the physician and sportsmedicine

ORIGINAL RESEARCH

Weight Training Injury Trends

A 20-Year Survey

Chester S. Jones, PhD; Carin Christensen; Michael Young, PhD

THE PHYSICIAN AND SPORTSMEDICINE - VOL 28 - NO. 7 - JULY 2000

BACKGROUND: Weight training is a popular activity, but injuries can be a consequence. Research has documented the types and venues of weight training injuries.

OBJECTIVE: The objective of this study was to identify weight lifting injury trends.

DESIGN: A retrospective review of data from US emergency departments (EDs) that reported injuries from weight training and weight training equipment. The data include people who were treated for injuries from weight training or weight equipment from October 1, 1978, through December 31, 1998, and were identified by the National Electronic Injury Surveillance System (NEISS).

RESULTS: NEISS identified 20,489 weight training-related injuries. An estimated 980,173 persons were treated in EDs for injuries related to weight training activity or equipment during the study period. The number of ED-treated injuries has increased 35% since 1978. About one of four injuries occurred from the misuse or abuse of weight training equipment.

CONCLUSION: Cautionary messages should be aimed at young children, older adults, and users of home gyms. Those who train with weights should be instructed in the proper use of weight equipment.

People of almost all ages participate in weight lifting and resistance exercise for training and recreation. Researchers estimate that each month, about one of five US adults participates in weight training activities (1). The same study also notes that one in three men and one in six women participate in weight training activities. Weight training is also popular among adolescents (2).

The risk of injury from weight training and weight equipment is estimated to be from 2.4% to 7.6% of participants per year (1,3). When compared with injuries in competitive team sports and high-impact activities such as running, injury rates in weight training are low. However, because participation in weight training is increasing, many individuals are at risk for injury (2,4). Previous injury prevention recommendations are to perform warm-up exercises, seek adequate coaching from a qualified professional to learn appropriate techniques, avoid lifting alone, and use a spotter when using free or heavy weights (3,5-9).

This study of weight training injuries over the past 20 years reported to emergency departments (EDs) and collected by the National Electronic Injury Surveillance System (NEISS) provides estimates of injury trends and identifies the groups at greatest risk.

Methods

Subjects and sampling. Study subjects were obtained from a sampling of all patients who reported injuries related to weight lifting activity or equipment between October 1, 1978, and December 31, 1998, and initially sought treatment from a hospital ED that was participating in the NEISS (product code 3265). Data included injuries related to weight training and to hazardous or inappropriate use of weight training equipment. The NEISS is a national probability sample based on data from 101 hospitals that are selected from the more than 5,000 hospitals nationwide with 24-hour EDs (10). The sample includes hospitals of varying sizes and locations, as well as children's hospitals and trauma centers. Inner-city, urban, suburban, and rural areas are represented. The NEISS was developed in 1971 by the US Consumer Product Safety Commission (CPSC) to track injuries related to consumer products and has been updated several times to maintain its statistical validity. Studies have analyzed the NEISS' validity and have found it to be representative of product-related injury incidents nationwide (10,11).

Study variables. The NEISS records the product or products related to the injury, injury description (primary diagnosis and anatomic location), injury severity, descriptions of the ED visit (ie, date, discharge, demographic characteristics of the injured person, hospitalization status), and a brief narrative of the injury incident. The narratives for a subset of 97 records were reviewed to verify consistency for the research questions of this investigation and to obtain information about the causes of the injuries. The NEISS does not include a detailed report for every case, and anecdotal reports were available for only a sample of the total data.

Anatomic location of injury was categorized into seven body regions:

- head (including eyes, ears, forehead, face, mouth, and neck),
- upper trunk (including shoulders),
- lower trunk (including pubic region),
- hand (including wrist and fingers),
- foot (including ankles and toes),

- arm (upper and lower), and
- leg (upper and lower).

The type of injury was also categorized into groups for this study. Soft-tissue injuries included NEISS-labeled contusions, abrasions, crushing injuries, hematomas, and strains or sprains. The laceration category included lacerations, punctures, and avulsions. Fractures and dislocations were combined for analysis. The "other" injury category included concussions, dental injuries, foreign bodies, nerve damage, internal organ injuries, hemorrhage, burns, dermatitis or conjunctivitis, and other injuries.

