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In recent years, we have seen many changes in our profession. These changes, including educational reform, reflect our professional maturation. However, complete professional maturation requires us to provide a greater leadership role within the sports medicine community. Specifically, we are beginning to face the challenge of providing useful, accurate, and scientifically valid information to the sports medicine community and to society in general. Failing to meet this challenge will likely result in our profession’s being marginalized within the scientific and professional arenas of sports medicine.

Approximately 3 years ago, the NATA decided to meet the challenge of providing scientifically valid and useful information to the membership and the public by establishing the Pronouncements Committee. The primary responsibility of the Pronouncements Committee is the development of position statements that represent the scientific state of the art on topics relevant to the athletic training and sports medicine communities. The process for developing a position statement starts with the proposal of a topic either by 5 NATA members or by the Pronouncements Committee. A topic proposed by NATA members is first reviewed by the committee to insure that it is appropriate for a position statement. If the topic is approved by the committee, a writing group is appointed. The writing group prepares an initial draft of the position statement and submits it to the Pronouncements Committee for review. After this initial review, the draft position statement may be sent back to the writing group for revisions or approved for external review. The external review consists of sending the document to independent experts for evaluation and is the most critical part of the process.

Superficially, the task of providing accurate and useful information appears easy. However, to be respected by other scientific and professional organizations, our opinions and positions must either meet, or be based on documents that meet, the standard of scientific validity through external peer review and scientific journal publication. The purpose of the peer-review publication process is to allow independent experts to evaluate a document’s content for accuracy, bias, and validity. Publication of a document that has undergone this process provides the reader with an assurance that the document represents the current state of the art. The ultimate goal is to achieve the same scientific quality as position statements produced by organizations such as the American College of Sports Medicine.

Currently, the Pronouncements Committee has 5 position statements in development (Lightning Safety, Fluid Replacement, Emergency Spine Management, Heat Illness, and Emergency Plan Development), 1 more planned (Weight Loss in Athletes), and 1 to be revised (Blood-Borne Pathogens). The current goal of the committee is to have several of the statements published in the Journal of Athletic Training within the next year.

Position statements developed by the Pronouncements Committee can be used for a variety of purposes. The main purpose is to provide the clinician with scientific information that can be used in everyday practice. For example, the Lightning Safety position statement will provide clinicians with useful guidelines for appropriate shelters, field evacuation, and return to activity. Similarly, the Fluid Replacement position statement will provide clinicians with specific information for developing precise protocols based on individual sweat losses rather than on average values, which may be inadequate for some athletes.

In addition to clinical benefits, these statements should provide some degree of legal protection to persons who use them. Those involved in lawsuits related to position statement topics will be able to provide the court with written documentation supporting their procedures. Furthermore, the statements can be used to persuade administrators that current policies and procedures are outdated and that revisions are needed.

While the development of scientifically valid position statements is an appropriate activity for the NATA, I believe the use of scientifically valid information should be the gold standard for all our professional activities. For example,
as we continue to develop databases such as the Reimbursement Advisory Group’s Outcomes Research Project and the NATA Injury Surveillance Project, our goal should not be to collect data for our own informational purposes. Rather, we should collect data with the purpose of producing peer-reviewed publications. It is through the mechanism of peer-reviewed publications that these data will gain scientific validity. Failure to publish peer-reviewed data results in the data’s being either ignored or perceived as invalid by the scientific community and, thus, does not advance our causes. Finally, as mature professionals, we all must strive to base our professional communications (including those among ourselves, with our patients, and with the public) on scientifically valid information. Not doing so diminishes our position within the sports medicine community and stunts our growth as a profession.
Letters to the Editor

Some Concerns

I am writing in response to an article that appeared in volume 33 entitled “Contrast therapy does not cause fluctuations in human gastrocnemius intramuscular temperature” (J Athl Train. 1998; 33:336-340). While we are pleased to see work that substantiates our research on contrast therapy, it appears the authors may have some methodologic errors and inappropriate assumptions in the discussion. Fortunately, these oversights do not seem to have affected the overall results and legitimacy of the authors’ conclusions.

Please note my following concerns:

1. The authors spoke of taking the skinfold of the subjects, but then seemed to ignore this when they used an L-ruler to measure the depth at which the hypodermic temperature probe was inserted into the subject’s leg. They say that “the temperature microprobe was inserted at the same site in the gastrocnemius muscle on each subject.”

2. A more critical issue is the depth of the microprobe’s sensor tip from the skin surface. If the hypodermic temperature probe was inserted into the triceps surae muscle group to a depth of 4 cm in the frontal plane, as Figure 2 indicates, then the depth of the sensor tip from the skin surface was only 2.5 cm from the posterior surface of the leg, not 4 cm as indicated in the paper.

My above 2 points need to be noted with respect to the first comments in the authors’ discussion. They say that, in the Myrer et al study (J Athl Train. 1994:29:318-322), the tissue temperature was measured at a depth of 1 cm. This was not the case, as our probes were inserted 1 cm below the subcutaneous fat. If we look at the mean skinfold for the women in our study, the probe would have been approximately 2.03 cm below the skin surface, and for our men, approximately 1.53 cm below the skin surface. If their depth was 2.5 cm, this makes our depths very close to theirs, much closer than the 1 cm to 4 cm distance indicated. This would account for the similarity in our results.

The authors also did not address whether or not temperature changes between immersions within the contrast group were significant. This is probably the most significant clinical question. Finally, the authors suggest further studies are needed “to examine the effects of using different hot-to-cold time ratios during a contrast therapy treatment.” We have done some additional work in this area (J Athl Train. 1997;32:238-241).

J. William Myrer, PhD
Brigham Young University
Provo, UT

Reply

We welcome the opportunity to respond to Dr. J. William Myrer’s Letter to the Editor regarding our article on contrast therapy. He raised some interesting points to which we offer further clarification and insight.

The L-ruler used in our study measured a vertical distance of 2.5 cm from the posterior aspect of the calf, “down” the lateral side to identify a uniform insertion site on each subject. The depth at which the microprobe was inserted insured that we would bypass the subcutaneous fat layer found between the skin and gastrocnemius muscle on each of our subjects. In fact, the average depth of subcutaneous fat was calculated to be approximately 0.36 cm in both treatment groups, so we were well below this level using the standardized depth marked by the L-ruler.

The microprobe sensor was inserted at the site marked by the L-ruler in a horizontal direction to a depth of 4 cm from the lateral skin’s surface (this is shown in Figure 1). It was necessary to insert the probe to this depth to insure that it was properly secured to handle the movements associated with each of the whirlpool and contrast therapy treatments. We would agree with Dr. Myrer that the vertical depth from the posterior calf was 2.5 cm. This depth was standardized through the use of the L-ruler. He makes an interesting point when the depths of vertical insertion are compared between his study and ours. This, indeed, adds further support to the similarity in findings between the 2 studies.

We did not find any significant difference in temperature change between immersions in the contrast group. Although this was not clearly delineated in the results of our paper, we would point to the plot of the data in Figure 3. It is clearly evident from the data that very little change in tissue temperature occurred between hot and cold immersions in the contrast group.

We, too, continue to perform further research examining different contrast therapy ratios. In a more recent study, we have examined a 1:1 ratio in addition to the 2 groups used in this study. The results of this were recently presented at the American Physical Therapy Association meeting in Seattle, WA.

Thank you.

Diana Higgins, ATC, PT
West Virginia University
Morgantown, WV

Thomas W. Kaminski, PhD, ATC/L
University of Florida
Gainesville, FL
Injury Rates and Profiles of Elite Competitive Weightlifters
Gregg Calhoon, MS, ATC; Andrew C. Fry, PhD, CSCS
Human Performance Laboratories, University of Memphis, Memphis, TN

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 $\chi^2$ 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. The lifts in the sport of weightlifting emphasize explosive muscular power, an essential property of many sports. As a result, weightlifting-related exercises are often a training tool to enhance performance for numerous other sports. In the literature, weightlifting is often termed Olympic-style weightlifting, in contrast with power lifting, body building, or general weight training. 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. Three anatomical areas thought to be at high risk of injury for weightlifting are also common injury sites in many sports: the knee, the low back, and the shoulder. Data on proper lifting and body building indicate that most injuries occur in the shoulder region, followed by the low back and the knee. Injuries in weightlifting have been reported to include not only soft tissue muscle injuries, but also conditions such as spondyloysis and meniscal injuries. In weightlifting, existing literature indicates that most injuries occur at the knee, followed by the shoulder and the back. Kulund et al. also found that most injuries occur in the clean and jerk lift in weightlifting.

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, 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. 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 spondyloysis, a degenerative condition where the vertebrae develop stress fractures. 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
athlete to spondylolysis.\textsuperscript{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.\textsuperscript{15,17} As a result, instability of the shoulder joint has been reported in weightlifters.\textsuperscript{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.\textsuperscript{3} This places the shoulder in a vulnerable situation and may increase the rate of shoulder injury.\textsuperscript{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.\textsuperscript{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.\textsuperscript{2}

\section*{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-
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." A chronic injury is "an injury with long onset and duration." 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...
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, spasms, 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 χ² 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 (χ² = 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 (χ² = 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 (χ² = 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 (χ² = 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

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

Table 5. Nature of Injury and Frequency by Location

<table>
<thead>
<tr>
<th>Nature of Injury</th>
<th>No. of Cases</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mid and Low Back</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acute</td>
<td>92</td>
<td>58.6</td>
</tr>
<tr>
<td>Chronic</td>
<td>49</td>
<td>31.2</td>
</tr>
<tr>
<td>Other</td>
<td>16</td>
<td>10.2</td>
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<tr>
<td>Total</td>
<td>157</td>
<td>100</td>
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<tr>
<td>Knees</td>
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<tr>
<td>Acute</td>
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<tr>
<td>Chronic</td>
<td>51</td>
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</tr>
<tr>
<td>Other</td>
<td>15</td>
<td>14.0</td>
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<tr>
<td>Total</td>
<td>107</td>
<td>100</td>
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<tr>
<td>Shoulders</td>
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<td></td>
</tr>
<tr>
<td>Acute</td>
<td>67</td>
<td>67.7</td>
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<tr>
<td>Chronic</td>
<td>25</td>
<td>25.3</td>
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<tr>
<td>Other</td>
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</tr>
<tr>
<td>Total</td>
<td>99</td>
<td>100</td>
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Table 4. Nature of Injury and Frequency

<table>
<thead>
<tr>
<th>Nature of Injury</th>
<th>No. of Cases</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>All injuries</td>
<td></td>
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<tr>
<td>Acute</td>
<td>334</td>
<td>59.6</td>
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<tr>
<td>Chronic</td>
<td>170</td>
<td>30.4</td>
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<tr>
<td>Other</td>
<td>56</td>
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<tr>
<td>Total</td>
<td>560</td>
<td>100</td>
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</tbody>
</table>

Table 6. Recommended Training Time Missed Due to Injuries

<table>
<thead>
<tr>
<th>Time Missed</th>
<th>No. of Cases</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>All injuries</td>
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<td></td>
</tr>
<tr>
<td>&lt;1 d</td>
<td>507</td>
<td>90.5</td>
</tr>
<tr>
<td>&lt;1 wk</td>
<td>48</td>
<td>8.6</td>
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<tr>
<td>&lt;3 wk</td>
<td>2</td>
<td>0.4</td>
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<tr>
<td>&gt;3 wk</td>
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<td>0.5</td>
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<tr>
<td>Total</td>
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Table 7. Recommended Training Time Missed Due to Injuries by Location

<table>
<thead>
<tr>
<th>Time Missed</th>
<th>No. of Cases</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mid and Low Back</td>
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<tr>
<td>&gt;3 wk</td>
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<td>0.0</td>
</tr>
<tr>
<td>Total</td>
<td>157</td>
<td>100</td>
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<tr>
<td>Knees</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;1 d</td>
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<td>95.3</td>
</tr>
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<tr>
<td>&lt;3 wk</td>
<td>1</td>
<td>0.9</td>
</tr>
<tr>
<td>&gt;3 wk</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
<td>107</td>
<td>100</td>
</tr>
<tr>
<td>Shoulders</td>
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<td></td>
</tr>
<tr>
<td>&lt;1 d</td>
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<tr>
<td>&gt;3 wk</td>
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</tr>
<tr>
<td>Total</td>
<td>99</td>
<td>100</td>
</tr>
</tbody>
</table>

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.1-5,10-17 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.1-3,4,7,9,10,11,12,13,14,16,18-22 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.6,7,9,10,12-14,16,18,22,23 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 al3 reported that low back pain constitutes a “small problem” for weightlifters, whereas Granhed and Morelli10 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.
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. 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. One study indicated that the weightlifter is at high risk of patellofemoral osteoarthritis. 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. 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 for the sport of weightlifting, with the shoulder being one of the most injured sites. The shoulder accounted for the most injuries in weightlifting. Although instability of the shoulder complex has been reported in weightlifters, we found that only 4.0% of the shoulder injuries directly related to instability. 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. The shoulder is prone to strains as well as instability from the dynamic power movements and the techniques used in weightlifting. Anatomical shoulder stabilization is critical for the throwing athlete. 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.

