

# Relative Safety of Weightlifting and Weight Training

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## Reference Data

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## ABSTRACT

This paper discusses statistics derived from surveys and competitions. Analyses of previous publications and comparative data from other studies appear to contradict a general view that weight training is safer than weightlifting, when the latter is defined according to the International Weightlifting Federation's rulebook. Both activities appear to be safer than many other sports. The age group considered is largely school age.

**Key Words:** injury : hours ratio, sports, adolescents

## Introduction

In British educational circles, weightlifting and weight training are reputed to be dangerous activities for young people (6, 18). The concept of a high school strength coach is unknown. The belief that strength training helps protect against injuries incurred from other sports is not as widespread as in the U.S. Weightlifting is considered more suspect than weight training (6).

There is strong opinion from prestigious sources that weight training is not suitable, except with very light weights, until after the growth spurt of adolescence (13). These attitudes create difficulties for knowledgeable weightlifting and weight training coaches who wish to influence teacher training and practice in schools in order to maximize the benefits and safety of power and strength training for pupils and to introduce weightlifting as a sport option.

This study set out to review the evidence upon which this caution is based and to examine objectively the safety record of the activities in a sample of British schools. It became clear that a major source of confusion is the failure to differentiate the various types of weight resisted activity. Thus weightlifting is frequently blamed for injuries that were actually due to

other causes (5, 19). Such confusion obscures the relative dangers of the various weight resisted activities and leads to inappropriate advice.

Definition is crucial. Jones and McCabe (10) quote the annual statistics of the Office of Population and Census Surveys (17), which lists two deaths caused by weightlifting in 1988. Repeated inquiries at the medical statistics unit of this office, both by myself and an orthopedic surgeon, failed to elicit more detailed information beyond the comment that "the deaths were not as a result of weightlifting pursued as a sport." Since it is barely conceivable that anyone pursues Olympic weightlifting other than as a sport, apparently the activity was not weightlifting but some type of weight training. The statistics do imply, however, that weight resisted activity contributed to the deaths.

*The Guardian* newspaper (22) headlined a weightlifting death in December 1992. The victim was killed when weights fell on his face and neck while using a bench press machine. Again, this is not an accident in the sport of weightlifting. In order to avoid further confusion, this paper adopts the following scheme:

- *Category A—Weightlifting:* competition in the snatch and the clean and jerk; associated weight training.
- *Category B—Weight Training:* progressive resistance exercise with machines or free weights, for body conditioning to achieve fitness, strength, or improvement in other sports.
- *Category C (a)—Powerlifting:* competition in the squat, bench press, and dead lift; associated weight training.
- *Category C (b)—Bodybuilding:* weight training designed to achieve muscle hypertrophy for aesthetic effect.

Category A is characterized by predominantly rapid movements, often through a great range of movement. It is an Olympic sport using barbells, also called Olympic lifting. Category B involves a mixture of slow and fast movements but is often dominated by slow exercises. The extreme knee, shoulder, and hip flexions found in Category A are rarely used. The exercises seldom reach the same speeds as in Category A, which

may influence opinions about the relative safety of the first two categories.

Categories C (a) and (b) are characterized by slow movements, often through short ranges. They differ principally in the number of repetitions, low in powerlifting and relatively high in bodybuilding. Both are more similar in character to weight training than to weightlifting.

## Methods

### *Unit of Comparison*

This paper uses injuries per 100 participation hours to simplify comparison with previous studies (3, 12, 18, 21, 23). It can be argued that this understates injury rates. Zemper (24) used number of injuries per 1,000 athlete exposures in attempting to take into account the opportunity for injury. A collision sport such as soccer can be expected to have more injury opportunities per activity hour than a noncollision sport.

Injuries per 100 participation hours may therefore produce a better result for noncontact sports, but since total hours of participation relate directly to the lifetime risk of a sport, injuries per 100 hours might be considered to give the most objective assessment of that lifetime risk. Micheli (15) argues that repetitive impact sports such as running should give more cause for anxiety than should weight training.

