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Injury Rates and Profiles of Elite Competitive Weightlifters

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Objective: To determine injury types, natures, anatomical locations, recommended amount of time missed, and injury rates during weightlifting training.

Design and Setting: We collected and analyzed medical injury records of resident athletes and during numerous training camps to generate an injury profile.

Subjects: Elite US male weightlifters who were injured during training at the United States Olympic Training Centers.

Measurements: United States Olympic Training Center weightlifting injury reports from a 6-year period were analyzed. Data were expressed as percentages and were analyzed via χ^2 tests.

Results: The back (primarily low back), knees, and shoulders accounted for the most significant number of injuries (64.8%). The types of injuries most prevalent in this study were strains and tendinitis (68.9%). Injuries of acute (59.6%) or chronic (30.4%) nature were significantly more common than recurrent injuries and complications. The recommended number of training days missed for most injuries was 1 day or fewer (90.5%). Injuries to the back primarily consisted of strains (74.6%). Most knee injuries were tendinitis (85.0%). The majority of shoulder injuries were classified as strains (54.6%). Rates of acute and recurring injuries were calculated to be 3.3 injuries/1000 hours of weightlifting exposure.

Conclusions: The injuries typical of elite weightlifters are primarily overuse injuries, not traumatic injuries compromising joint integrity. These injury patterns and rates are similar to those reported for other sports and activities.

Key Words: snatch, clean and jerk, resistance exercise, strains, tendinitis

As weightlifting becomes increasingly popular, safety is a growing concern.[1,2] The lifts in the sport of weightlifting emphasize explosive muscular power,[2,3] an essential property of many sports.[4] As a result, weightlifting-related exercises are often a training tool to enhance performance for numerous other sports.[4,5] In the literature, weightlifting is often termed Olympic-style weightlifting, in contrast with power lifting, body building, or general weight training.[6] Weightlifting consists of the snatch and the clean and jerk lifts (Figures 1 and 2). Power lifting consists of the squat, dead lift, and bench press. Body building's primary concern is muscle hypertrophy, whereas many other types of athletes employ general weight training. Weight training consists of general body conditioning, as well as sport-specific strength and power training with free weights and machines.

Injuries always concern those in athletics, and weightlifting is no exception. Injury mechanisms, prevalence, and rates provide critical information for the coach, athlete, and athletic trainer. Such information may ultimately help to provide a safer environment for the athlete.[2,7,8] Three anatomical areas thought to be at high risk of injury for weightlifting are also common injury sites in many sports:[9–11] the knee, the low back, and the shoulder. Data on power lifting and body building indicate that most injuries occur in the shoulder region, followed by the low back and the knee.[12]

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Injuries in weightlifting have been reported to include not only soft tissue muscle injuries, but also conditions such as spondylolysis and meniscal injuries.[3,5,13] In weightlifting, existing literature indicates that most injuries occur at the knee, followed by the shoulder and the back.[2,3,7,11,14–17] Kulund et al[3] also found that most injuries occur in the clean and jerk lift in weightlifting.[3]

Knee injuries concern not only those in the sport of weightlifting, but all athletes in general. Knee tendinitis, especially patellar tendinitis, is a problem for many athletes,[9] and high knee forces during weightlifting movements are typical. It is presently unclear whether long-term weightlifting training increases a person's risk of chronic inflammatory problems with the knee. Figures 1 and 2 illustrate the typical range of motion for the knee during the snatch and the clean and jerk lifts.

Back problems associated with both work and play are prevalent in our society.[10] Weightlifting demands high levels of dynamic force using both the upper and lower extremities, with the trunk musculature serving as both stabilizers and primary movers, depending on the phase of the lift. As a result, the loads used in weightlifting may put the back at risk of injury. One commonly cited injury is spondylolysis, a degenerative condition where the vertebrae develop stress fractures.[3,18] This could lead to a much more serious problem of the fractured vertebra sliding forward (spondylolisthesis). It has been suggested that weightlifting may predispose the