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. 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, 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.

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.

ACKNOWLEDGMENTS

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REFERENCES

Eversion Strength Analysis of Uninjured and Functionally Unstable Ankles

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* University of Florida, Gainesville, FL; † Curry School of Education, University of Virginia, Charlottesville, VA

Objective: Functional ankle instability (FAI) afflicts many athletes. Several causes of FAI have been implicated, including peroneal muscle weakness. Traditional musculoskeletal rehabilitation programs have focused on concentric muscle strength. The purpose of our study was to compare concentric and eccentric isokinetic and isometric eversion ankle strength measurements between subjects identified as having unilateral FAI and subjects having no history of inversion ankle sprain.

Design and Setting: Employing a matched-pairs technique, subjects with no history of ankle injury were compared with subjects with unilateral FAI using isokinetic and isometric measures of eversion ankle strength. Strength testing was performed in a sports medicine clinic setting.

Subjects: Forty-two subjects volunteered for this study: 21 subjects suffered from unilateral FAI (age = 19.3 ± 1.1 years, wt = 84.0 ± 9.5 kg, ht = 181.5 ± 9.2 cm), while 21 subjects served as matched-paired controls (age = 19.5 ± 1.2 years, wt = 82.5 ± 10.9 kg, ht = 179.5 ± 7.9 cm).

Measurements: Ankle eversion concentric and eccentric strength (peak torque) was assessed at 0°/s, 30°/s, 60°/s, 90°/s, 120°/s, 150°/s, and 180°/s using an isokinetic dynamometer.

Results: We found no significant differences in concentric, eccentric, or isometric eversion ankle strength between the 2 groups of subjects.

Conclusions: The exact cause of FAI remains elusive. Based on our results, those who suffer from unilateral FAI do not appear to have eversion strength deficits. Unless clear evidence of weakness exists, clinicians may find that eversion strength training exercises are unnecessary. Future research should examine other causes of FAI, including reciprocal muscle group strength ratios and proprioception deficits.

Key Words: isokinetic, peak torque, eccentric, concentric

Ankle injuries, specifically lateral ligament sprains, are a common sport-related problem.1-5 These injuries result in more time loss than any other single injury in athletics.4 The high-intensity nature of sporting activities requires optimal neuromuscular development and control of the lower extremity. Prevention and treatment programs for ankle injuries can be time consuming and costly. Despite efforts to rehabilitate these ligamentous injuries, repeated episodes of ankle injury (sprain) often occur. Freeman6 first introduced the concept of functional ankle instability (FAI) to describe the feeling of “giving way,” which was a symptom many of his patients experienced after an initial ankle sprain. O’Donoghue7 later categorized this as “once a sprain, always a sprain.” Previous research has demonstrated that this entity may be prevalent in as many as 40% of the patients suffering from an acute lateral ligament injury to the ankle.8,9

Several causes of FAI have been implicated in the literature. Decreased range of motion was described by Cahill10 as a potential cause of chronic ankle instability. Several studies8,9,11-16 have suggested that a decrease in ankle joint proprioception after an initial ankle sprain leads to chronic ankle instability. Mechanical instability has also been mentioned as a factor contributing to FAI.17 However, as Freeman6 postulated and others have supported13,18,19 the pathologic processes to which FAI is usually attributed (ie, mechanical instability) are rarely, if ever, responsible for initiating the disability. Perhaps the most questionable factor contributing to chronic FAI is peroneal muscle weakness. The potential role of peroneal weakness as a cause of ankle instability has been given little attention in the literature. Previous research8,11,14,20-23 has indicated that decreases in ankle eversion muscle strength were present in those with FAI. However, several recent reports contradict these findings,15,24-28 showing no deficit in eversion strength in those with functionally unstable ankles. These discrepancies in the role of eversion strength in ankle instability suggest the need for additional research.

Programs for follow-up therapy and rehabilitation of the functionally unstable ankle vary according to the athletic trainer’s or therapist’s background, philosophy, and physician familiarity. Until recently, the accepted standard for rehabilitation of the strength component after ankle injury was to rely solely on the concentric action of the muscle. Our own approach to ankle injury rehabilitation has focused on both the
concentric and eccentric actions of normal muscle physiology. Isokinetic dynamometers are often used to examine the progress of rehabilitation and to assess levels of muscle performance. These devices have enabled both the clinician and researcher to quantify concentric, eccentric, and isometric force production about a body joint. A potential problem with the use of these devices as rehabilitative and assessment tools has been the clinicians’ reluctance to rely solely on the concentric (shortening) phase of muscle action. Typical lower extremity function requires both the concentric and eccentric (lengthening) components of muscle activity.

Providing quantitative data on the concentric activity of muscles surrounding the joint provides only partial information on a muscle’s total performance capacity, particularly with respect to the ankle joint. This holds true because a significant proportion of normal gait involves eccentric muscle control. Those individuals lacking adequate eccentric muscle control and those unable to develop adequate contraction velocity either concentrically or eccentrically may be predisposed to initial ankle injury or find themselves functionally unstable. Newer active isokinetic dynamometers are capable of assessing both the concentric and eccentric action of muscle. The ability to assess muscle strength is particularly important to the clinician in the evaluation and rehabilitation of individuals with musculoskeletal disorders.

The purpose of our study was to compare concentric and eccentric isokinetic and isometric eversion ankle strength between subjects identified as having unilateral FAI and subjects having no history of inversion ankle sprain.

METHODS

The ankles of 42 college-aged male subjects were tested in this study. Subjects were recruited for participation from the student population at a small midwestern college. Twenty-one subjects (age = 19.3 ± 1.1 years, wt = 84.0 ± 9.5 kg, ht = 181.5 ± 9.2 cm) experienced unilateral chronic FAI at the time of the study. To be characterized as functionally unstable, the subjects satisfied the following criteria: (1) experienced at least 1 significant lateral (inversion) ankle sprain of either the right or left ankle, but not both, in which the subject was unable to bear weight or was placed on crutches, within the last year, (2) no reported history of fracture to either ankle, (3) sustained at least 1 repeated injury or the experience of feelings of ankle instability or “giving way” in either the right or left ankle, but not both, (4) not undergoing any formal or informal rehabilitation of the unstable ankle, and (5) have no evidence of mechanical instability as assessed by a physician using an anterior drawer test. Subjects were pain free and full weight-bearing, without a limp, at the time of the study. The average time period since their last episode of instability was 6 weeks.

The other 21 subjects (age = 19.5 ± 1.2 years, wt = 82.5 ± 10.9 kg, ht = 179.5 ± 7.9 cm) served as controls. These subjects were matched with the subjects suffering from unilateral chronic FAI. The side of unilateral FAI was matched with the same uninjured side on the control subjects. In addition, height, weight, age, body type, and activity level were used to match the subjects between groups. For the entire group of matched pairs, the average weight difference was 5.1 ± 4.8 kg and the average height difference was 3.4 ± 3.1 cm.

Subjects were briefed on all testing procedures and asked to read and sign a consent form approved by a university committee for the protection of human subjects.

Instrumentation

The Kin Com 125 AP (Chattanooga Group, Inc, Hixson, TN) isokinetic dynamometer was used to assess peak torque (PT) for the motion of ankle eversion. The Kin Com is an isokinetic strength testing device, integrated with a computer and the appropriate software to provide precise strength measurements from both concentric and eccentric muscle actions. In addition, the dynamometer can be used to assess isometric strength. Kin Com dynamometers allow for precise and reliable measurement and storage of data from isokinetic, isotonic, and isometric muscular actions.

Test Procedures

Subjects reported to an isokinetic testing laboratory on one occasion. Subjects were acquainted with the isokinetic dynamometer and the test environment. Height and weight measurements were recorded with the subjects barefooted and in shorts. Subjects rode a stationary bicycle for a 5-minute warm-up and performed several general lower body flexibility exercises. Testing of the ankle occurred at 7 predetermined velocities, ranging from 0° to 180° per second. The presentation of velocities was counterbalanced using a 7-by-7 latin square.

Eversion ankle motion was tested with the subject seated on the dynamometer chair. All tests were performed with the subject wearing socks. The subject was stabilized in the chair according to manufacturer’s guidelines, with straps securing the chest and waist. The isokinetic dynamometer was moved to the appropriate position and height for eversion strength testing using the automatic positioning function of the dynamometer. A universal stabilizer was used to position and hold the lower leg and to help prevent any unwanted muscle substitution (Figure). The foot was securely fastened into the ankle inversion-eversion footplate attachment using hook-and-loop closures. With the foot securely fastened into the footplate, the subject’s active ankle eversion range of motion was determined. A procedure described by Donatelli was used to find the position of subtalar joint neutral, which became the start position (0°). The start and stop angles for eversion motion were set at 0° and 25°, respectively.

Isokinetic tests of the ankle evertors (peroneals) were performed at 30°, 60°, 90°, 120°, 150°, and 180° per second. To become familiar with the isokinetic exercise concept and especially the eccentric mode, each subject was allowed 3
subject positioned on the Kin Com 125 AP isokinetic dynamometer for eversion strength testing.

submaximal (50% capacity) and 3 maximal (100%) warm-up repetitions at 105°/s in a continuous manner. A 2-minute rest was provided at the end of the practice session. According to Cress et al,34 105°/s allows subjects to become familiar with the eccentric mode without letting them get additional practice at one of the test velocities. The order of test velocity presentation was counterbalanced to minimize any potential learning effects. Each subject in the matched-pairs control group performed the test sequence in the same order as the FAI counterpart. For each test velocity, 3 maximal eccentric and concentric test repetitions were completed through the 25° of eversion range of motion. Using the interrupted sequence protocol of the Kin Com software package, each of these repetitions was completed individually with a 15-second pause between repetitions. Subjects were instructed to provide maximal effort throughout the entire repetition. A 1-minute rest period was given between each of the 7 test velocities.

One isometric (0°/s) test was included in the 7 test velocities. This test was performed with the foot in the subtalar joint neutral position, corresponding with the start angle (0°) previously entered into the Kin Com computer. Each isometric contraction lasted 5 seconds, with a 30-second rest between contractions. A total of 3 maximal isometric contractions were completed.

Both ankles of subjects in the FAI group and control group were tested using the same procedure. The highest PT value recorded from the 3 maximal test repetitions at each of the 7 test velocities was used for further statistical analysis. PT values for the functionally unstable ankle were matched against the control counterpart for analysis.

Statistical Analysis

A separate mixed-model analysis of variance (ANOVA) statistical procedure was conducted on each of the concentric and eccentric data sets. Isometric data were included in both analyses. The SPSS for Macintosh Release 6.1.1 (SPSS Inc, Chicago, IL) was used to assist in the statistical analysis. PT values were the dependent measure. This analysis, to determine differences between normal and functionally unstable ankles, used one within-subjects variable (velocity [0°, 30°, 60°, 90°, 120°, 150°, and 180° per second]) and one between-subjects variable (ankle stability status [functional instability versus control]). Mean comparisons within the analysis were conducted using a Tukey honestly significant difference post hoc analysis. An a priori α level of significance was set at P < .05 for all comparisons. An a priori power analysis was conducted to determine the power of the statistical design to detect significant differences. Using our proposed sample size of 21 subjects, the analysis resulted in a power of 0.94.

RESULTS

Concentric PT Data

The descriptive statistics for concentric PT and PT/body weight (BW) ratios, including the isometric data, are presented in Table 1. The results of the ANOVA showed no significant interactions involving the between-subjects factor of group (F6,240 = 0.71, P = .644). There was no significant difference between the groups (F1,46 = 1.13, P = .294). As expected, the ANOVA revealed a main effect for velocity (F6,240 = 99.39, P < .001). PT production decreased as the velocity of movement increased.

Eccentric PT Data

The descriptive statistics for eccentric PT and PT/BW ratios, including the isometric data, are presented in Table 2. The results showed no significant interactions involving the between-subjects factor of group (F6,240 = 0.94, P = .466). There were no significant differences between the groups (F1,46 = 0.10, P = .753). A main effect for velocity (F6,240 = 5.95, P < .001) was evident when the eccentric ANOVA was analyzed. Eccentric PT values appeared to show very little variation between velocities. However, significant differences were present when comparing the PT values between 90°/s and 30°/s and 90°/s and 0°/s. In addition, significant differences existed between 180°/s and the eccentric velocities of 60°, 90°, 120°, and 150° per second.