Data analysis. Statistical analysis included a variance computation that accounts for the stratified sample design of the NEISS (10). Frequencies and univariate analyses were computed to describe basic demographics, injury characteristics, and risk calculations. Approximate 95% confidence intervals (CI) were computed by a statistical computation developed by the CPSC (10). The data were analyzed using the Statistical Package for the Social Sciences program.

Injury rates were computed per 100,000 population. Population counts for each age-group, gender, and year were obtained from the US Census Bureau (12,13). The percent change in injury rates was calculated by averaging the means from the years 1979 through 1983 and 1994 through 1998. The averaged means were compared to determine the percent change in the injury rate. Comparisons of the 5-year mean for the first and last 5 years of the study were done to control for fluctuations of the number of injuries by gender and age-group between each year.

Results

Trends. From 1978 through 1998, the NEISS identified 20,489 ED-treated injuries that involved weight training or weight training equipment. About 980,173 (95% CI, 864,905 to 1,095,441) weight training-related injuries were estimated to have occurred nationwide during that time (table 1). The injury rate increased by 35% between 1978 and 1998 (table 2). The population increased by 20% for the same period. Figures 1 through 3 (not shown) highlight the injury rates by age-group for men, women, and total for the study years.

TABLE 1. Estimates of Weight Training Injuries Treated in US Hospital Emergency Departments, 1978 Through 1998

Age-Group (yr)	Number	95% Confidence Interval	% of Total Injuries
0-4	49,926	41,119-58,733	5.1

5-14	188,625	159,049-218,201	19.2
15-24	426,627	368,094-485,160	43.5
25-44	318,757	275,024-362,490	32.5
45-64	39,861	32,830-46,892	4.1
65 and older	6,303	4,450-8,156	0.7
Sex			
Male	789,136	696,334-881,938	80.5
Female	191,037	164,827-217,247	19.5
Venue of Injury			
Home	393,708	339,691-447,725	40.2
Sports or recreation site	174,368	147,027-201,709	17.8
School	92,581	78,064-107,098	9.4
Not recorded	319,516	275,389-363,354	32.6

TABLE 2. Percent Change in Weight Training Injury Rates per 100,000 Population, 1978 Through 1998

	Age-Group						
Sex	**0-4**	**5-14**	**15-24**	**25-44**	**45-64**	**65+**	**Total**
Male	22.6	-11.6	30	86	183	303	28
Female	3.7	39	78	108	281	141	64

By age-group. The median age for individuals seen in the ED for weight training-related injuries was 22.9 years. Eighty percent of those seen in the ED were male, 20% were female, with 15- to 24-year-old males having the highest injury rate; however, women and older men accounted for the largest increases in injury rates (see table 2). Boys ages 5 to 14 were the only group that experienced a decline in injury rate. Table 3 details the mean injury rates by age-group.

TABLE 3. Mean Injury Rates per 100,000 Population for Weight Training by Age-Group, 1978 Through 1998

	Age-Group						
Sex	**0-4**	**5-14**	**15-24**	**25-44**	**45-64**	**65+**	**Total**
Male	16.0	28.3	92.2	33.6	5.7	1.4	32.4
Female	10.9	9.8	17.8	7.2	2.5	0.7	7.5

Anatomic site. The hand was the most often injured site (23.8%), followed by the upper trunk (18.8%), head (16.9%), lower trunk (15.5%), and foot (14.6%) (table 4). The most common diagnosis in the ED (see table 4) was soft-tissue injury (64.1%), followed by laceration (15.1%) and fracture/dislocation (13.3%).

TABLE 4. Estimated Numbers and Percentage Distribution for Weight Training Injuries by Body Part and Diagnosis, 1978 Through 1998

Injured Body Part	Number	Confidence Interval (95%)	% of Total Injuries
Hand	233,607	201,556-265,658	23.8
Head, neck	160,638	135,400-185,826	16.4
Arm	52,121	42,927-61,315	5.3
Upper trunk	184,466	155,542-213,390	18.8

Lower trunk	151,585	127,816-175,354	15.5
Leg	47,833	39,395-56,271	4.9
Foot	143,122	120,680-165,564	14.6
Unknown	6,801	4,801-8,801	0.7
Diagnosis			
Soft-tissue injury	627,879	541,734-714,024	64.1
Fracture or dislocation	130,751	110,249-151,253	13.3
Laceration	147,647	124,496-170,798	15.1
Other	73,896	60,861-86,931	7.6

Severity and venue of injury. The estimated number of persons who were hospitalized for weight training-related injuries was 22,616 (2.3%), (95% CI, 17,740 to 27,492). The most common venue of injury was in the home (40.2%, 95% CI, 21.4% to 44.8%); other locations included sports or recreation sites (17.8%, 95% CI, 7.5% to 27.1%) and schools (9.4%, 95% CI, 7.2% to 10.9%). Approximately one in three injury reports did not include an injury venue.