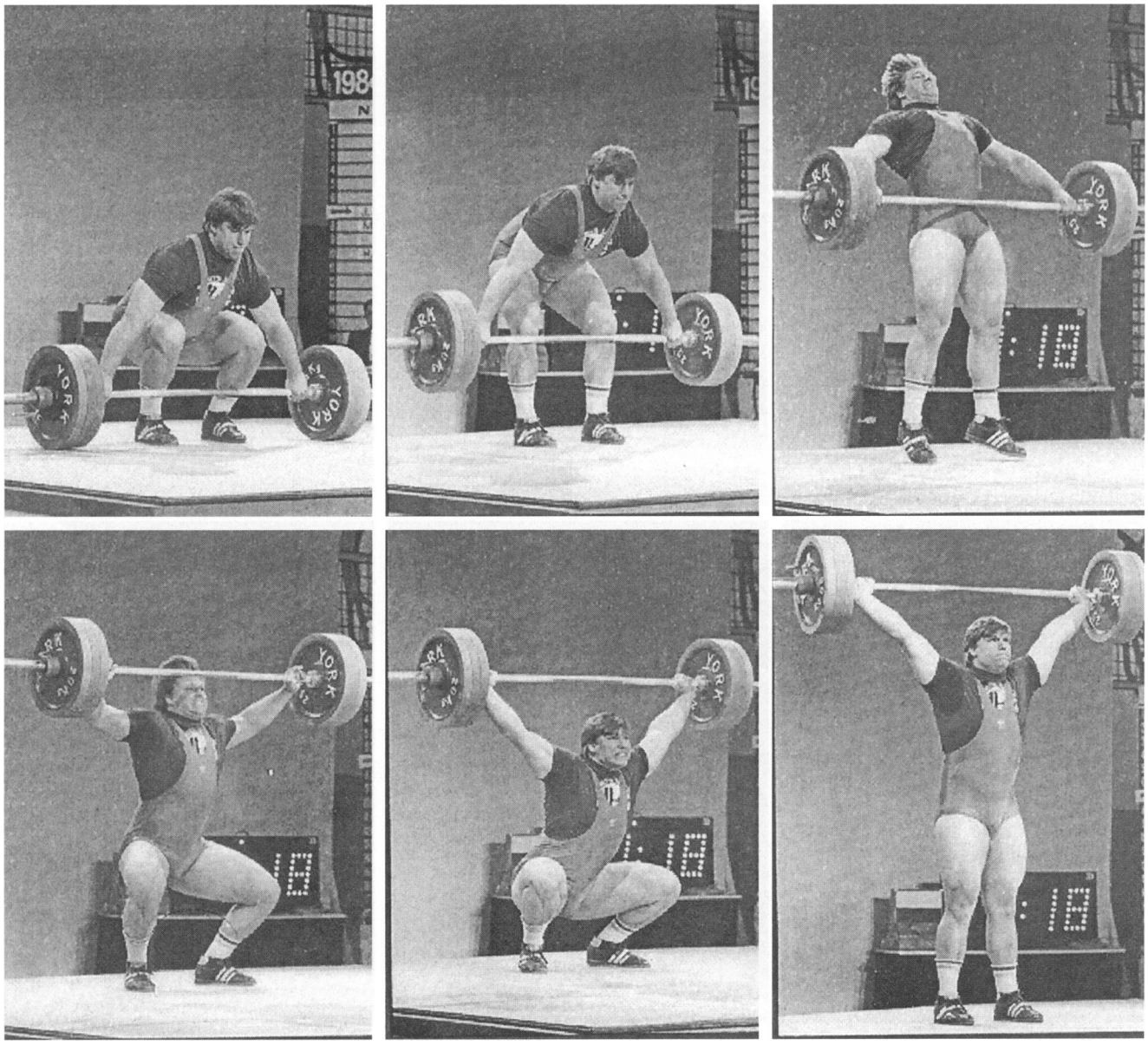

Figure 1. The snatch lift (Photos by Bruce Klemens, Courtesy of USA Weightlifting).

athlete to spondylolysis.[10,12,13] Figures 1 and 2 illustrate lower back involvement during the snatch and the clean and jerk lifts.

Another potential injury site for weightlifting is the shoulder. Because of its anatomical structure, flexing the shoulder into an extreme overhead position increases the risk of injury.[15,17] As a result, instability of the shoulder joint has been reported in weightlifters.[15] Figures 1 and 2 illustrate the typical range of motion for the shoulder during the snatch and the clean and jerk lifts. In weightlifting, missed lifts sometimes involve dropping the weight behind the lifter. Such a motion results in extreme external rotation and flexion of the shoulders.[3] This places the shoulder in a vulnerable situation and may increase the rate of shoulder injury.[2,3,7,11,15–17]