Table 1. Concentric and Isometric Peak Torque (Nm) and PT/BW* Ratio Mean Values (± SD) for Ankle Eversion in Control (Uninjured) and Experimental (Functional Instability) Groups

<table>
<thead>
<tr>
<th>Velocity (°/s)</th>
<th>Control (PT)</th>
<th>Control (PT/BW)</th>
<th>Experimental (PT)</th>
<th>Experimental (PT/BW)</th>
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</thead>
<tbody>
<tr>
<td>0</td>
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<td>.37 ± .06</td>
<td>29.71 ± 7.63</td>
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</tr>
<tr>
<td>30</td>
<td>25.81 ± 4.26</td>
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<td>24.38 ± 5.23</td>
<td>.29 ± .06</td>
</tr>
<tr>
<td>60</td>
<td>23.05 ± 3.99</td>
<td>.29 ± .05</td>
<td>21.38 ± 4.34</td>
<td>.26 ± .05</td>
</tr>
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<td>90</td>
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<td>19.95 ± 4.86</td>
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<td>20.19 ± 3.88</td>
<td>.26 ± .06</td>
<td>19.86 ± 3.97</td>
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<tr>
<td>150</td>
<td>20.57 ± 4.62</td>
<td>.27 ± .06</td>
<td>18.90 ± 4.57</td>
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<td>180</td>
<td>19.52 ± 2.80</td>
<td>.25 ± .05</td>
<td>17.81 ± 4.40</td>
<td>.22 ± .05</td>
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</tbody>
</table>

* PT, peak torque; BW, body weight.
DISCUSSION

Strength of the peroneus longus and brevis muscles is highly important in the absorption of stress and in providing support to the lateral ligaments of the ankle.20,21 Kaumeyer and Malone35 indicated that the evertor and pronator muscles play a major role in preventing ligamentous injuries of the ankle. Our study did not show evertor muscle weakness in subjects with unilateral FAI when compared with a control group of subjects with uninjured ankles. This finding was evident when each of the concentric, eccentric, and isometric PT values was analyzed. A follow-up analysis using PT/BW ratios also produced no significant differences and was consistent with the analysis using PT measures only. This was important, considering the effect that body mass has on force production. Our research findings are inconsistent with the earlier conclusions of several researchers8,11,14,20–23 who reported evertor strength deficits in subjects with FAI. Several inconsistencies in strength measurement exist with these earlier studies. Various reports8,11,20–23 used subjective manual muscle tests to assess strength. This method of strength assessment provides a less accurate measure and does not reflect the true dynamic nature of the inversion–eversion ankle motion. The availability of newer isokinetic dynamometers provides a more accurate and precise assessment of ankle strength. In contrast with the earlier studies, the results of our study are consistent with several recent reports15,24–27,36 that have shown no deficits in eversion strength in subjects with FAI. Lentell et al15 examined concentric eversion ankle strength and found no differences between the uninjured and chronically unstable ankles in the same subjects. This was later supported in a follow-up study26 that again showed no bilateral differences in eversion strength in subjects with FAI. The authors concluded that there appears to be a greater need for retraining proprioception capabilities than muscle strengthening at the ankle joint in those who experience ankle instability.26 We would suggest that, unless an obvious weakness in the ankle evertors exists, strength training of these muscles may be a waste of time and energy.

One major difference between our study and several of the previously mentioned studies25–27,36 is that we used a control group instead of the opposite, uninjured ankle for comparison. The primary reason for using an uninjured matched control group was the concern that, if FAI was present in 1 ankle, the same factors that led to that instability might have made the opposite, so-called uninjured ankle just as susceptible. Biomechanical compensatory changes or motor patterns might have developed differently in the opposite uninjured extremity. In our own clinical experiences, we have found it difficult to recruit subjects who have sprained only 1 ankle. If we do, who is to say that the predisposing factors that produced the sprain may not also exist in the uninjured ankle, even if it has not yet been sprained? We knew beforehand that we would sacrifice a bit of statistical power by adding a between-subjects factor (group status); however, we more than offset that by conducting an a priori power analysis and settling on a subject pool of 21 in each group. The fact that we had more than the necessary number of subjects, yet found no differences in eversion strength between the groups, lends further credibility to our results and our suggestions about strength training.

The failure to reject the null hypothesis (no difference between the groups) raised 2 interesting questions: (1) How robust was our statistical test in detecting significant differences? (2) Was our instrument reliable? A post hoc power analysis is often used to help explain the nonrejection of the null hypothesis. At the end of our study, we performed a post hoc power analysis using the standard deviations derived from our isokinetic PT/BW values and found a power value of >0.995. We were convinced that we did indeed have enough power to detect statistically significant differences had they existed. The next question we had to answer involved the reliability of the measurements themselves. In our previous work,31 we concluded that the Kin Com was a reliable device for measuring inversion and eversion isokinetic strength; however, we questioned the validity of the footplate attachment device. That study was conducted on a Kin Com II isokinetic dynamometer. The Kin Com 125 AP isokinetic dynamometer used in this study was part of the new generation of Kin Com dynamometers. In these newer dynamometers, the footplate connection to the load cell was reconfigured, which in turn corrected the problems we faced in our original investigation concerning validity. We believe the other modifications to the new generation Kin Com (eg, exterior design) did not negatively affect reliability of assessing ankle inversion and eversion. As such, we were reasonably confident that our measurement protocol produced reliable PT values. Having answered these 2 questions, we were confident that the results were an accurate depiction of the lack of eversion strength differences between the 2 groups.

Very little research exists on the measurement of eccentric ankle strength for comparison with our study. Schrader24 examined eversion and dorsiflexion eccentric PT values in subjects with FAI and concluded that muscle strength was not a factor contributing to chronicity. Bernier et al25 also examined eccentric ankle strength using the Kin Com dynamometer at a velocity of 90°/s. They found no significant differences in the eccentric strength of the ankle invertors and evertors between the injured and uninjured ankles in the FAI group and...
the dominant and nondominant ankles in the nondisabled group. Our results seem to support the assertion that eversion muscle strength may not be drastically altered in those with functional ankle instabilities. It appears that, at various concentric and eccentric velocities, functionally unstable ankles perform the same as uninjured ankles do. In addition, the lack of differences in either concentric or eccentric eversion strength between the groups measured may support the contention that individuals with FAI may not be different in relation to their strength level before an injury encounter. This supports Schrader's claim that individuals may not be predisposed to ankle sprain because their muscles are weaker than those same muscles in uninjured individuals.

Determining the actual presence of eversion muscle weakness in individuals who subjectively indicate FAI presents an interesting challenge for the researcher. The subjective method of determining FAI has been questioned in prior reports because relying on subjects to assess their own FAI may provide inaccurate information. Tropp assessed concentric ankle strength and found significant eversion muscle weakness when comparing the unilateral injured ankle with the contralateral uninjured ankle. He concluded, however, that the muscular impairment was due to inadequate rehabilitation and secondary muscle atrophy and not true FAI as his subjects had reported. The subjects in our study had all undergone some form of rehabilitative strength therapy following their initial ankle injury, yet still experienced episodes of instability. This finding supports the contention that lack of strengthening may lead to further ankle instability, but that rehabilitation may counteract future episodes of instability due solely to eversion weakness. Termansen et al concluded that plantar flexion strength in the functionally unstable ankle was significantly less than in the opposite, uninjured ankle that served as control. A closer look at the mean values indicates that the difference was quite small and probably clinically insignificant. In addition, strength was assessed only isometrically, thereby not providing an accurate dynamic assessment of the true strength output of the muscle. Although we did not examine plantar flexion strength, an earlier study by Termansen et al may indicate the need to assess plantar flexion strength in addition to eversion strength in those with FAI. Confusing the matter is evidence from a more recent report that indicates ankles with greater plantar flexion strength had a higher incidence of inversion ankle sprain. Interestingly, Schrader found concentric dorsiflexion strength in a group of chronically sprained ankles to be stronger than the contralateral, never-sprained ankles. If strength is an issue for those suffering from FAI, it appears that it lies in muscles other than those involved in eversion and dorsiflexion. Several more recent reports have found inversion performance deficiencies in the involved extremity of subjects with FAI. Further study is needed to examine combined multiaxial ankle motions, invertor deficiencies, and eversion-to-inversion strength ratios.

Glick et al examined the biomechanics of ankle sprains and showed that subjects with FAI exhibited increased inversion just before heel strike during normal walking. In addition, electromyogram recordings showed an increase in the contraction time of the peroneus brevis before heel strike. Tropp et al later showed that, if the ankle is inverted at the moment the foot touches the ground, the result could be a varus thrust from an inversion lever through the subtalar axis. If the eveter muscles are not strong enough to counter this motion, the tensile strength of the lateral ligaments is exceeded and injury results. Bernier et al theorized that, if the functionally unstable ankle strikes the heel in an inverted position, the ankle pronators are called on to stabilize the ankle with every step. In addition, they suggested that walking and functional activities alone may have acted to return muscle function in the injured ankle. Many of the subjects in our study were intercollegiate athletes who, despite their instability, had continued participating in their respective sports. The rigors of athletic competition may have been instrumental in maintaining adequate muscle strength in the ankle evertors. In 2 recent studies examining ankle injury risk factors, the authors concluded that improved peroneal muscle strength may represent an adaptive mechanism to protect an ankle susceptible to injury. Our results seem to support this rationale because, despite the fact that the subjects suffered repeated episodes of ankle sprain, no differences in peroneal eversion strength were evident.

Muscle strengthening protocols have been an integral part of ankle rehabilitative programs for many years. Freeman reported initially on the importance of regaining strength in the prevention of FAI. The focus on muscle strengthening has long been considered the traditional approach to treating and preventing FAI. Although none of our experimental group subjects were currently involved in a rehabilitation program, they had all indicated previous participation in some form of rehabilitative therapy. Included as part of that therapy was some form of strength training. The length of time spent in therapy ranged from a few days to several weeks. Seto and Brewster indicated that most chronic lateral ankle sprains require more time for appropriate recovery than acute sprains, due to compensations that have occurred with motion and strength, repeated irritation of the soft tissues, decreased proprioception, and atrophy of muscles. It appears from the results in our study that the FAI subjects may have achieved success from their rehabilitative programs, at least with regard to the strength component. Therefore, the functionally unstable subjects may have regained strength and muscular stability in their ankle evertors. This is consistent with the findings of Tropp et al and Schrader, who indicated that strength rehabilitation can improve the functional disability that muscle weakness purportedly contributes to FAI. Despite this finding, the experimental group subjects in our study continued to suffer subsequent episodes of instability. Further study examining the role of previously mentioned risk factors is warranted.
A considerable amount of attention has been given to examining deficits in proprioception as a cause of FAI. Several researchers\(^9,11-13,15,16,42\) have concluded that long-term ankle instabilities can be related to decreased joint proprioception. In fact, several recent reports\(^6,13\) have suggested that decreased proprioception as a cause of FAI is a more important consideration than first thought. Lentell et al\(^26\) concluded that deficits in passive movement sense and anatomical stability are of greater concern than strength deficits when managing the ankle with functional instability. This finding supports the earlier work by Garn and Newton,\(^44\) who demonstrated decreases in passive movement sense in those with functionally unstable ankles. The lack of differences in both concentric and eccentric strength between groups tends to lend support to the earlier conclusions drawn by Fiore and Leard,\(^45\) who suggested that muscle mechanoreceptors may control the instantaneous and qualitative muscle contractions necessary for foot control. Research by Lofvenberg et al\(^13\) showed that a delayed proprioceptive response of the ankle was a cause of chronic lateral ankle instability. Furthermore, the lack of neuromuscular control may prove to be a better explanation for the cause of chronic ankle injury than any of the other previously reported causes of instability. Although we did not examine proprioceptive parameters, it appears that the results point to potential causes of FAI other than muscular strength deficits.

**CONCLUSIONS**

The neuromuscular and biomechanical relationships in the ankle are complex. In order to fully understand the nature of FAI, the clinician must be able to comprehend these complex relationships. Based on the results of our study, statistically significant eversion muscle strength deficits were not found to exist between a group of subjects who self-reported FAI and a group of uninjured control subjects. Clinicians should be careful in determining whether or not eversion strength training exercises will be beneficial in those with FAI. Strengthening exercises in individuals without obvious weaknesses may prove to be costly and a waste of time. Future research should examine other purported causes of FAI. Recent reports have suggested that differences in proprioception measures exist, as well as strength differences in reciprocal muscle groups (evertors to invertors). Further study of eccentric muscle actions in the ankle and their contributions in ankle injury prevention is also needed.

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Exercise in the Heat. I. Fundamentals of Thermal Physiology, Performance Implications, and Dehydration

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Objective: To present the critical issue of exercise in the heat in a format that provides physiologic foundations (Part I) and then applies the established literature to substantial, usable guidelines that athletic trainers can implement on a daily basis when working with athletes who exercise in the heat (Part II).

Data Sources: The databases MEDLINE and SPORT Discus were searched from 1980 to 1999, with the terms “hydration,” “heat,” “dehydration,” “cardiovascular,” “thermoregulatory,” “physiology,” and “exercise,” among others. The remaining citations are knowledge base.

Data Synthesis: Part I introduces athletic trainers to some of the basic physiologic and performance responses to exercise in the heat.

Conclusions/Recommendations: The medical supervision of athletes who exercise in hot environments requires an in-depth understanding of basic physiologic responses and performance considerations. Part I of this article aims to lay the scientific foundation for efficient implementation of the guidelines for monitoring athletic performance in the heat provided in Part II.