Children ages 0 to 4 were three times more likely to be injured in the home than those age 15 and older (odds ratio [OR] = 2.93, 95% CI, 2.90 to 2.96), and children younger than 6 years were almost six times more likely to be injured in the home (OR = 5.86, 95% CI, 5.71 to 5.93). This exposure to weight lifting equipment was found only in the home. Analyses of other environments found no exposure to weight equipment.

People 65 years old and older were at slightly higher risk for experiencing injuries in the home compared with those younger than 65 (OR = 1.25, 95% CI, 1.19 to 1.31).

Discussion

The NEISS data suggest that ED-treated injuries from weight training-related activity have increased over the past 20 years in all but one age-group. Most were soft-tissue injuries involving the hands, feet, and extremities. Only a few injuries (2.3%) were serious enough to require hospital admission. Young children were more likely to be injured in the home from weight training equipment than were other age-groups.

Incident summary reports from a selection of cases provided information on the causes of the injuries. However, a limitation of this study is that such reports were not available for all cases. Among 97 cases analyzed, the most common causes of injury were unsafe behavior (63%), equipment malfunction (37%), lack of supervision (30%), and inattention (10%). Almost two of three incidents involved free-weight equipment. Further research is needed to determine the behavioral and environmental injury contributors that may then be used to guide the development of education and training programs and improvement of protective equipment and clothing.

Fatalities. Another limitation of the NEISS data is that they were not designed to report fatalities. However, 34 injury summary reports noted deaths associated with weight training. Most of the fatalities were men (31, or 91%, with a mean age of 21), involved head or neck trauma (27, or 80%), involved suffocation or strangulation (22, or 65%), and occurred during the use of free weights (33, or 97%). Two out of three lifters who died were unsupervised at the time of injury. The primary contributing factor in almost all (33, or 97%) of the deaths was unsafe behavior of the participant. For example, one lifter died from asphyxiation after the barbell fell from a homemade bench onto his neck. A 48-year-old man drowned in a swimming pool after using a weight belt as an anchor for a breath-holding exercise. An 11-year-old boy drowned after jumping into a swimming pool while wearing ankle weights. A 1-year-old girl died from strangulation after becoming wedged between a bed and a weight bench.

Recommendations

This study highlights some common risk factors for injury from weight training activity and equipment. Injury-prevention efforts should be aimed at young children, older adults, women, and users of home gyms and should focus on appropriate use of weight equipment. The finding that children younger than age 6 were six times more likely that other groups to be injured with weight equipment was alarming: four of five sustained injuries from home weight equipment. Parents and caregivers should be reminded that children of this age should not be lifting weights and should be protected from weight equipment in the home. (The data reveal that children were playing with or around the weight equipment.)

Other people who experienced increased injury rates from weight training and weight equipment are those older than age 45. With increased life expectancy and more active lifestyles, older people are enjoying more active years and have increased their physical activity levels (14,15). Exercising with weights and using weight equipment have increased in popularity among older Americans. Research conducted over the past 10 years has documented bone mass, strength, and functional benefits of strength training for older people (16-22). However, our data suggest that injuries are increasing in this group as well. This is a concern because recovering from injuries at this age is more difficult and could lead to permanent disability and increased risk for other health problems. Healthcare and fitness professionals should continue to provide guidance and caution when selecting weight training activities for older people. Older people should be advised to select a qualified fitness professional who can instruct them on proper and safe use of weights.

Women are also experiencing increased injury rates from weight training equipment, most likely because the number of female participants has increased.

Another injury risk factor is the lack of supervision of participants. The injury risk is greater when participants use home gyms because they often lift alone and may not have spotters. These factors can delay emergency treatment if an injury occurs. Most deaths reported in this study might have been prevented if supervision had been available.

