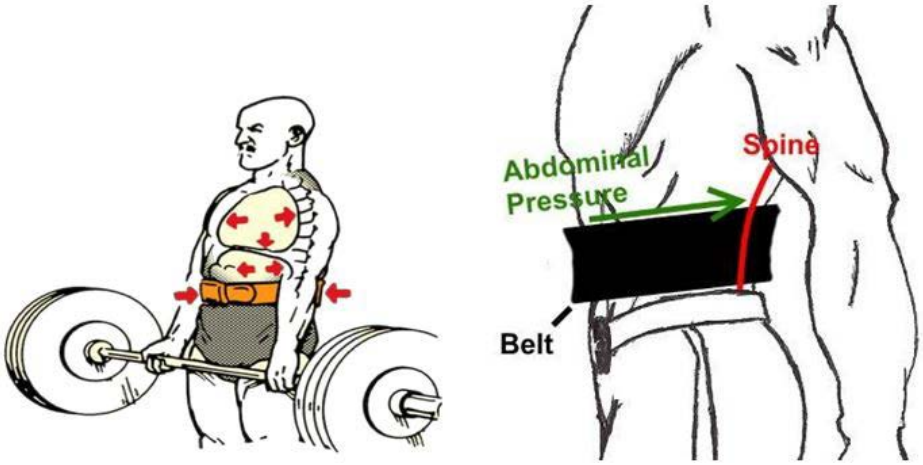

Figure 3. Special belt for strength training; internal pressure is increased during lifting weight and belt causes external pressure. The sum causes an increase in power, more stability, and supports the back and trunk thereby allowing an athletic to lift more weight. Right) powerliftingbelts.org 2017, Left) gelisimalani.com 2018

include technical errors, immature skeletal structure, and abuse of anabolic steroids. Acute injuries in weight training include the training sessions (12). Squat, deadlift, chest press, and shoulder press are the most injury-inducing exercises (7, 8, 12, 16). Sudden accidents in the gym could also cause injury. When athletes move between machines, weights might fall on them by others (12, 17). That is the reason why the proper distance between machines is necessary. In the following, the results of the studies are reported based on three groups of severity of injuries, age group, and gender.

Discussion

Injury Severity

Acute Injury

Musculoskeletal injuries from exercise have been important for several systems such as the Consumer Product Safety Commission's report (2, 18). Possible risk factors for injuries sprains, dislocation, tendon avulsion, and compartment syndrome. Further, it is possible that problems other than musculoskeletal injuries such as retinal bleeding and cardiovascular problems would occur (1).

Figure 4. Biceps curl with a dumbbell, where anterior arm forces forearm and pushes it upward. Now if shoulder joint is not fixed, the scapula goes forward (A) and the movement is incorrect; the force is not efficient which leads to increased injury in the shoulder region. By contrast, shoulder fixation gives rise to efficient force and the lowest risk of injury (B).

Figure 5. Women-specific exercises in specific warm-up: all exercises are isometric. Hold for 10 seconds and three sets with rest for 20 seconds in between sets

A study by injury supervision National Electronic Injury Surveillance System (NEISS) in 1987 was performed on 64 emergency units in the US. The goal was to study referral to emergency for sports injuries. The results indicated that annually 17000 injuries from strength training occur in 10-19 years old which cause referral to the emergency room with most of these injuries occurring at home (17, 18). In a study in 1985 for sports injuries, 5.6 million people under 20 referred to the emergency room in that year in the US (19).

Chronic injuries

Strength training is usually done with heavy weights and should be done for a long time for achieving the desired results. This is a cause of chronic injuries. Rotator cuff muscle tendon inflammation, pressure injury to a vertebra, and clavicle injury are the most common chronic injuries. Also, muscular hypertrophy, poor technique, or overuse of a muscle could cause muscular injuries such as thoracic outlet syndrome or suprascapular neuropathy. Further, clinical

chronic problems also occur in weight training, with the most common being vascular stenosis, weight lifter's cephalgia, and hernia (20).