Key Words: cardiovascular, heat stress, thermoregulatory

Exercise in the heat, as compared with a neutral environment, causes many physiologic changes in the dynamics of the human body, including alterations in the circulatory, thermoregulatory, and endocrine systems. Many interrelated physiologic processes work together to sustain central blood pressure, cool the body, maintain muscular function, and regulate fluid volume. Attempting to sustain exercise (especially if it is intense) in a hot environment can overload the body’s ability to properly respond to the imposed stress, resulting in hyperthermia, dehydration, deteriorated physical and mental performance, and a potentially serious (even fatal) exertional heat illness.

CIRCULATORY RESPONSES

The circulatory responses to exercise involve 3 important components: skin and muscle vasodilation, nonactive tissue vasoconstriction, and maintenance of blood pressure (Figure 1). Skin vasodilation occurs in proportion to the degree of heat load (both exogenous and endogenous), and the amount of blood supplied to the muscles is dictated by the intensity of the exercise. Constriction of the splanchnic vascular system (supplying the kidneys, stomach, and other abdominal organs), in addition to an overall increase in the cardiac output, allows increased blood flow to the active tissues.

However, when intense exercise occurs in the heat, the cardiovascular (CV) system simply cannot meet the maximal demands of the skin (to decrease thermal load) and the muscle simultaneously. Ultimately, maintenance of blood pressure will take precedence over skin blood flow (ie, body cooling) and muscle blood flow (ie, performance capacity), but simultaneously increases the rate of hyperthermia and metabolic inefficiency. This prioritizing can result in hyperthermia, especially in populations committed to maximal physical exertion (soldiers, athletes, etc). The metabolic changes are reflected in an increased lactate level, which results from decreased hepatic blood flow; muscle vasoconstriction (which influences waste removal, oxygen delivery, buffering capacity, etc); and an increase in muscle temperature. Variations in the onset of these changes can alter the rate at which the athlete experiences fatigue.

Decreased venous return reduces the stimulation of pressure-sensitive baroreceptors in the right heart and the pulmonary circulation. Messages are then sent to the medullary CV control centers, which can cause muscle or skin vasoconstriction, or both, thereby preserving blood pressure and CV function.

Minimal decreases in cardiac output have been found in subjects exercising at submaximal intensities in the heat. An increase in heart rate compensates for the decreases in stroke volume, and CV capacity is not hindered, unless
Exercise in the heat

\[ \uparrow \text{Cardiac output} \]

\[ \downarrow \text{BF to splanchnic organs} \quad \uparrow \text{BF to muscles} \quad \uparrow \text{BF to skin} \]

\[ \downarrow \text{Venous return} \]

(when demands of skin and muscle become too great)

\[ \downarrow \text{Heart rate and cardiovascular strain} \]

\[ \downarrow \text{Baroreceptor stimulation} \]

Cardiovascular control centers in medulla respond

\[ \downarrow \text{Muscle function} \quad \text{Muscle and skin vasoconstriction} \quad \downarrow \text{Heat dissipation} \]

Blood pressure and cardiovascular function preserved (temporarily)

Figure 1. Potential circulatory responses to exercise in the heat.\(^1\)\(^7\)\(^8\)\(^12\)\(^13\) BF, blood flow.

extreme sweat rates or lengthy exercise sessions, for example, induce significant dehydration. But when maximal exercise is attempted in the heat, the heart rate’s finite limit does not compensate for the larger decreases in stroke volume, due mostly to shunting of blood to the skin and active muscle and to the progressive dehydration.\(^1\)\(^7\)\(^13\) Rowell\(^1\) concluded that the end result is decreases in both \(V_O_2\) and performance capacity.

**THERMOREGULATORY RESPONSES**

The circulatory and thermoregulatory responses are interrelated, with each influencing and being influenced by the other. The degree of stress imposed by exercise in a hot environment is determined by the thermal load. Heat gain must be equaled (or closely matched) by heat dissipation if the athlete wishes to continue exercising at a consistent performance level. Exogenous factors that contribute to heat acquisition include ambient temperature, wind speed, humidity, solar radiation (direct and indirect), ground thermal radiation, and clothing.\(^15\) Ambient temperature and humidity are the major contributors; lack of wind in the presence of high humidity and high ambient temperature can impose severe heat stress because copious sweating is not cooling the body (sweat is not evaporating from the skin), which exacerbates the hyperthermia.\(^16\) The predominant endogenous factor is the metabolic heat from contracting muscle (capable of increasing 15 to 20 times during exercise in healthy young adults), which is profoundly influenced by the intensity of the exercise.
The body attempts to balance internal temperature by dissipating heat via conduction, convection, evaporation, and radiation. Heat dissipation while exercising depends on the ambient temperature. As ambient temperature rises, radiation and convection decrease markedly; heat loss by conduction is insignificant at almost all times and evaporation is thwarted by a small water vapor pressure gradient. With no heat dissipation, dehydration occurs, and the core temperature rises at a potentially dangerous rate. The decreased physiologic function associated with hyperthermia is well documented and the rate of onset of hyperthermia can be influenced by fitness, acclimation, type of exercise, age, and numerous other factors.

PERFORMANCE IMPLICATIONS

The additive effect of the stresses imposed by exercise in the heat will ultimately compromise athletic performance. In addition, exercise in the heat often causes dehydration (since rates of sweating are rarely matched by rates of rehydration), which further exacerbates the situation. It is extremely difficult to separate the effects of heat and dehydration, since they often occur in parallel during prolonged exercise, but some researchers have attempted to match sweat loss with fluid intake during exercise. Rowell et al found large reductions in stroke volume despite maintained central blood volume. Enhanced physical fitness and heat acclimatization increase heat tolerance independently but similarly and optimize heat tolerance when combined.

Sawka et al reported a 7% decrease in maximal aerobic power in the heat as compared with euhydrated subjects in cool temperatures. Febbraio et al and Galloway and Maughan showed the effects of increasing temperature on the capacity to exercise to exhaustion. Febbraio et al found that subjects could exercise for 95 minutes at 37°F (2.78°C), 75 minutes at 68°F (20°C), and only 33 minutes at 104°F (40°C), indicating an inverse linear relationship between ambient temperature and performance capacity. The 20-minute difference in the 2 cooler environments is an important reminder that extreme heat is not necessary for potential performance decrements. Galloway and Maughan concurred, reporting that subjects exercised for 92 minutes at 52°F (11.11°C), 83 minutes at 70°F (21.11°C), and 51 minutes at 86°F (30°C). These studies supported the concept of Sawka et al that heat stress and dehydration can act independently to compromise physiologic function when the extreme demands for skin blood flow cause decreased cardiac output, which in turn limits the supply of oxygenated blood to the entire body. When heat stress and dehydration occur together (as they often do), this physiologic condition is exacerbated. In addition to performance decrements, the potential for an exertional heat illness increases as the environmental conditions worsen. The American College of Sports Medicine provided a concise analysis of how to determine when the environmental conditions preclude physical activity and what procedures should be followed to ensure safe participation in a hot environment (to be addressed in part II).
DEHYDRATION AND EXERCISE

Each physiologic system in the human body is influenced by severe dehydration. The degree of dehydration will dictate how much these systems are compromised. Figure 2 describes similar terms used to describe water losses and gains. The work of Sawka and colleagues\textsuperscript{34-36} is definitive in the domain of hypohydration and its impact on performance and physiologic function. Their laboratory, located within the US Army Research Institute of Environmental Medicine in Natick, MA, is one of the preeminent locations in the world for investigating the human body's capacity to perform exercise in a variety of environments.

Physiologic Changes

Isolating which particular physiologic changes contribute to decrements in performance is difficult, if not impossible. The interrelation of the human body's systems means that any change in one system influences others. However, recent research has begun to uncover what occurs when an athlete becomes dehydrated during exercise. Dehydration induces changes in the thermoregulatory, cardiovascular, plasma, gastrointestinal, endocrine, muscular, and metabolic responses to exercise.\textsuperscript{37,38}

As discussed earlier, the CV system of a hypohydrated, exercising subject attempts to maintain cardiac filling pressure while sacrificing peripheral circulation,\textsuperscript{1} but hypohydration in combination with heat dissipation at the skin and increased muscle blood flow limits CV capacity, regardless of how much blood is shunted from the periphery to the central circulation.\textsuperscript{1,39,40} Increased viscosity and decreased volume of blood returning to the heart decrease filling pressure, and in turn, stroke volume.\textsuperscript{14,41,42} To counteract these changes, heart rate rises to its limit, but then cardiac output begins to fall, signaling CV system responses, which limit skin and muscle function.\textsuperscript{34,43} The end result is a diminished ability to dissipate heat, and thus, heat production exceeds heat loss. Excess heat in combination with decreased muscle perfusion limits performance and causes thermal strain.\textsuperscript{1,35}

Exercising while dehydrated has some effects on the thermoregulatory system\textsuperscript{34,44-49} (Table) and may negate the physiologic advantages resulting from increased fitness\textsuperscript{24,50} and heat acclimatization.\textsuperscript{24,51} Sawka et al\textsuperscript{36} noted decreased heat tolerance (by more than half) in subjects dehydrated by 8% of body weight and found that soldiers became exhausted at lower core temperatures when hypohydrated. While 8% is an extreme amount of dehydration rarely encountered in sports, the study emphasizes the decreased heat tolerance associated with dehydration.

The human body is composed of about 65% water, separated into extracellular (plasma and interstitial) and intracellular fluid.\textsuperscript{52} At rest with normal hydration, about 45% of body weight is intracellular fluid, 15% is interstitial fluid, and 5% is plasma.\textsuperscript{52} Exercise, heat stress, and dehydration all influence the redistribution of body fluids with changes in hydrostatic and osmotic pressure.\textsuperscript{52,53} For instance, because sweat is hypotonic to plasma, the dehydrated athlete experiences plasma hyperosmolality, which affects the distribution of fluids.\textsuperscript{35} Mild dehydration causes mostly extracellular space fluid losses, but, as dehydration worsens, proportionally more fluid is lost from the intracellular space.\textsuperscript{54,55} Nose et al\textsuperscript{56} reported that the loss of intracellular and extracellular fluid is largely from muscle and skin. This selective regulation of body fluids preserves the internal environment of the most essential organs: for instance, the brain and liver.\textsuperscript{35} Changes in the distribution of body fluids are associated with the ability to mobilize fluids from the intracellular space, which is intimately linked with sweat sodium concentrations.\textsuperscript{57} Thus, the de-

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Figure 2. Clarification of terms to describe body water losses and gains during exercise. Adapted with permission from Epstein and Armstrong.\textsuperscript{46} The term "retrohydration" is used courtesy of P. M. Meenen, July 1999.
creased sweat sodium concentrations noted after heat acclimation may help to conserve plasma volume during dehydration. Ultimately, the fluid redistribution that results from dehydration causes a hypovolemic hyperosmolality, which stimulates the volume and fluid receptors in the body to conserve fluid and stimulate rehydration.

Plasma changes have been cited as the major cause for the thermoregulatory changes during hypohydration. Hyperosmolality and hypovolemia are likely responsible for the changes noted in skin blood flow and sweating rate and the resultant rises in core temperature. Fortney et al have argued that hypovolemia is primarily responsible for the thermoregulatory changes by reducing central blood volume, which may alter the feedback to the hypothalamus via the atrial baroreceptors. The hypothalamic thermoregulatory centers may then decrease the blood volume perfusing the skin in an attempt to reestablish a normal central blood volume. Some studies have provided support for this hypothesis, but it is clearly not the only variable influencing thermoregulation during hypohydration.

Two primary hypotheses have been proposed to explain the role of hyperosmolality on the thermoregulatory system. The first is a strong osmotic pressure influence of the interstitium, which may limit the available fluid sources for the eccrine sweat glands. While this pressure is likely to exert some influence, it seems more feasible that brain regulation, the second hypothesis, has the largest contribution. The neurons surrounding the thermoregulatory control centers in the hypothalamus are quite sensitive to osmolality. Thus, changes in the plasma perfusing the hypothalamus can affect body water regulation and the desire for fluid consumption. The human body is well equipped to identify small changes in the internal environment and to respond with appropriate modifications. While research may someday identify a proportional contribution to the age-old question of hyperosmolality versus hypovolemia, it is most likely that both will always be considered major contributors to the mechanisms that perturbate body fluid regulation.

Potential muscle changes associated with dehydration include an increased rate of glycogen synthesis, compromised buffering capacity of the muscle tissue, elevated muscle temperature, and decreased substrate exchange. These factors are caused by a decrease in blood flow perfusing the muscle tissue, which may alter the dynamics during the recovery between contractions. These muscle changes seem to occur when exercise exceeds 30 seconds, which is reasonable from a metabolic perspective. These arguments would support the notion that strength during short-term activity is not affected until dehydration becomes more pronounced, largely due to the fact that the muscle energetics of very short-term activity are, for the most part, self-contained, and thus, not as influenced by changes in blood flow.