### *Questionnaire*

Schools were surveyed by questionnaire (Figure 1) to determine the injury rate among students receiving instruction in weight training and weightlifting. The age group was primarily 13–16 years. Other popular sports were compared. Questionnaires were sent only to teachers who had attended instruction courses held by the British Amateur Weightlifters' Association, since these were the most likely to have experience with free weights for both weightlifting and weight training.

The injuries were defined according to the scheme by Hejna et al. (8). However, most teachers lacked detailed medical information and failed to follow the scheme in detail. Nevertheless, sufficient information was generated to enable comparisons to be made.

## Results

### *Questionnaire*

The response rate was almost 90%. The sports involved in the winter programs were Rugby Union, soccer, basketball, and field hockey. The summer sports were cricket and athletics. Responses are summarized in Table 1. The overall rate of injury for weight training and weightlifting (WT/WL) was 0.0012 per 100 participation hours. Two schools provided valuable, unsolicited information which is also summarized in Table 1.

### *Literature Review*

The papers by Kotani et al. (11) and Aggrawal et al. (1) are frequently cited by British critics of strength

training, and particularly weightlifting, as research based justifications for their cautious attitude. Kotani claimed that 31% of weightlifters suffer from spondylolysis, a disabling spinal degenerative syndrome. His sample, 26 competitive Olympic weightlifters, all presented with back pain; thus they were not randomly selected. According to Kotani, the incidence of spondylolysis in a random population would likely be 7%.

The incidence of defects of this nature can be expected to follow a Poisson distribution (16) in which the standard deviation approximates to the square root of the average frequency. If so, 8 in 26 (31%) is highly significant and would indicate that weightlifting is strongly correlated with spondylolysis. Kotani's observation, however, has never been duplicated, nor is spondylolysis encountered as a frequent condition by weightlifting cognoscenti. Since the sample was biased, this is not surprising. To justify concern, one would have to demonstrate a similar percentage of spondylolysis in a sample of weightlifters drawn at random, not selected on the basis of known symptoms.

Aggrawal et al. (1) studied 25 weightlifters and 25 athletes who used weight training. The authors consistently discussed spondylosis, not spondylolysis. These are different conditions with different etiologies. They refer to Kotani's paper as if it too deals with spondylosis. Their paper, analyzed by the chi-square method, showed no difference between the weightlifters and the athletes with respect to spondylosis, a condition associated with aging, not with trauma. It is relatively common in those over 30 years of age (A.J. Banks, orthopedic surgeon, personal communication, 1984).

In contrast to the above, Fitzgerald and McLatchie (7), studying weightlifters and powerlifters, ages 24 to 49, observed that degenerative osteoarthritis was half as frequent as in the population at large. This is particularly striking since both groups squat, and weightlifters squat to full knee flexion, an exercise frequently considered dangerous. The sample was small and diverse.

Brown and Kimball (3) studied adolescent powerlifters, revealing an injury rate of 0.0027 per 100 participation hours. All the injured athletes were questioned while in a competition. Clearly the injuries were not disabling. Their paper might be interpreted as indicating a high level of danger in powerlifting. However, the injury rate appears little different from, for example, USA basketball (Table 2). We do not know from the Brown and Kimball paper whether more serious injuries were suffered by powerlifters, who therefore could not compete. The figure may be an underestimate.

Sparks (21) gathered data during his 30 years as a medical officer at Rugby, a British boarding school. He logged injuries leading to a layoff of 1 week. His data, along with other published data, are incorporated in Table 2.

## Discussion

There is no statistically convincing evidence in the scientific literature that weightlifting or weight training

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Dear \_\_\_\_\_

Would you be so kind as to complete the following questionnaire and return it by end April? Please add any comments which might help.

#### Definitions

*Injury*: Any traumatic act against the body sufficiently serious to have required first aid, filing of school and/or insurance reports, or medical treatment.

*Serious injury*: Those causing disruption of one or more supporting structures of the body or damage to important organs (e.g., brain, liver, kidney). NB sprains, contusions, lacerations, superficial injuries are not serious.