For maximizing their athletic performance, athletes perform weight training with heavier weights. The poor technique causes extra pressure on rotator cuff when lifting the weight which gives rise to shoulder injuries in athletes. Teaching proper techniques of weight lifting could lessen injuries (21).

Specifically, 36% of professional weightlifters who attend competitions have one spondylosis in their spine (20, 22). The prevalence of patellofemoral or tibiofemoral osteoarthritis in weightlifters has been reported as 31%; in competition runners, it has been 14%; and patellofemoral arthritis has been more prevalent in them (28%) than in football players (20, 23). Also, pressure fractions in the forearm, arm, and sternum in weightlifters are more common (20, 24-27). Further, studies have shown that weightlifters suffer headaches while lifting weights (20, 28-30).

Age group

Use of weights can lead to various injuries in adolescents and teenagers (2) with most injuries occurring among 13-18 (9). Athletes under 18 who have not reached full bone growth are prone to wrist and distal epiphysis of forearm (radius and ulna) fracture due to lack of control in shoulder press exercise (3-5).

It has been seen that short-term strength training conducted under the supervision of a teacher for elementary school students could prevent adverse effects on growth, flexibility, the performance of motor control, bones, and muscles, leading to low injury prevalence (31, 32).

Risser et al. in 1990 completed a study of weight training injuries among teenagers. A total of 354 teenagers and adults participated in the study and completed the injury questionnaire. The participants were divided into 3 groups with mean ages of 13, 15, and 17. The most common injuries were muscle rupture (74.1%) in the back (59.3%). The results revealed that the most dangerous exercise in 13 was chest press (95.2%), shoulder press (54.1%), and squat (42.9%). The most injuring exercises in 15 were chest press (95.7%), squat (72.3%), and shoulder press (71.9%). Finally, in 17, chest press (97.9%), shoulder press (87.6%) and squat (73.2%) (8) were the most damaging exercises.

Brown and Kimbal studied 71 participants across young adult weightlifting competitions. In their view, the definition of injury is any athlete missing one day of training because of sports injury. They found that the most common anatomical location of injury was lower back (>50%) with musculotendinous injury (inflammation, strain, and cramps). The mean lost time for each injury was 11.5 and the total lost time for all 98 injured people was 1126 days (61%) (7).

In Risser et al. study on sports injury among teenagers and adults, the absence of more than 7 days was the baseline. Further, the results showed the most prevalent site of injury as lower back (48%) and strain with 74% (8).

In Zemper et al. study on injury among 10908 adult football players for 4 years through data collection by Athletic Injury Monitoring System (AIMS), sports injury showed the common injury as strain (44%) in the lower back (44%) (12).

Other studies on different age groups suggested that more injuries occur in young adults (3, 7, 8, 11, 33). The common anatomical locations of the injury were lower back, leg (3, 7, 8, 11-14), and shoulder (11, 34) by strain (8, 12) (Figure 2).

Gender

Men and women differ in terms of musculoskeletal and metabolic features. Women's bones are relatively smaller, shorter, with less density. Thus, stress fractures are more probable for them. Women's pelvis is wider whereby the body center is lowered and balance is increased. However, a wide pelvis causes increased valgus angle in the hips causing hip injuries, iliotibial tendonitis, and trochanteric bursitis. Also, wide pelvis leads to Q angle changes. This change and weak quadriceps cause the patella to go outward. This, in turn, increases patella chondromalacia in women. Also, women's ligaments are looser because of relaxing hormones resulting in looseness in joints. Loose joints and increased Q angle promote knee injuries in women (35).

Injury in men was 82.3% and the mean age of injured 27.6 years (9). Also, other studies showed that most injuries of weight training occur in men (33, 36). Men in strength training are more affected by sprain and strain injuries, but women have more accidents in the gym. The trunk is the most commonly injured anatomical location followed by limbs which are injured more in women (37) (Figure 3).