**Performance Implications**

Research investigating the role of dehydration on muscle strength has yielded conflicting results. Some studies have shown performance decrements, while others have shown no changes. However, when strength decrements were found, they usually occurred when dehydration exceeded a 5% reduction in body weight. In addition, dehydration resulting from fluid restriction seems to be more harmful than that caused by exercise and heat stress; thus, the fluid restriction may be partially inducing a caloric deficit.

The research on muscle endurance is a bit more conclusive. A sampling of the numerous studies that have addressed the influence of dehydration on muscle endurance reveals, generally speaking, that 3% to 4% dehydration elicits a performance decrement, but some studies investigating greater levels of dehydration did not find any differences in performance. Horsswill concluded that, in wrestlers (who are frequently hypohydrated), combined hypohydration and maximal or near-maximal muscle activity exceeding 30 seconds may combine to decrease performance. Environmental conditions may also play an important role in muscle endurance, and, since greater hypohydration often occurs in hot conditions, more studies should investigate this relationship.

The research concerning maximal aerobic power and the physical work capacity for extended exercise is also relatively conclusive and consistent. Maximal aerobic power usually decreases when dehydration exceeds a 2% to 3% reduction in body weight, and, when performed in the heat, the decrements are exaggerated. Nearly every study that has examined physical work capacity has shown some degree of performance decrement. Even with only 1% to 2% hypohydration in a cool environment, a decrement is noted. Pinchan et al and Walsh et al noted decreases in physical work capacity with less than 2% dehydration during intense exercise in the heat. As expected, when dehydration increased, physical work capacity decreased, sometimes by as much as 35% to 48%, and physical work capacity often decreased even when maximal aerobic power did not change. Generally, hypohydration may be partly due to an increased perception of fatigue. The degree of change in physiologic function will be dependent on various exercise parameters, including intensity, duration, environmental stress, and individual factors.

**CONCLUSION**

Exercise in the heat triggers a disturbance of the internal environment of the human body. Understanding the responses
requires an astute ability to focus on many independent physiologic processes that function cooperatively. The athlete wishes for these systems to rise to any challenge, but often excessive heat, dehydration, or both cause some degree of decrement in performance. The ensuing part of this 2-part series about exercise in the heat attempts to identify ways in which athletic trainers and athletes can work toward minimizing the decrement by maximizing heat dissipation and body fluid balance.

ACKNOWLEDGMENT

I would like to dedicate this paper to the memory of my former supervisor, Dean Leo W. Anglin, Jr, PhD. I would later learn that he took his final breaths as I wrote this article. He was a visionary in the field of education, and the passion that drove him was contagious. I shall strive in his memory.

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**Exercise in the Heat. II. Critical Concepts in Rehydration, Exertional Heat Illnesses, and Maximizing Athletic Performance**

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**Objective:** To acquaint athletic trainers with the numerous interrelated components that must be considered when assisting athletes who exercise in hot environments. Useful guidelines to maximize performance and minimize detrimental health consequences are presented.

**Data Sources:** The databases MEDLINE and SPORT Discus were searched from 1980 to 1999, with the terms "body cooling," "dehydration," "exercise," "heat illnesses," "heat," "fluid replacement," "acclimatization," "hydration," "rehydration," "performance," and "intravenous," among others.

**Data Synthesis:** This paper provides an in-depth look at issues regarding physiologic and performance considerations related to rehydration, strategies to maximize rehydration, modes of rehydration, health consequences of exercise in the heat, heat acclimatization, body cooling techniques, and practice and competition modifications.

**Conclusions/Recommendations:** Athletic trainers have a responsibility to ensure that athletes who exercise in hot environments are prepared to do so in an optimal manner and to act properly to avoid the potentially harmful heat illnesses that can result from exercise in the heat.

**Key Words:** body cooling, dehydration, heat acclimatization, hydration, intravenous

For an athlete who becomes dehydrated while exercising, rehydration is critical to maintaining athletic performance and physiologic function. Many factors contribute to the amount of rehydration, including the environment, the timing of rehydration in relation to the exercise session, and the contents of the rehydration beverage. Ingesting fluid to reestablish normal hydration is both complicated and essential for the competitive athlete.

**REHYDRATION AND EXERCISE**

**Factors Influencing Rehydration**

Armstrong and Maresh\(^1\) addressed many of the critical environmental and host factors that influence the process of rehydration. The degree of environmental stress is influenced by such factors as temperature, humidity, wind speed, and radiation. The extent of environmental stress directly influences the degree of physiologic change (eg, sweating rate, hyperosmolality of extracellular fluids, etc). These physiologic changes in turn affect the rehydration process.\(^2\)\(^3\) Welch et al\(^4\) provided support for the influence of environmental stress on rehydration by noting a substantial increase in fluid intake when ambient temperature rose above 25°C.

Similarly, environmental stress affects certain psychological variables. A dehydrated athlete exercising in the heat prefers ingesting cold fluid.\(^5\)\(^6\) Armstrong and Maresh\(^1\) also noted individual differences in learned behavior. An athlete who understands how proper rehydration can enhance subsequent performance is more apt to consume fluid before significant dehydration occurs. Thus, appropriate education of young athletes by knowledgeable sport supervisors is essential.

The physical characteristics of the rehydration beverage can also dramatically influence the extent of fluid replacement.\(^1\)\(^5\)\(^7\) Salinity, color, mode, sweetness, temperature, flavor (eg, grape is preferred), carbonation, and viscosity all affect how much the athlete drinks.\(^7\)\(^9\)

Since most fluid consumed by athletes is with meals, the thirst response at meals and the presence of ample fluid during meals are critical in rehydration.\(^8\) And since fluid losses of 1% to 2% of body weight are necessary to elicit a thirst response, an athlete who participates in frequent practices or competitions may become chronically dehydrated.\(^10\)

It is important to note that dehydration resulting from sodium depletion does not elicit a thirst response.\(^1\) Reduced mouth dryness and increased stomach distention also decrease the desire to drink, even though significant dehydration may still be present. However, this form of dehydration is relatively rare and develops in 3 to 5 days in athletes who train in the heat many hours each day.

Other factors that contribute to fluid replacement include the individual's mood (calmness is associated with enhanced rehydration) and the degree of concentration required by the
task. For example, industrial laborers need frequent breaks to rehydrate because they must remain focused on a specific task. This need for mental concentration may explain why many elite mountain bikers use a convenient back-mounted hydration system instead of the typical rack-mounted water bottle. The back-mounted bottle allows the cyclist to rehydrate while remaining focused on terrain, speed, gears, braking, and exertion.

The critical message from the cited research regarding rehydration is an appreciation of the many interrelated variables that contribute to the degree of fluid consumed in response to exercise-induced dehydration. Athletic trainers should be conscious of these and other possible factors that may undermine the rehydration process for the athletes they supervise.

**Hydration Before Exercise**

The athlete should begin exercising well hydrated. Many athletes who perform repeated bouts of exercise on the same day or on consecutive days become chronically dehydrated. When a hypohydrated athlete begins to exercise, physiologic mechanisms are altered. Cardiovascular (CV) strain is increased, core temperatures rise more quickly and to higher levels, and the ability to dissipate heat by skin blood flow and sweating rate is limited, resulting in performance decrements, the extent of which are related to the thermal load. Athletes may require substantial assistance in obtaining fluids, as evidenced by the phenomena of voluntary dehydration (when individuals drink insufficient quantities to replace fluid losses) and involuntary dehydration, as well as societal habits.

To ensure proper hydration when exercise begins, the American College of Sports Medicine (ACSM) has provided guidelines for fluid ingestion, which include consuming 500 mL of fluid 2 hours before an event to assure proper hydration (ie, normal fluid volume and osmolality) and ample time to urinate excess fluid. In addition, CV strain is reduced and core temperatures are lower when fluid is ingested 60 minutes before exercise. Mandatory pre-exercise hydration is physiologically advantageous and more practical than ad lib hydration, which is well documented to be insufficient. Ingesting a nutritionally balanced diet and fluids during the 24 hours before an exercise session is also crucial, given that a large portion of rehydration occurs during meals.

Electrolytes (either in foods or fluids) are necessary to regain normal hydration after exercise-induced dehydration. This is not surprising because excessive sweating during exercise alters both plasma osmolality and electrolyte levels (primarily sodium) due to salt levels in sweat. The inclusion of sodium will enhance both water retention and the taste of the beverage.

Another consideration in pre-exercise hydration is hyperhydration. Sawka et al reported that thermal strain, CV strain, or both may be reduced during exercise while hyperhydrated. Obviously a hyperhydrated individual will eventually excrete the excess volume, but recent experiments with glycerol in the hyperhydrating solution reduced the volume excreted, allowing a true state of hyperhydration to be maintained. Leutkeimer and Thomas reported improved cycle performance time with hyperhydration, which supports many of the physiologic findings, but the jury is still out on the ergogenic effects of hyperhydration. Recently, Kavouras et al found increased exercise time and plasma volume during exercise to exhaustion in the heat when subjects were rehydrated (from a previous dehydration) with water and glycerol before exercise, as compared with rehydration using an equal volume of water without glycerol.

**Rehydration During Exercise**

Proper maintenance of hydration status during exercise will influence CV, thermoregulatory, fluid volume, performance, and other variables favorably. These factors also depend on whether the exercise is occurring in a hot or cool environment. This topic has been extensively reviewed through the years, but some reports are especially notable.

The physiologic benefits associated with maintaining fluid volume are well documented. As mentioned earlier, proper hydration during exercise enhances heat dissipation (increased skin blood flow and sweating rate), limits plasma hypertonicity, and helps sustain cardiac output. The enhanced evaporative cooling that can occur (due to increased skin blood flow and maintained perfusion of working muscles) is the result of sustained cardiac filling pressure. Rehydration allows for conservation of the central blood volume and optimal physiologic responses to intense exercise in heat. Rehydration during exercise in a cool or neutral environment seems to minimally affect plasma volume, while primarily allowing intracellular and interstitial fluid volumes to be maintained. With exercise in a warm environment, plasma volume responses are somewhat variable, but plasma volume is better maintained with rehydration than without. In other words, the athlete may still be hypovolemic after substantial rehydration, but the plasma volume is closer to being restored. Equally critical is the role rehydration has in preventing hyperosmolality and cellular dehydration. Also, the rate of alteration in CV strain is positively correlated with environmental temperature and relative exercise intensity, and the onset of CV drift is preventable with proper rehydration.

Rehydration limits the degree of hyperthermia and maintains athletic performance. A classic study by Pitts et al was one of the first to show that changes in rectal temperature during exercise depended on the degree of fluid intake. When water intake equaled sweat loss, rise in core temperature was slowest when compared with ad lib water and no-water groups. This benefit of rehydration on physiologic function is likely due to increased blood volume, reduced hyperosmolality, reduced cellular dehydration, and improved maintenance of extravascular fluid volume.
Rehydration After Exercise

Replenishing fluid volume and glycogen stores is critical in the recovery of many body processes. This topic has been insightfully reviewed by Maughan et al. Rehydration after exercise is also critical and should be addressed independently of hydration before and during exercise.

Intravenous Rehydration and Exercise

Most studies have explored the efficacy of intravenous infusion to rapidly restore hydration in unconscious patients or those with hemorrhage or heat illness. The use of intravenous fluid to rapidly restore physiologic function when health is severely compromised is a proven and useful treatment. But, recently, some athletes have used intravenous rehydration to maximize rehydration before an ensuing exercise session. Some recent studies have addressed intravenous infusion to rehydrate athletes before an exercise session. Castellani et al. and Riebe et al. were the first to assess intravenous rehydration as a potential ergogenic aid while properly controlling concentration, volume, and timing in dehydrated athletes before an exercise bout. A later study from the same laboratory decreased the amount of time for rehydration was considered 6 hours after exercise.

Based on volume and osmolality, water may not be the best fluid to drink after exercise to replace the fluids that are lost via sweating. Consuming water alone decreases osmolality, which limits the drive to drink and slightly increases urine output. Including sodium in the rehydration beverage (or diet) allows fluid volume to be better conserved (keeping vasopressin and aldosterone levels low) and increasing the drive to drink. Including carbohydrates in the rehydration solution may improve the rate of intestinal absorption of sodium and water and replenishes glycogen stores. Replenishing glycogen stores will enhance performance in subsequent exercise sessions. While a normal diet commonly restores proper electrolyte concentrations, many athletes are forced to rehydrate between exercise sessions in the absence of meals. In addition, some athletes' meals are eaten many hours after an exercise session, which may compromise electrolyte availability during rehydration after intense exercise in hot conditions.