*Permanent injury*: Where the body structure was not restorable to its original anatomy or function (broken tooth, paralysis, etc.).

*Weightlifting*: Snatch, C. and J., related fast assistance exercises.

*Weight training*: All other work with free weights.

NB if you feel it impossible to distinguish the two, please enter all under weight training and strike out the WL section clearly.

Your data will be compared with an American study involving many sports. I am only approaching teachers who have passed a BAWLA course and show evidence of skill and knowledge in the field, as evidenced by participation of pupils in competitive weightlifting.

If you feel you cannot fill in the questionnaire, then I will still value your comments, especially if you can give some objective measurement of the comparative safety of WT, WL and other sports in the school context.

Yours sincerely,  
Brian Hamill

### Injury and Progressive Resistance Exercise Questionnaire

Major winter sports of school:

Major summer sports of school:

1. For major winter sport during last 3 complete terms:

- (a) Serious injuries during school activity
- (b) Permanent injuries during school activity
- (c) All injuries during school activity
- (d) Number of participants
- (e) Injuries per 100 participants
- (f) Total estimated participant hours (i.e., number of participants  $\times$  average number of hours participation by each participant)

2. For major summer sport during last 3 complete terms:

- (a) Serious injuries during school activity
- (b) Permanent injuries during school activity
- (c) All injuries during school activity
- (d) Number of participants
- (e) Injuries per 100 participants
- (f) Total estimated participant hours (i.e., number of participants  $\times$  average number of hours participation by each participant)

3. For weightlifting during last 3 complete terms:

- (a) Serious injuries during school activity
- (b) Permanent injuries during school activity
- (c) All injuries during school activity

(d) Number of participants

(e) Injuries per 100 participants

(f) Total estimated participant hours (i.e., number of participants  $\times$  average number of hours participation by each participant)

4. For weight training during last 3 complete terms:

- (a) Serious injuries during school activity
- (b) Permanent injuries during school activity
- (c) All injuries during school activity
- (d) Number of participants
- (e) Injuries per 100 participants
- (f) Total estimated participant hours (i.e., number of participants  $\times$  average number of hours participation by each participant)

5. At what age do you begin weightlifting?

6. At what age do you begin weight training?

Signed \_\_\_\_\_

Name \_\_\_\_\_

School \_\_\_\_\_

Figure 1. Questionnaire used in survey.

**Table 1**  
Summary of Injury Statistics Derived From Survey

Sport	Serious injury	Other injury	Total	Partic- ipants	Particip. hrs (PH)	Injuries
						per 100 PH
Rugby	10	40	50	520	6,250	0.8000
Soccer/Rugby	24	66	90	1,770	65,750	0.1400
Cricket	0	3	3	950	18,525	0.0300
Athletics	0	2	2			
Winter sports <sup>†</sup>	17	58	75	3,230	125,700	0.0600
Summer sports <sup>†</sup>	1	13	14	2,840	142,355	0.0098
Soccer*	0	7	7	1,300	50,300	0.014
Basketball*	0	9	9	2 sch.	?	
Gymnastics*	1	7	8	1 sch.	?	
Badminton*	0	4	4	1 sch.	?	
Cross-country*	0	3	3	1 sch.	?	
Tennis*	0	3	3	1 sch.	?	
WT/WL <sup>a</sup>	1	0	1	4,698	80,725	0.0012
Weight training	1	2	3	520+	25,190	0.0120
Weightlifting	1	1	2	560+	148,370	0.0013
Total 3-5	3	3	6	5,868+	254,285	0.0023
All WL (est) <sup>b</sup>	2	1	3	1,634+	168,551	0.0017
All WT (est) <sup>c</sup>	1	2	3	4,040+	85,733	0.0035

<sup>†</sup>Two schools provided a partial analysis by individual sport; these figures do not include that analysis (indicated by \*).