In light of this information, we determined the types, anatomical locations, and frequencies of weightlifting injuries for elite-level weightlifters. Some individuals hesitate to prescribe weightlifting-related exercises due to unsubstantiated perceptions of high rates of injury for this sport and misinformation as to the types of injuries encountered.[1,2] Such data may be beneficial in identifying actual areas of concern regarding injury manifestation for these high-velocity lifts. In this manner, the actual risks and types of injuries for this sport, as well as their rates of occurrence, can be accurately quantified.[2]

METHODS

Injury report forms over a 6-year period (January 1990 to November 1995) from the United States Olympic Training Centers (USOTCs) at Colorado Springs and Lake Placid provided the data for this study. Currently competing residents or partici-

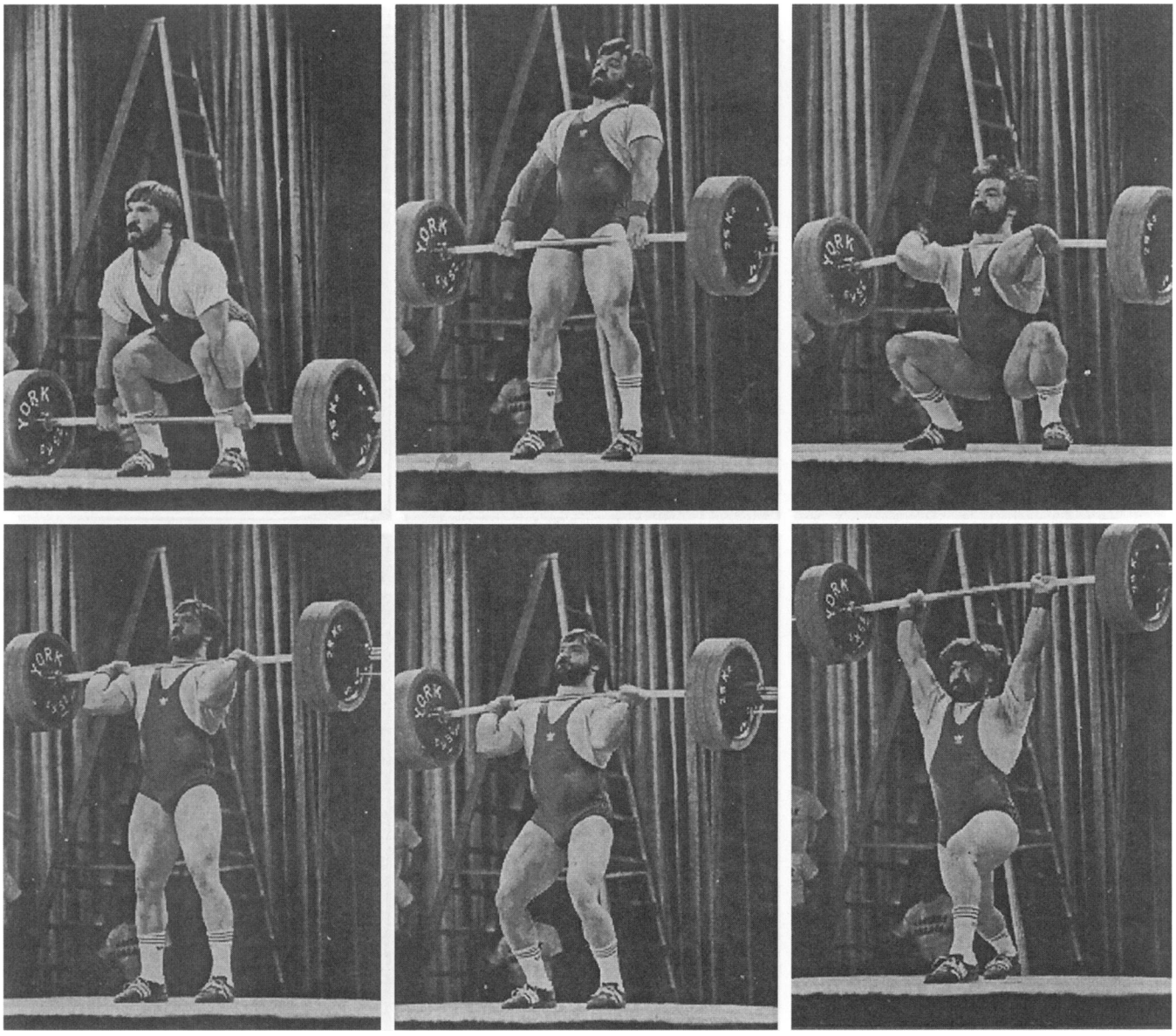

Figure 2. The clean and jerk lift (Photos by Bruce Klemens, Courtesy of USA Weightlifting).

pants in training camps at the USOTCs served as subjects. The athletes trained at the USOTCs as resident athletes or participated in Junior National Squad training camps or training camps in preparation for international competitions. The USOTC sports medicine staff, including athletic trainers, orthopaedic surgeons, family practitioners, and chiropractors, all of whom were either on full-time staff or on volunteer appointments, generated the injury reports. Permanent members of the USOTC medical staff supervised and reviewed the recording of all injury reports.