Fluid replacement after exercise should equal sweat losses, but the athlete who follows this rule will actually remain dehydrated due to urine losses. An insightful study by Shirreffs et al. reported that ingesting fluids with a high sodium concentration equal to 150% of weight loss was the optimal rehydration amount when hydration status was considered 6 hours after exercise.
Rowell et al\textsuperscript{72} used intravenous infusion to study CV function during exercise because the infusion negated sweating losses and allowed better assessment of "normal" CV function. These responses would be expected to be different from those that occurred when an individual was allowed to become dehydrated while exercising. Hamilton et al\textsuperscript{73} found an enhanced CV response for those subjects who received intravenous infusion versus oral ingestion during exercise at 70% \( \text{VO}_{2}\text{max} \) at 22°C. This was the first study to find an advantage for intravenous infusion over oral ingestion. However, the mode cannot be isolated as the cause of the difference because glucose was included in the intravenous infusion and not in the oral drink. Once again, because the intravenous rehydration occurred during exercise, the results have limited applications for athletes. In contrast, Montain and Coyle\textsuperscript{74} found lower rates of perceived exertion and core temperature after oral ingestion, compared with intravenous infusion, during exercise at 65% \( \text{VO}_{2}\text{max} \) and an ambient temperature of 33°C. Once again, the fluid concentrations were different, and the rehydration occurred during exercise.

Castellani et al\textsuperscript{69} and Riebe et al\textsuperscript{75} made important progress into the potential ergogenic roles of oral and intravenous rehydration before exercise. Subjects were exercised to dehydration of -4% body weight and then were treated with no fluid, intravenous infusion (0.45% NaCl), or oral saline (0.45% NaCl). After resting for 75 minutes, they exercised at 50% \( \text{VO}_{2}\text{max} \) at 36°C for 90 minutes. The authors found lower heart rates at some time points for the intravenous group, possibly the result of an exaggerated norepinephrine response in the oral trial. In addition, lower ratings of perceived exertion and thirst were reported for the oral trial. Intravenous infusion may mediate physiologic variables, whereas the oral ingestion may be beneficial psychologically, but no performance difference was noted between IV and oral rehydration.

What would happen if an athlete exercised immediately after intravenous rehydration? Recently, Casa et al\textsuperscript{68} reported physiologic advantages during exercise to exhaustion (about 30 minutes) in a 36°C environment after oral compared with intravenous rehydration (same amounts and concentrations of fluid). These advantages included lower rectal temperatures, blood lactate levels, and skin temperatures, among others, when rehydration occurred orally as compared with intravenously. Although the finding was not significant (\( P = .07 \)), exercise time to exhaustion increased 5 minutes after oral rehydration. Some of the discrepancy in performance time may have had a psychological root.\textsuperscript{9} Unique to this study was the brief 20-minute rehydration period, which is similar to breaks in many sports (eg, halftime during a soccer game). Intravenous rehydration, as commonly practiced by many athletes attempting to maximize rapid fluid replacement during their breaks, may not be beneficial and may actually be a hindrance to maximizing athletic performance. Although not yet supported by research, some combination of oral and intravenous rehydration may prove to be optimal.

**EXERTIONAL HEAT ILLNESSES**

Motivated athletes, soldiers, or industrial laborers who are exercising at a high intensity or for prolonged periods of time can experience an excessive rise in core body temperature associated with increasing dehydration. An exertional heat illness reduces physical work capacity and, in some cases, can lead to a medical emergency and even death. All athletes, coaches, and medical staff should know about the different heat illnesses, their pathophysiology, common signs and symptoms, and prevention.

Recent reviews\textsuperscript{66,76–80} provide excellent information regarding the etiology, diagnosis, treatment, and prevention of exertional illnesses. Although the *International Classification of Diseases*\textsuperscript{81} lists 10 separate categories of heat illness, the 3 most common resulting from strenuous physical exertion are heat cramps, heat exhaustion, and heatstroke.

The least serious, heat cramps, is likely the result of an NaCl deficit.\textsuperscript{77} Athletes with heat cramps usually sweat copiously (ie, lose large amounts of NaCl), replace sweat losses with a hypotonic fluid, or both. The resultant decrease in plasma NaCl may alter the degree of intramuscular water expansion\textsuperscript{78,80,82} due to changed sodium-potassium pump kinetics and the resultant action potential changes across the cell membrane. Changes in the internal environment about the cell membrane may influence the muscle contraction by elevating resting calcium levels and inducing additional calcium release from the sarcoplasmic reticulum, ultimately resulting in random muscle contractions.\textsuperscript{83} Heat-acclimatized athletes appear to have a reduced incidence of heat cramps,\textsuperscript{78,80} although some experts disagree.\textsuperscript{84}

Heat exhaustion is the most common heat illness.\textsuperscript{66,77} It usually occurs when unacclimatized individuals exercise strenuously in the heat and lose large amounts of water and electrolytes in sweat. Heat exhaustion is usually classified as either water or salt depletion. Water-depletion heat exhaustion has a more rapid onset and is more likely to progress to heatstroke if not treated.\textsuperscript{66,79} Continued exercise in the heat and increased dehydration limit the ability of the cardiac output to meet muscle and skin blood flow requirements.\textsuperscript{76} Eventually, and by definition, the athlete is unable to continue exercising in the heat.\textsuperscript{77}

Exertional heatstroke can occur in the absence of significant dehydration,\textsuperscript{76,80} the result of either overloading or failure of the thermoregulatory system in response to intense exercise, usually in a hot environment.\textsuperscript{77} The metabolic requirements of working muscle and cooling skin, exacerbated by temperature and humidity extremes, can overwhelm the capacity to dissipate heat. The body preferentially maintains arterial blood pressure over thermoregulation and skin dilation.\textsuperscript{85–87} Ultimately, heat production exceeds heat dissipation, and core temperature rises dramatically, until dangerous hyperthermia exists.\textsuperscript{78,84,86}

**Signs, Symptoms, and Treatment**

Unlike typical exercise-induced cramps, heat cramps are usually not spread throughout the entire muscle; instead,
individual muscle bundles contract in a spastic manner. A low plasma sodium level, decreased urinary NaCl, and urinary specific gravity >1.016 also indicate heat cramps. Treatment includes the ingestion of salt tablets in water (2 10-grain salt tablets dissolved in 1 L of water) or intravenous saline if nausea and vomiting are present.

Heat exhaustion is characterized by headache, extreme weakness, dizziness, vertigo, “heat sensations” on the head or neck, nausea, vomiting, profuse sweating, syncope, elevated pulse rate, and low blood pressure. Compared with heatstroke, mental function and thermoregulation are mildly impaired. Water-depletion heat exhaustion usually occurs after exercise starts; salt-depletion heat exhaustion occurs usually after several days of exercising in a hot environment. Treatment includes immediate rest, cooling (eg, ice bags, moving the athlete to the shade, etc), and rehydration. Rehydration consists of cool water (1.5 L of water and 2 gm NaCl per hour of intense exercise) and should aim to restore sweat losses and normal plasma NaCl. If nausea and vomiting are present, intravenous saline infusion is recommended.

Heatstroke is a medical emergency and should be treated as such. Immediate recognition of symptoms and initiation of treatment are necessary to maximize the odds for a complete restoration of normal physiologic function. Negligence on the part of the supervisors or medical staff can result in potentially fatal consequences. The diagnosis of exertional heatstroke includes thermoregulatory failure and obvious mental impairment. Rectal temperature higher than 39°C to 40°C, elevated serum enzymes (eg, aspartate aminotransferase), hypotension, vomiting, diarrhea, coma, and convulsions may also occur. Sweating may be present, and dehydration is likely, but not essential. The gold standard for the immediate treatment of exertional heatstroke, due to its superior whole-body cooling and lowest mortality rates, is cold and ice-water immersion (approximately 5°C to 15°C). The speed with which the athlete can be cooled is critical to the survival rate. If available equipment does not allow immersion, ice packs on the neck, axillae, proximal femurs, and behind the knees, etc, or fans, or a combination of these, will assist in cooling. Secondary interventions include intravenous infusions; quantity should be based on the degree of dehydration. Serum enzyme levels should be monitored for continued rises for several days.

Prevention Techniques

Prudent preparation by knowledgeable athletes, coaches, and medical staff can prevent most heat illnesses (Table 1). The emphasis in prevention should be on establishing rehydration procedures that match sweat losses, modifying or rescheduling practices or competitions in extreme conditions, monitoring athletes, and recognizing physiologic limitations when exercising in hot weather. The coaches and medical staff should

- know the signs and symptoms of heat illness;
- provide an ample supply of proper rehydration beverages;
- have a plan in case heat illness occurs;
- be willing to modify the established practice schedule;
- offer numerous and regular rehydration breaks;
- organize whole-body cooling equipment and supplies;
- be able to recognize the signs and symptoms of heat illness;
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Armstrong and Maresh\textsuperscript{107} provided valuable recommendations for heat acclimatization (Table 2). The bottom line is that proper heat acclimatization is an important training component when competition will take place in a hot environment. The United State Olympic Committee endorsed many of Armstrong and Maresh’s\textsuperscript{107} recommendations in preparation for the Barcelona Olympics.\textsuperscript{35}

**Amount of Rehydration**

It is absolutely imperative that an athlete know the rate at which he or she loses fluid via sweat at various practice intensities and during competition. Body weight changes, urine color, subjective feelings, and thirst, among other indicators, offer cues to the need for rehydration. Temperature, humidity, wind speed, intensity, duration of exercise, individual sweating rate differences, and other factors also affect hydration before, during, and after exercise in the heat.

The ACSM’s position stand,\textsuperscript{8} “Exercise and Fluid Replacement” is the current gold standard for rehydration requirements (Table 3). Recent compilations by Horswill\textsuperscript{108} and Shi and Gisolfi\textsuperscript{109} are also valuable sources when attempting to maximize rehydration. Perhaps the simplest yet most fundamental goal is the avoidance of voluntary dehydration by encouraging athletes to drink beyond thirst satiation and to replace lost body weight.\textsuperscript{110}

While preparing for an event, an athlete should be able to determine sweating rate, assess hydration status, and develop a rehydration plan. Determinations of sweating rate can be made according to Armstrong\textsuperscript{45} or Murray.\textsuperscript{16} Hydration status (ie, percentage of dehydration) can be assessed by measuring body weight before and after exercise sessions or simply by monitoring urine color.\textsuperscript{111,112} A refractometer can provide a precise measurement (urinary specific gravity < 1.010 indicates a hydrated state).\textsuperscript{45} The hydration plan should take into account the length of the event, the individual’s sweating rate, exercise intensity, average temperature and humidity, and the availability of fluids (Is fluid constantly available, as in cycling, or is it consumed in a large bolus during a break?). Any plan for rehydrating during competition should be instituted and perfected during practice sessions. Armstrong et al\textsuperscript{113} provide a plan for an elite athlete preparing for an event, and Armstrong and Maresh\textsuperscript{1} offer an exhaustive list of the environmental and host factors that can influence the rehydration process.

**Composition of Rehydration Fluid**

The ACSM\textsuperscript{8} recommended that 30 to 60 g/h of carbohydrates be replaced to maintain the rate of carbohydrate oxidation and delay the onset of fatigue (prevent glycogen depletion). Diluting the carbohydrate in 1 L of fluid will not hinder fluid absorption. The carbohydrate concentration should ideally be close to 6% (g · 100 mL\textsuperscript{–1}) and should not exceed 8%. The simple sugars (glucose or sucrose) or a starch (such as maltodextrin) are the best carbohydrate forms, and a combination of multiple types of carbohydrates will speed gastric emptying and intestinal absorption. Fructose should not be the primary source of carbohydrates, given the gastrointestinal stress it may cause. If the athlete’s diet is sufficient in sodium, adding sodium to the rehydration solution will not enhance intestinal absorption, but it may enhance fluid palatability and fluid retention and prevent hyponatremia (ie, water intoxication: replacing large amounts of fluid losses with water in the absence of electrolytes) in a susceptible individual. Sodium concentration should be approximately 0.5 to 0.7 g/L. Other valuable sources of practical information concerning rehydration are available.\textsuperscript{9}

**Body Cooling Techniques**

The athlete can enhance body cooling by wearing light-colored, loose-fitting clothing made of fibers that wick sweat

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**Table 2. Recommendations for Heat Acclimatization\textsuperscript{107}**

<table>
<thead>
<tr>
<th>Recommendation</th>
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<tbody>
<tr>
<td>1. Attain adequate fitness in cool environments before attempting to</td>
</tr>
<tr>
<td>heat acclimatize.</td>
</tr>
<tr>
<td>2. Exercise at intensities &gt;50% Vo\textsubscript{2max} and gradually increase</td>
</tr>
<tr>
<td>the duration (up to 90 min/d) and intensity of the exercise sessions</td>
</tr>
<tr>
<td>during the first 2 wk.</td>
</tr>
<tr>
<td>3. Perform highest-intensity workouts during the cooler morning or evening</td>
</tr>
<tr>
<td>hours and other training during the hottest time of the day.</td>
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<tr>
<td>4. Monitor body weight to ensure that proper hydration is maintained</td>
</tr>
<tr>
<td>as sweat rate increases.</td>
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<tr>
<td>5. Monitor rectal temperature to ensure that body temperature stays</td>
</tr>
<tr>
<td>within safe limits.</td>
</tr>
<tr>
<td>6. Athletes who live in a cool environment but will travel to a hot</td>
</tr>
<tr>
<td>environment for competition can induce partial acclimatization by wearing</td>
</tr>
<tr>
<td>insulated clothing, although they should leave some skin surface uncovered</td>
</tr>
<tr>
<td>and monitor rectal temperature to avoid hyperthermia.</td>
</tr>
</tbody>
</table>