We recommend more and better instruction on the appropriate use and maintenance of weight equipment. Some of the injuries in this study were attributed to the inappropriate use of weight equipment and could have been prevented if the participants had used the weight equipment properly. These participants may have lacked education on appropriate weight training techniques. Instruction can be conducted in schools, fitness facilities, sports shops, or other places where weight training is endorsed. Current and future participants need to be reminded of the dangers involved.

Weight training is safe when done correctly and with supervision. Caution is necessary when considering use of a home gym. The safest option might be for participants to use weights in fitness facilities under the supervision of experienced and knowledgeable professionals.

References

1. Powell KE, Heath GW, Kresnow MJ, et al: Injury rates from walking, gardening, weightlifting, outdoor bicycling, and aerobics. Med Sci Sports Exerc 1998;30(8):1246-1249
2. Risser WL, Risser JM, Preston D: Weight-training injuries in adolescents. Am J Dis Child 1990;144(9):1015-1017
3. Risser WL: Musculoskeletal injuries caused by weight training: guidelines for prevention. Clin Pediatr (Phila) 1990;29(6):305-310
4. Frankle M: Weightlifting, weight training and injuries, letter. Orthopedics 1986;9(1):29
5. Requa RK, DeAvilla LN, and Garrick JG: Injuries in recreational adult fitness activities. Am J Sports Med 1993;21(3):461-467
6. Risser WL: Weight-training injuries in children and adolescents. Am Fam Phys 1991;44(6):2104-2108
7. Mazur LJ, Yetman RJ, Risser WL: Weight-training injuries: common injuries and preventative methods. Sports Med 1993;16(1):57-63
8. Reeves RK, Laskowski ER, Smith J: Weight training injuries: part 1: diagnosing and managing acute conditions. Phys Sportsmed 1998;26(2):67-83
9. Reeves RK, Laskowski ER, Smith J: Weight training injuries: part 2: diagnosing and managing chronic conditions. Phys Sportsmed 1998;26(3):54-63
10. US Consumer Product Safety Commission: The National Electronic Injury Surveillance System (NEISS) Sample (Design and Implementation). Washington, DC, US Consumer Product Safety Commission, July 1997

11. Quinlan KP, Thompson MP, Annest JL, et al: Expanding the National Electronic Injury Surveillance System to monitor all nonfatal injuries treated in US hospital emergency departments. Ann Emerg Med 1999;34(5):637-645
12. US Census Bureau: The United States, 1970-96, Bureau of the Census, Department Of Commerce, Washington, DC
13. US Census Bureau: Resident Population Estimates of the United States by Age and Sex: April 1, 1990 to May 1, 1999. Population Estimates Program, Population Division, US Census Bureau, Washington, DC
14. US Department of Health and Human Services: Physical Activity and Health: A Report of the Surgeon General. Atlanta, DHHS, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, 1996
15. Ward J: Exercise and the older person. Aust Fam Physician 1994;23(4):642-645, 648-649
16. Frontera WR, Meredith CN, O'Reilly KP, et al: Strength conditioning in older men: skeletal muscle hypertrophy and improved function. J Appl Physiol 1988;64(3):1038-1044
17. Seto JL, Brewster CE: Musculoskeletal conditioning of the older athlete. Clin Sports Med 1991;10(2):401-429
18. Graves JE, Pollock ML, Carroll JF: Exercise, age, and skeletal muscle function. South Med J 1994;87(5):S17-S22
19. Evans WJ: Exercise training guidelines for the elderly. Med Sci Sports Exerc 1999;31(1):12-17
20. Ades PA, Ballor DL, Ashikaga T, et al: Weight training improves walking endurance in healthy elderly persons. Ann Intern Med 1996;124(6):568-572
21. McCartney N, Hicks AL, Martin J, et al: A longitudinal trial of weight training in the elderly: continued improvements in year 2. J Gerontol A Biol Sci Med Sci 1996;51(6):B425-B433
22. Rogers MA, Evans WJ: Changes in skeletal muscle with aging: effects of exercise training. Exerc Sport Sci Rev 1993;21:65-102

Dr Jones is an assistant professor, Ms Christensen is a graduate assistant, and Dr Young is a professor in the Department of Health Science, Kinesiology, Recreation, and Dance at the University of Arkansas in Fayetteville. Address correspondence to Chester S. Jones, PhD, University of Arkansas, Department of Health Science, Kinesiology, Recreation, and Dance, 308 HPER Bldg, Fayetteville, AR 72701; e-mail to ches@comp.uark.edu.