Injury Prevention

All practice educations for all ages should be based on technical skills and maturation. Further, qualified professionals and coaches aware of strength training educations should work with these age groups (38).

Conclusion

Based on the review article, men get more injured than women in strength training. Injuries occur more in 14-18 and 23-30 years old. A common cause of injury in 14-18 is lack of knowledge about exercise machines causing weights to fall on limbs. However, among 23-30, the main cause of injury is the tendency to increase weights resulting in sprains and strains in the trunk. Hence, bodybuilding coaches and sports professional can prevent injuries by teaching proper exercise to athletes.

Review article suggestion

The timing of strength training

American children academy suggests the best time for strength training with free weights in teenagers with the onset of secondary sex features (39). At this age, some epiphysis such as wrists has become complete and not vulnerable anymore (2).

Gym and exercise machines

Resistance training salon should be large, cool, and air-conditioned. Exercise machines should be in place and not left in the salon and should be checked regularly to be replaced and repaired in case of any breaks. Equipment should fit the athlete's size and age. Nowadays, equipment is designed for teenagers and young adults and should be used in gyms.

Use of exercise machines and resistance band are safer for beginners. When people have basic physical readiness and nerve-muscle coordination, they can use free weights (2). It should be mentioned that injury could occur by machines; therefore, the proper use of machines and exercise should be taught and light weights should be used. Also, the tempo of exercise should be slow and controlled (40).

Special training belts are used for lifting heavy weights. It is believed that contracting the abdomen and the increase in abdominal pressure lessens the pressure to the vertebra (Figure 3). This has been proved in the squat (41). Note that weightlifting belts have flaws. If used regularly, they might prevent abdominal and back muscle growth. Also, their application is not possible for some weight training. For example, in the snatch, the barbell might get stuck to the belt. Further, the pressure of the belt on upper abdominal part prevents blood flow to the heart; therefore, the belt should not be used for this exercise (41). Lender et al. (1990) recommended the use of special belts in exercise with more than 80% weight for an individual. The belt should be loosened between sets. Special belts are divided into two groups. The first group consists of light belts of 7mm and 100mm width for beginners. The second group is heavy 3-layer belts with 11mm and 100mm width for professionals (41).

Many people do weight training for fun and leisure. Some exercises are done at home. The technique should be correct and heavyweight lifting needs an assistant. If the pressure gets too much, the exercise should be stopped immediately and weights should be reduced. If the pain is present, the athlete should refer to the doctor ASAP (2).

Technique

The proper technique could help with injury prevention. During exercise, the athlete should contract his/her core muscles relatively, activate muscle stabilizer, exhale during the contraction, and inhale when returning to the baseline and perform the weight with control. Also, it is better for the exercises to be performed under the supervision of a coach (40) (Figure 4 (42)).

Physical examination

Before weight training, a doctor should examine athletes physically. Some health problems limit weight training. Some structural problems such as crossed legs predispose the athlete to a knee injury. Further, musculoskeletal problems might occur that could be prevented by examination such as a seizure (43), cardiac diseases (44) and high blood pressure (45).

Warm-up and cool-down

Before exercise warm-up is needed. The main purpose of the warm-up is making the body ready for heavy activities and preventing injury by specific exercises. The warm-up should

be general and specific. First, in general warm-up, the athlete performs a general exercise such as static stretches with low intensity to prepare big muscles for activities. Then, with running in place, they increase the central body temperature. Then, specific warm-up is required. The coach or athlete should choose the exercises by considering the plan for the training. Women's bodies are different and some injuries might occur because of their structure; hence women should perform some specific exercises at the beginning of this warm-up (Figure 5). Then, they should practice the warm-up like men. For example, on Saturday, the goal of the training session is to strengthen chest muscles. Exercises include circular shoulder joint movements, elbow, and wrist with medium speed. Then. the main muscles (chest) and accessory muscles (deltoid and triceps) get ready with one to two sets of light weight exercises. After the training, the athlete should cool-down with light exercise for better recovery and decreasing exhaustion (46).

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