**Table 3. Basic Rehydration Recommendations of the American College of Sports Medicine\textsuperscript{8} and Recent Developments\textsuperscript{43}**

<table>
<thead>
<tr>
<th>Recommendation</th>
</tr>
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<tbody>
<tr>
<td>1. Consume a nutritionally balanced diet and maintain normal hydration in the</td>
</tr>
<tr>
<td>24 h before an event and/or training session.</td>
</tr>
<tr>
<td>2. Consume about 500 ml of fluid in the 2 h before an event, which will</td>
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<tr>
<td>allow adequate time to excrete excess fluid before the event begins.</td>
</tr>
<tr>
<td>3. Consume enough fluids during exercise to equal the amount of fluid lost</td>
</tr>
<tr>
<td>from sweating. If this is not feasible, drink to tolerance.</td>
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<tr>
<td>4. The fluid should be cool (approximately 15°C), flavored to maximize</td>
</tr>
<tr>
<td>palatability, and accessible in ample quantity in convenient containers.</td>
</tr>
<tr>
<td>5. For activities lasting about 50 min or more or those of an extremely</td>
</tr>
<tr>
<td>intense nature, or both, use sport drinks instead of water to encourage</td>
</tr>
<tr>
<td>proper muscle glycogen levels in addition to adequate hydration.</td>
</tr>
<tr>
<td>6. For activities of about an hour or more, include sodium to increase</td>
</tr>
<tr>
<td>palatability, to enhance fluid retention, and to prevent hyponatremia.</td>
</tr>
</tbody>
</table>

Table 4. When Athletes Exercise in the Heat: A Checklist for the ATC

<table>
<thead>
<tr>
<th>1. Pre-event preparation</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Am I challenging unsafe rules (eg, a 10K track runner may not be able to receive fluids; can these rules be changed to maximize safety)?</td>
<td></td>
</tr>
<tr>
<td>Am I encouraging athletes to drink before the onset of thirst?</td>
<td></td>
</tr>
<tr>
<td>Am I familiar with which athletes have a history of a heat illness?</td>
<td></td>
</tr>
<tr>
<td>Am I discouraging alcohol, caffeine, and drug use before and during exercise?</td>
<td></td>
</tr>
<tr>
<td>Am I encouraging proper acclimatization procedures?</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. Checking hydration status</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Do I know the pre-exercise weight of the athletes I work with (to allow percentage of dehydration to be determined during and after practice or competition)?</td>
<td></td>
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<tr>
<td>Are the athletes familiar with how to assess urine color? Is a urine color chart accessible?</td>
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</tr>
<tr>
<td>Do the athletes know their sweat rates so they know how much to drink during exercise?</td>
<td></td>
</tr>
<tr>
<td>Is a refractometer present to double-check hydration status?</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>3. Environmental assessment</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Am I regularly checking the wet-bulb globe temperature (WBGT) during the day?</td>
<td></td>
</tr>
<tr>
<td>Am I knowledgeable about the risk categories of a heat illness based on the WBGT?</td>
<td></td>
</tr>
<tr>
<td>Are alternate plans made in case a high WBGT forces a rescheduling of events or practices?</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>4. Coaches' and athletes' responsibilities</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Are the coaches and athletes educated about the signs and symptoms of heat illnesses?</td>
<td></td>
</tr>
<tr>
<td>Are athletes properly prehydrated for the activity?</td>
<td></td>
</tr>
<tr>
<td>Am I double-checking to make sure coaches are allowing ample rest and rehydration breaks?</td>
<td></td>
</tr>
<tr>
<td>Are modifications being made to reduce risk in the heat (eg, decrease in intensity, change practices to morning or evening, more frequent breaks, elimination of double sessions, reduction or change in equipment, clothing requirements, etc)?</td>
<td></td>
</tr>
<tr>
<td>Are shaded or indoor areas used for practices when possible, to minimize thermal strain?</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>5. Event management</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Have I checked to make sure proper amounts of fluids will be available and accessible?</td>
<td></td>
</tr>
<tr>
<td>Are carbohydrate-electrolyte drinks available at events and practices lasting longer than 50 to 60 minutes and those that are extremely intense in nature?</td>
<td></td>
</tr>
<tr>
<td>Am I aware of the factors that may increase the likelihood of a heat illness?</td>
<td></td>
</tr>
<tr>
<td>Am I promptly rehydrating athletes to pre-exercise weight after an exercise session?</td>
<td></td>
</tr>
<tr>
<td>Are shaded or indoor areas used for practices when possible, to minimize thermal strain?</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>6. Treatment considerations</th>
<th></th>
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<tbody>
<tr>
<td>Am I familiar with the most common early signs and symptoms of a heat illness?</td>
<td></td>
</tr>
<tr>
<td>Do I have the proper field equipment and skills to assess a heat illness?</td>
<td></td>
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<tr>
<td>Is an emergency plan in place in case an immediate evacuation is needed?</td>
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</tr>
<tr>
<td>Is a kiddie pool available in situations of high risk in order to initiate immediate cold/ice-water immersion of heatstroke patients?</td>
<td></td>
</tr>
<tr>
<td>Are ice bags available for immediate cooling when ice-water immersion is not possible?</td>
<td></td>
</tr>
<tr>
<td>Have shaded, air-conditioned, and cool areas been identified to use when athletes need to cool down, recover, or receive treatment? Are fans available to assist evaporation when cooling?</td>
<td></td>
</tr>
<tr>
<td>Am I properly equipped to assess high core temperatures?</td>
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</tr>
</tbody>
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7. Other situation-specific considerations

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<td>from the body. Avoiding the sun's direct rays will limit the radiant heat load.</td>
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<td>Athletes who must exercise for multiple sessions in the heat can use ice packs (under the arm, in the groin, behind the neck and the knees) to speed the decrease in core temperature and enhance physiologic capacity during the next session. While cooling, they should sit in the shade or in an air-conditioned room in front of a fan (to increase evaporation), drink cool fluids beyond thirst satiation, rest (to decrease the metabolic rate), replace glycogen stores, and refill coolers or water bottles for the next exercise bout. If a severe case of dehydration must be reversed rapidly, intravenous fluids are recommended.</td>
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<td>The fine-mist showers and cool sponges found at many athletic events do little to cool the body's core. Instead, the focus should be on replenishing lost fluids. As discussed earlier, all athletes and support staff must know the signs and symptoms of heat illness in order to recognize and treat problems as early as possible. In the event that an athlete becomes severely hyperthermic or develops heatstroke, cold water or ice-water immersion provide the fastest whole-body cooling. The simplest way to distinguish heatstroke from heat exhaustion in the field involves observing mental acuity. If disorientation, unconsciousness, bizarre behavior, or coma exist, heat stroke should be expected (rectal temperatures &gt;39°C to 40°C), and cooling should be instituted immediately, in response to this medical emergency.</td>
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<td>Practice and Competition Modifications</td>
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<td>The ACSM's position stand, &quot;Heat and Cold Illnesses During Distance Running,&quot; offers valuable guidelines to counteract critical levels of environmental conditions that may increase the risk of heat illness and hinder performance. Although the position stand focuses on running, the information is easily transferable to other sports, and the organization strategies apply to any competition director or coach who</td>
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supervises athletes practicing or competing in a hot environment. Some of the factors that must be considered by an ATC when supervising exercise in the heat are summarized in Table 4.

If the time of competition is fixed (ie, more difficult to reschedule than a practice), then participants, coaches, and medical staff must be alert to the possibility of cancellation or postponement and the need to practice extreme caution. Athletes who practice in extreme heat should plan lower-intensity training sessions for the heat of the day (to maximize acclimatization) and higher-intensity sessions for the early morning or evening (avoiding the 11:00 AM to 3:00 PM time period, shadeless fields or roads, and black ground surfaces).

Ample fluids should be easily accessible. In sports where athletes compete in weight classes, special care should be taken to ensure that athletes do not rapidly lose weight (increasing the risk for heat illness, since much of the weight loss is water) or use rubber suits or saunas to enhance sweating, since core temperatures may become dangerously high in a short period of time. All too often, the quest for athletic success is accompanied by dangerous training techniques. The recent deaths of 3 collegiate wrestlers, which were due largely to a combination of thermal overload with dehydration, attest to this fact.

CONCLUSION

The information presented in these 2 review articles is aimed toward assuring that athletic trainers are knowledgeable and prepared to actively construct protocols for many aspects of exercising in the heat. The goals of maximizing athletic performance and minimizing the health risks of the athletes we supervise must always focus on health first and on performance second.

ACKNOWLEDGMENTS

I thank the remarkable people who work and who have worked at the Human Performance Laboratory at the University of Connecticut. The environment in the laboratory is a wonderful combination of scholarly pursuits and human interactions. This paper is dedicated to the passion, tireless efforts, and friendship of Stavros A. Kavouras, PhD.

REFERENCES


Syncope and Atypical Chest Pain in an Intercollegiate Wrestler: A Case Report

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Objective: To present the case of a 20-year-old collegiate wrestler who suffered from atypical chest pains and syncope after rigorous exercise, dehydration, and ingestion of a metabolic stimulant.

Background: As a result of pressure to obtain a lower body weight for competition, wrestlers often pursue practices to lose a substantial amount of weight in a short period of time. These practices include rigorous exercise, starvation, dehydration, laxatives, diuretics, and over-the-counter stimulants. Our case involves an athlete who ingested a metabolic stimulant containing ma huang (ephedrine) and suffered from syncope and atypical chest pains during a bout of rigorous exercise and dehydration to lose weight for competition.

Differential Diagnosis: Hypertrophic cardiomyopathy, electrolyte imbalance, drug overdose, traumatic head injury, myocardial infarction, syncope.

Treatment: The emergency medical services transported the athlete to the emergency room, and he was hospitalized for 2 days. After discharge, the team physician counseled the athlete in the dangers of metabolic stimulants and excessive weight-loss techniques.

Uniqueness: This case is unique because it presents an athlete who ingested an over-the-counter stimulant to lose weight and suffered from syncope and atypical chest pains during a bout of rigorous exercise and dehydration.

Conclusions: Athletic trainers must understand not only the dangers of excessive weight loss, but also the dangers of using unregulated ephedrine-containing stimulants to aid in weight loss.

Key Words: wrestling, Chinese herbal stimulants, ephedrine, weight loss

For scholastic and collegiate wrestlers, the pressure to attain and maintain a certain weight class is substantial. Wrestlers often rely on extended bouts of rigorous exercise, in combination with starvation and dehydration, to attain a competitive weight.1-3 Unfortunately, wrestlers will often go so far as to pursue practices designed for a substantial amount of weight loss over a short period of time, including the use of saunas, hot boxes, steam rooms, impermeable rubber or nylon suits, laxatives, and diuretics.2,3 As in our patient's case, wrestlers occasionally use over-the-counter (OTC) metabolic stimulants, which are available at most nutritional stores. Nutrition stores market these supplements to increase the body's metabolism, leading to an increase in weight loss.4 Because these stimulants are marketed as "natural" and are so readily available, users feel they are safe.5-8 Even though these stimulants are believed by the public to be safe, they sometimes contain Chinese herbal extracts, like ma huang extract, which has known side effects. The purpose of our paper is to report the case of an intercollegiate wrestler who suffered from syncope and atypical chest pains during a rigorous bout of exercise and dehydration after ingestion of an OTC stimulant containing ephedrine (ma huang) and caffeine.

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REPORT OF THE CASE

A 20-year-old African-American male intercollegiate wrestler weighing approximately 61.23 kg experienced severe substernal chest pain, tachycardia, hyperventilation, and loss of consciousness during wrestling practice. Before the incident, the athlete had no previous history of cardiac pain or dysfunction. The athletic trainer intervened by initiating the prepared emergency action plan for prompt arrival by the emergency medical services. Initially, the supine athlete experienced an altered state of consciousness in which he did not always respond to verbal cues. He eventually described his chest pain as "chest pressure"; however, he reported no abnormal sensations into the upper extremities. Although the athlete was conscious when the emergency medical services arrived, his heart rate was significantly elevated (160 beats per minute). Upon arrival at the emergency room, the athlete had a blood pressure of 120/80 mm Hg and a pulse of 90 beats per minute. He was coherent and oriented but continued to suffer from intermittent chest pain, and his breathing was quick and shallow for approximately 2 hours. The athlete was admitted to the hospital for further evaluation.

At the emergency room, the athlete revealed that he had ingested a metabolic stimulant known as Ripped Fuel (Twin Lab, Ronkonkoma, NY). Ripped Fuel is available at most stores specializing in nutritional supplements. The athlete admitted taking 4 tablets daily for 2 months, 2 tablets at...
breakfast and 2 tablets at dinner. On the day of the incident, with no food or beverage consumption for that day, the athlete ingested 2 tablets just before practice. His rationale for taking the medication was to increase his basal metabolism to aid in weight loss.