Injury Occurrences

Recorded conditions under which each injury occurred included competition, scrimmage, training, and nonsport related. We analyzed only injuries occurring during weightlifting training. Nonsport-related reports were predominantly illnesses and thus not included in the analysis. Since the USOTCs are primarily training sites, few reported injuries were from competitions or scrimmages.

Classifications of Injuries

Injury classifications were acute, chronic, recurrent, or complication. Acute injuries are "injuries with rapid onset due to a traumatic episode, but with short duration."[6] A chronic injury is "an injury with long onset and duration."[6] A recurring injury involves recovery and reinjury for a particular condition. Complications involve injuries that occurred due to an already existing injury condition.

Recommendations for Missed Training Time

Each report included the recommendation of the examining clinician regarding how much training time should be missed

Table 1. Injury Locations and Frequencies

Injury Location	No. of Cases	% of Total
Low back	130	23.1
Knee	107	19.1
Shoulder	99	17.7
Hand	56	10.0
Neck	30	5.4
Midback	27	4.8
Quadriceps	18	3.2
Groin	15	2.7
Elbow	14	2.5
Hip	14	2.5
Hamstrings	13	2.3
Shin	10	1.8
Calf	9	1.6
Foot	6	1.1
Ankle	5	0.9
Head	4	0.7
Chest	2	0.4
Abdomen	1	0.2
Total	560	100

Table 2. Injury Types and Frequencies

Injury Type	No. of Cases	% of Total
Strain	251	44.8
Tendinitis	135	24.1
Sprain	73	13.0
Spasm	34	6.1
Contusion	17	3.0
Synovitis	10	1.8
Bursitis	9	1.6
Other	8	1.4
Abrasion	6	1.1
Fracture	6	1.1
Subluxation	5	0.9
Neurotrauma	4	0.7
Avulsion	1	0.2
Concussion	1	0.2
Total	560	100

due to the injury. The 4 choices included <1 day, <1 week, <3 weeks, and >3 weeks.

Types of Injury

Twenty choices were available for types of injury, including abrasion, avulsion, burn, bursitis, concussion, contusion, dislocation, fracture, laceration, neurotrauma, puncture, spasm, sprain, strain, subluxation, synovitis, tendinitis, drug or chemical illness, illness, and other. Each report included an anterior and posterior drawing of the anatomical body, allowing the evaluator to circle the problem area.

Operational Definitions

For this project, the low back included L1 through L5 and the midback included T7 through T12. The elbow comprised the elbow flexor and extensor musculature, as well as the forearm musculature. The hand included the wrist (ie, ulnar-radio-carpal articulations) and all parts distal. The shin comprised the anterior portion of the anatomical leg (ie, below the knee).

Injury Rates

Injuries for a subset of athletes in residence at the USOTC in Colorado Springs ($n = 27$) were analyzed for injury rates (number of injuries/1000 training hours). The coaching staff provided training records so that we could determine total training hours. The analysis included only acute and recurring injuries. We calculated this critical injury information only for those athletes whose training program records were complete for extended periods of time.

Data Analyses

Injury frequencies were reported as ratios (relevant injuries/total injuries) and percentages. We used SPSS for Windows version 5.0.1 (Chicago, IL) statistical package to perform χ^2 analyses on the location, type, nature, and recommended time missed ($P < .05$).