<sup>a</sup>Respondents did not differentiate. <sup>b</sup>Assumes 25% of undifferentiated WT/WL time was WL and includes all WL injuries. <sup>c</sup>Assumes 75% of same (see<sup>b</sup>) and includes all WT injuries.

are particularly hazardous. The overwhelming impression from the surveys and literature is that both are markedly safer than many other sports, certainly when supervised by qualified people. Occasionally the literature describes injuries to weightlifters and powerlifters, but weight training seems to be the more common source of injury from resistance training. Falls are known to fracture wrists (19) and seem to be the universal background of frequent claims that weight training and lifting damage active epiphyses. In spite of exhaustive literature searches, I could find only one such injury reported in weightlifting (9). The boy concerned was unsupervised, training at home, and was not known to the Welsh National Weightlifting Federation (John M., secretary, Welsh Amateur Weightlifters' Assoc., personal communication, 1986).

The evidence is clear. Weight training and weightlifting are both very safe activities, certainly when competently supervised. Two factors may explain the perhaps unexpected relative safety of weightlifting, even when pursued by young coevals. First, weightlifting skills are complex and require a high coach-to-participant ratio, with knowledgeable coaching. Second, the skills can only be learned with light or easy weights at first. In other words, the participants are forced to take a gradual approach.

**Table 2**  
Multi-Sport Comparative Injury Rates

Sport	Injuries per 100 participation hours
Schoolchild soccer	6.20
UK Rugby	1.92
South African Rugby	0.70
UK basketball	1.03
USA basketball	0.03
USA athletics	0.57
UK athletics	0.26
UK Cross-country	0.37
USA Cross-country	0.00
Fives	0.21
P.E.	0.18
Squash	0.10
USA football	0.10
Badminton	0.05
USA gymnastics	0.044
UK tennis	0.07
USA powerlifting	0.0027
USA tennis	0.001
Rackets	0.03
USA volleyball	0.0013
Weight training	0.0035 (85,733 hrs)
Weightlifting	0.0017 (168,551 hrs)

Note. From data in Refs. 3, 12, 14, 19, 21, and 23.

The argument that weightlifting is inherently more dangerous than weight training because it involves single, maximum efforts (2, 4) implies that other sports, considered safer, do not. In fact, jumping, kicking, striking, tackling, and throwing are often single maximum efforts. The last repetition of a set in weight training is frequently a maximum effort. Jumping from a height of 80 cm is said to impart a force 20 times that of body weight on the ankles (20). No such impact occurs in weightlifting.

Competitive Olympic weightlifting includes many organized competitions for adolescents in the U.K., Australia, the U.S., and Eastern Europe. Britain's Schoolboy Championship has been staged annually for at least 18 years and has involved some 54,600 competition lifts (maximal or nearly so) and at least 54,600 lighter but still heavy warm-up lifts. In this period one boy suffered a concussion when he fell onto a weight after losing control, and another was bruised when he dropped a weight onto his upper back. In neither case has there been any evidence of a long-term consequence.

The serious injury from a fall represents roughly 0.0018 injuries per 100 participation hours, consistent with the survey results. In short, there seems to be no rational case for continued widespread anxiety about weight training or weightlifting in children.

## Practical Applications

The apparently low risk in weightlifting and weight training for young people should not lead to a laissez-faire attitude. The groups studied were, without exception, supervised by qualified physical education teachers. In almost every case the teachers were awarded additional specialist qualifications following courses organized by the British Amateur Weightlifters' Association.

These courses are characterized by close attention to technical skills and a thorough analysis of safety precautions, including questions of child development. In the U.S., similar courses are offered by the National Strength and Conditioning Association and the U.S. Weightlifting Federation.

Thus the practical implications of the information are as follows:

- Children involved in weight training and weightlifting should be supervised closely at all times by knowledgeable specialists.
- Weightlifting, under conditions of adequate supervision, is at least as safe as weight training.
- Both weightlifting and weight training are much safer than many other sports for this age group.
- Adequate training courses should be available for those who intend to supervise either weightlifting or weight training for children.

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