RESULTS

A total of 873 reported incidents occurred during the time period investigated. Injury classifications included 560 reports (64.2%) classified as training related and 313 reports (35.8%) classified as nonsport related. These data include no injuries from actual competitions. Illnesses constituted the majority of the nonsport-related problems. Table 1 demonstrates that the low back was the anatomical area with the greatest number of injuries ($\chi^2_{17} = 863$, $P < .01$), followed by the knee and the shoulder. Strains, tendinitis, and sprains constituted the most frequent types of injuries (Tables 2 and 3). Strains and tendinitis occurred significantly more than other types of injuries ($\chi^2_{13} = 1649$, $P < .01$). The most frequent types of injuries reported for the most commonly injured areas included back strains, knee tendinitis, and shoulder strains. Most of the injuries can be described as acute in nature for the low back, midback, and shoulder areas and chronic in nature for the knees (Tables 4 and 5). Injuries of an acute or chronic nature ($\chi^2_3 = 461$, $P < .01$) occurred significantly more often than complications and recurrences. Tables 6 and 7 indicate that injuries resulting in recommendations for missing training times most often involved less than 1 day ($\chi^2_3 = 1289$, $P < .01$) when compared with longer durations of missed training. Of the 3 most noted injury sites, the majority of injuries caused the athlete to miss less than 1 day of activity. Injury rates for the subset of resident athletes at the USOTC were 3.3 injuries/1000 weightlifting training hours.

Table 3. Injury Types and Frequencies by Location

Injury Type	No. of Cases	% of Total
Low Back		
Strain	97	74.6
Tendinitis	1	0.8
Other	32	24.6
Total	130	100
Knees		
Strain	7	6.5
Tendinitis	91	85.1
Other	9	8.4
Total	107	100
Shoulders		
Strain	54	54.6
Tendinitis	24	24.2
Other	21	21.2
Total	99	100

Table 4. Nature of Injury and Frequency

Nature of Injury	No. of Cases	% of Total
All injuries		
Acute	334	59.6
Chronic	170	30.4
Other	56	10.0
Total	560	100

DISCUSSION

Our study is the first to report injury types and rates during Olympic-style weightlifting training of elite athletes over a 6-year period.[1–5,10,11,13–17] We found that the most commonly injured sites include the back, knee, and shoulder and that most of the injuries can be described as either acute or chronic rather than recurring or due to complications and consisted primarily of strains, tendinitis, and sprains. In addition, the recommended training time missed was usually less than 1 day. These findings are consistent with previous reports on weightlifting injuries.[1,3,4,7,10,11,13–17] The results are also similar to injury reports for other types of activities.*

Low back pain in athletes, as well as in the general population, has been well documented.[3,5–7,9–14,18,20–23] Our results indicate that the low back is the most commonly injured area of the body in weightlifting. This finding is similar to those reported for participants in other activities and sports, such as ballet dancers, gymnasts, javelin throwers, football players, and other types of competitive lifters.[6,7,9,10,12–14,18,22,23] One commonly reported back injury is spondylolysis, which has been observed in 3% to 7% of the sports and general populations.[10,21,22] It has been reported that athletes have a 13.49% greater risk for back injury than the general population.[22] Spondylolysis is the "most common serious" injury found in the low back region of athletes.[18] Spondylolysis is a fatigue fracture of the neural arch at the pars interarticularis,[3] which can lead to spondylolisthesis (ie, anterior sliding of the vertebra). One study noted that activities incorporating alternating flexion and extension of the lumbar area create a greater risk than those requiring compressive loading.[10] Kulund et al[3] reported that low back pain constitutes a "small problem" for weightlifters, whereas Granhed and Morelli[10] reported that retired wrestlers suffer more from chronic low back pain than retired weightlifters.[10] In addition, retired weightlifters reported a similar frequency of low back pain when compared with untrained individuals.[10]

* *References 4, 6, 7, 9, 10, 12, 14, 16, 18–22.*

Table 5. Nature of Injury and Frequency by Location

Nature of Injury	No. of Cases	% of Total
Mid and Low Back		
Acute	92	58.6
Chronic	49	31.2
Other	16	10.2
Total	157	100
Knees		
Acute	41	38.3
Chronic	51	47.7
Other	15	14.0
Total	107	100
Shoulders		
Acute	67	67.7
Chronic	25	25.3
Other	7	7.0
Total	99	100

Table 6. Recommended Training Time Missed Due to Injuries

Time Missed	No. of Cases	% of Total
All injuries		
<1 d	507	90.5
<1 wk	48	8.6
<3 wk	2	0.4
>3 wk	3	0.5
Total	560	100

Table 7. Recommended Training Time Missed Due to Injuries by Location

Time Missed	No. of Cases	% of Total
Mid and Low Back		
<1 d	137	87.3
<1 wk	20	12.7
<3 wk	0	0.0
>3 wk	0	0.0
Total	157	100
Knees		
<1 d	102	95.3
<1 wk	4	3.8
<3 wk	1	0.9
>3 wk	0	0.0
Total	107	100
Shoulders		
<1 d	91	91.9
<1 wk	6	6.1
<3 wk	0	0.0
>3 wk	2	2.0
Total	99	100

Our study on weightlifting included no reports of spondylolysis, and, therefore, it appears that this population of weightlifters had no increased incidence of spondylolysis. It has been proposed that the clean and press lift (Figure 3) in weightlifting competition before 1972 may account for previous reports of spondylolysis and spondylolisthesis.[2] During the execution of the pressing phase of the lift, extremely lordotic positions could occur while the athlete was holding very heavy weights overhead. As a result, injury data from before 1972 must be interpreted with caution, since the current lifts (ie, snatch and clean and jerk) do not emphasize a lordotic position, as did the former competitive pressing motion.

The knee is one of the most injured joints in sports.[9] One study indicated that the weightlifter is at high risk of patellofemoral osteoarthritis.[4] The knee was the second most commonly injured site in our study. Although the knee is a common site of injury in other activities, the occurrence of severe or joint integrity injuries is not common in weightlifting.[1–3] The lower extremities move through a very controlled range of motion in weightlifting when compared with other activities such as football, basketball, or soccer. Also, cutting and turning, the common pathomechanics of many knee injuries, are not characteristic of weightlifting. Our study supports the suggestion that knee injuries in weightlifting are mainly chronic inflammatory problems and not the traumatic stability problems observed in other sports.

Our study reflects a pattern first reported by Kulund et al[3] for the sport of weightlifting, with the shoulder being one of the most injured sites. The shoulder accounted for the most injuries in weightlifting.[15] Although instability of the shoulder complex has been reported in weightlifters,[15] we found that only 4.0% of the shoulder injuries directly related to instability.

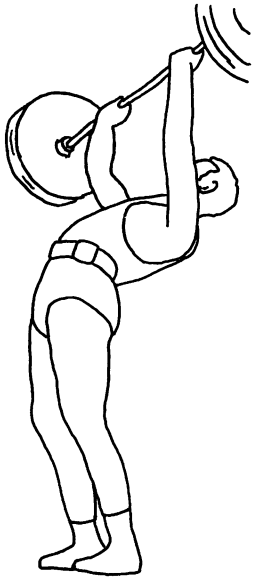

Figure 3. An example of an extremely lordotic position during the pressing motion of the clean and press lift. This lift was discontinued from competition in 1972.

It should be noted that the skill, flexibility, and strength of the weightlifter may help to prevent many of the problems that could affect the shoulder.[2,3,5–7,12,17] The shoulder is prone to strains as well as instability from the dynamic power movements and the techniques used in weightlifting.[3] Anatomical shoulder stabilization is critical for the throwing athlete.[9] The shoulder is also at risk in the nonthrowing athlete when it is placed in similarly precarious positions. Heavy weights lifted in the at-risk position (ie, extreme flexion and abduction) place the connective structures of the shoulder at an increased risk of injury.[15,17]

Many sporting activities are associated with a high incidence of ankle injuries. However, the ankle accounted for only 0.9% (5/560) of all injuries in our study. As with the knee, the ankle moves through a smaller range of motion in weightlifting than in other activities, such as football, basketball, or soccer.[2,4,9] Cutting and turning, the pathomechanics of most ankle injuries, are avoided during weightlifting.

As reported, the recommended training time missed was usually less than 1 day for injuries in our investigation. It appears that weightlifting injuries are usually not severe, with 90.5% of the injuries resulting in recommendations of less than 1 day of training missed. The actual injury rate for the sport of weightlifting is comparable with many other sports and activities,[4,8–10,12,13,23] indicating that training for this sport presents no greater risk of injury than other popular sports.

In summary, our results indicate that the lower back, the knees, and the shoulders constitute the most commonly injured anatomical areas in the sport of weightlifting. The most frequent types of injuries were strains and tendinitis. The majority of injuries were acute occurrences, followed by chronic types of injuries. Most of the injuries were relatively minor, resulting in missed training time recommendations of less than 1 day. Overall, the injury rates for weightlifting are very similar to rates for many other sports.[4,6,7,14,17,21,23] In general, the types of injuries most often encountered included typical overuse types of injuries and did not impair joint or skeletal integrity. Considering that the athletes monitored in our study were elite level and used very high training volumes and intensities, the injury rates compared favorably with most other sports and do not indicate a greater risk of injury than for other sports.

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