The athlete underwent a battery of tests during his hospitalization. An electrocardiogram revealed normal cardiac intervals and normal sinus rhythm. A Holter cardiac monitor of cardiac activity over a 24-hour period revealed no cardiac arrhythmia. An echocardiogram revealed no hypertrophic cardiomyopathy, and an arterial blood gas test ruled out the possibility of a pulmonary embolus. Urinalysis revealed an increased level of creatinine in his urine secondary to dehydration (the athlete reported no history of creatine supplement usage) and the presence of ephedrine. One day after the incident, the athlete performed a cardiovascular exercise tolerance test. He had minor chest pain lasting about 15 seconds during minute 16 of exercise, with normal cardiac rate, rhythm, and blood pressure and no signs of ischemia. Because the athlete lost consciousness and experienced hyperventilation, tachycardia, increased creatinine level, and atypical chest pain, the team physician diagnosed the athlete as suffering from syncope and atypical chest pains resulting from a combination of dehydration, physical stress, and use of the metabolic stimulant.

The athlete followed up with the team physician 4 days after the incident and was counseled about the dangers of nutritional supplements in combination with excessive weight loss. He was advised not to take medications containing ephedrine and pseudoephedrine without consulting a physician and to screen all medications with the team physician and athletic trainer. The team physician examined and cleared the athlete 4 days after the incident. The athlete has had no recurrence of signs and symptoms and has not used metabolic stimulants.

**DISCUSSION**

This athlete attempted to lose approximately 4.54 to 6.80 kg (10 to 15 lb) to compete in the 57.15-kg (126-lb) weight class. To aid in his weight loss, he ingested Ripped Fuel to theoretically increase his metabolism, thereby decreasing his weight. Ripped Fuel contains caffeine and a derivative of ephedrine called ma huang. Ma huang is extracted from the *Ephedra* species and has been used in Far Eastern societies for thousands of years. In Western society, ma huang is marketed as a diet or energy pill. Because ma huang is considered a nutritional supplement, it is not subject to the controls and vigorous testing of the Food and Drug Administration (FDA). Even though ma huang is not strictly regulated, the FDA, through the MEDwatch program, is well aware of the dangers involved with its use. The MEDwatch program asks health professionals, as well as federal, state, and local health agencies, to voluntarily report adverse effects resulting from dietary supplement use. On April 10, 1996, the FDA issued a warning to consumers to avoid nutritional supplements containing ephedrine. In addition, the FDA proposed, and is currently deliberating over, the use of warning labels addressing the adverse effects of ephedrine and the banning of products containing more than 8 mg per serving and those containing ephedrine in combination with caffeine (like Ripped Fuel), as well as limiting product use to 7 days. No clinical studies have proved the safety or claimed benefits of mu huang products.

Over the past decade, over 500 reported adverse effects, including more than 15 deaths, have resulted from the use of ephedrine products like ma huang. Theoharides reported the death of a healthy 23-year-old male who regularly consumed 1 or 2 Ripped Fuel drinks daily over a 6-month period. The autopsy revealed myocardial necrosis associated with ephedrine toxicity. The Centers for Disease Control and Prevention reported on a 38-year-old male who suffered from seizures and syncope after ingestion of an ephedrine-containing product. A 35-year-old woman used ephedrine to aid in weight loss, and, although she used the recommended dose for 30 days, she experienced anterior chest pain and shortness of breath. Wiener et al reported crushing chest pains suffered by a 28-year-old healthy male after ingestion of an ephedrine alkaloid (pseudoephedrine). A case report by Derreza et al revealed substernal chest pain, shortness of breath, and diaphoresis after pseudoephedrine ingestion. Cockings and Brown reported diffuse myocardial injury in a 25-year-old male after intravenous injection of ephedrine as a substitute for an illicit street drug. Finally, Weesner et al reported a 14-year-old female who suffered from chest pain, dizziness, tachycardia, and blurred vision after ingestion of an OTC stimulant containing ephedrine and caffeine. Possible adverse effects experienced with ma huang use are presented in the Table. The athlete in this case suffered from substernal sharp chest pains, syncope, tachycardia, and hyperventilation, all of which are reported in the literature as possible adverse effects from ephedrine use. Since the athlete admittedly consumed the Ripped Fuel before practice, it is feasible that his signs and symptoms resulted from the ephedrine-containing product.

The goal of excessive weight loss in wrestling is to qualify at a lower weight class, where the wrestler believes he will be bigger, stronger, and faster and possess greater leverage over his opponent. Excessive weight loss to make a lower weight

### Possible Adverse Effects of Ma Huang Use

| Nervousness | Acute hepatitis |
| Diaphoresis | Renal failure |
| Blurred vision | Seizures |
| Insomnia | Arrhythmia |
| Headaches | Chest pain |
| Dizziness | Tachycardia |
| Paranoia | Palpitations |
| Psychosis | Hypertension |
| Tremors | Coronary spasm |
| Convulsions | Myocardial infarction |
| Syncope | Mortality |
class may occur 15 to 30 times over a 4-month period.\(^3\) As a result of dehydration, wrestlers often shed as much as 4% to 5% of their body weights on the day of competition.\(^3\) Brownell et al\(^1\) reported that most athletes who participate in sports with specific weight categories like wrestling compete at levels 5% to 10% lower than their normal body weights. Being dehydrated has many adverse effects on both athletic performance and overall health. Dehydration decreases muscle strength, decreases work performance, and lowers blood volume and liver glycogen, as well as affecting thermoregulation.\(^1,3,31-35\)

Elite wrestlers who lost 8% of their body weight exhibited decreased speed with uphill sprinting and isometric endurance.\(^33\) Both of these deficits are important indicators of athletic performance. A study of 9 intercollegiate wrestlers involved testing their peak work capacity before and after excessive weight loss over a 4-day period and revealed decreased work capacity.\(^31\) The mean weight loss for the 9-wrestler subject pool was 4.8% of body weight. After rehydration to simulate prematch activities, the group's body weight was still 2.2% lower than the pretest values, and peak work capacity was still decreased. Even though wrestlers have the opportunity to rehydrate after weigh-in, performance is still affected.\(^31\) Dehydration has also been shown to affect the thermal regulation of the body. Body weight loss of 5% significantly increases the risk of a wrestler's experiencing some type of heat-related illness.\(^3\) As an athlete continues to exercise in a dehydrated state, the body is unable to fully cool itself, which may lead to decreased renal blood flow and eventually kidney failure, decreased cardiac output, and even death.\(^3\)

The medical records for our patient revealed a diagnosis of syncope and atypical chest pains due to a combination of an OTC stimulant (Ripped Fuel), dehydration, and vigorous exercise. Burke et al\(^14\) defined syncope as a brief and sudden loss of consciousness and muscle tone secondary to some contributory factor. Contributory factors to syncope can include hyperventilation, dehydration, hypoglycemia, electrolyte imbalances, increased temperature and humidity, drug use, and cardiac conditions.\(^35\) A number of factors could have contributed to the syncope experienced by this athlete. As stated previously, ephedrine use can cause syncope and unresponsiveness.\(^19\) Heat illness and dehydration cause syncope.\(^20,35,36\)

The athlete in this report exhibited increased levels of creatinine in the urinalysis due to dehydration. The dehydration levels involved with “cutting weight” possibly contribute to syncope. Cardiac conditions can contribute to syncope.\(^35\) While no cardiac conditions like hypertrophic cardiomyopathy, myocardial infarction, or myocardial necrosis were diagnosed, the athlete suffered from tachycardia and atypical chest pains for approximately 2 hours. Thus, the cardiac abnormalities may have contributed to the syncope. The athlete exhibited hyperventilation during the episode and 2 hours thereafter. Since hyperventilation can cause syncope, it may have been a contributing factor.\(^35\) Because it is impossible to truly determine the exact cause of the syncopal episode and chest pains experienced by the athlete, we can only speculate as to the cause. We have noted several cases similar to this, in which ephedrine products were believed to have contributed to injury or illness.\(^17,19,24\)

**CONCLUSION**

This case study is unique in that it involves a collegiate wrestler experiencing syncope and atypical chest pains while attempting to lose weight. Whether the syncope and atypical chest pains resulted from the combination of exercise, dehydration, and Ripped Fuel or from a single cause, athletic trainers and coaches must understand not only the dangers of “cutting weight” but also the dangers of using unregulated stimulants like Ripped Fuel to aid in weight loss. The recent deaths of 3 collegiate wrestlers over a 2-month period while attempting to lose a substantial amount of weight have increased awareness of the dangers involved with “cutting weight.” Using a stimulant like Ripped Fuel may compound the risk of excessive weight loss.

**REFERENCES**


Assessment of First-Aid Knowledge and Decision Making of High School Athletic Coaches

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* School of Applied Health and Educational Psychology, Oklahoma State University, Stillwater, OK; † Department of Athletics, San Jose State University, San Jose, CA

Objectives: To assess the first-aid knowledge and decision making of interscholastic athletic coaches exposed to athletic injuries.

Design and Setting: Survey demographic information, First-Aid Assessment, and Game Situation Data Sheet in 17 metropolitan high schools.

Subjects: A total of 17 metropolitan high schools participated in this study, and 104 athletic coaches completed questionnaires. Fifteen different athletic sports were represented in this investigation. Thirty coaches (29%) worked with more than one athletic sport during the year. Male subjects constituted 83% (n = 85) of the sample. Years of coaching experience ranged from first-year coaches to those with more than 28 years of experience. Most coaches (61%, n = 63) investigated were teachers, and the remaining subjects were walk-on coaches.

Measurements: Central tendency scores were determined in the demographic analysis. \( \chi^2 \) analyses were performed to determine the interaction between First-Aid Assessment and the Game Situation Data.

Results: Thirty-eight (36%) of the 104 athletic coaches tested achieved passing scores of 29 or higher, with the total scores ranging from 19 to 34. For the Game Situation Data Sheet, 75% (n = 78) of the coaches selected the same response to 7 questions. Most coaches in this study chose to return injured players to the game. We analyzed the data to determine whether coaches who passed the First-Aid Assessment responded differently than those who did not. (The scenario presented in one question involved a starting player’s sustaining injury when losing a close game.) Coaches who passed the First-Aid Assessment tended to return injured starters to the game, whereas those who failed it kept injured players out of the game. \( \chi^2 \) analysis on the second question (the team is winning a close game when a regular player is injured) showed no tendency for passing or failing coaches to respond differently.

Conclusions: The athletic coaches did not adequately meet first-aid standards as established for this study in accordance with the American Red Cross. In addition, coaches who passed the First-Aid Assessment tended to return an injured starter to the game, whereas those who failed decided to keep the player out of the game. It is critical that an unbiased, objective professional person provide all medical care on the athletic playing field, preferably one who is certified in athletic training.

Key Words: athletic injury, injury outcomes

Injuries are part of athletic participation, and many of these injuries are initially treated by untrained personnel due to a lack of health care providers on the athletic field. Coaches are often faced with the responsibility of caring for these injured players. High school athletic programs are one level of athletics that have undergone scrutiny over the past 2 decades for their medical care. District and high school administrators, coaches, and team physicians are being held liable for injuries sustained by participants. Today’s legal system expects a high standard of medical care to be provided by high schools.

Numerous studies have investigated the multiple first-aid and athletic-injury treatment job responsibilities assigned to high school athletic coaches. Researchers have also examined coaches’ knowledge and ability to handle responsibilities related to providing first aid. When coaches are forced to treat athletic injuries due to a lack of available medical personnel, they may be forced to make medical decisions that exceed their educational training. It is important that coaches have the knowledge and expertise in medical care for which they are being held accountable. However, the educational background of coaches in medical assessment and injury care varies greatly; therefore, we need to ensure that coaches possess a minimum level of knowledge in first aid. Most states require coaches to maintain current certification in first aid and cardiopulmonary resuscitation (CPR), whereas a few states require coaches to have a degree in physical education or completion of specialized courses.

However, simply possessing sufficient first-aid knowledge does not ensure that coaches will provide adequate first aid because many coaches have a multitude of roles to fill. Not
only are they responsible for developing a winning team and providing first aid for injuries, but they must also care for athletic equipment, maintain practice and event facilities, and schedule travel arrangements. As a result of these many duties, a conflict may occur between work responsibilities and the desire to win, reducing the quality of medical care provided by coaches. Coaches must know the duties they are expected to fulfill in relationship to the medical care of their athletes. Therefore, the purpose of our study was to measure the first-aid knowledge of high school coaches and assess their decisions made in hypothetical athletic situations involving competition and injured athletes.

METHODS

Male and female coaches for boys' and girls' interscholastic athletic teams from 17 California metropolitan high schools were selected for this investigation. High school coaches were categorized according to the work of Hage and Moore:

Table 1. Examples of Questions Found in First-Aid Assessment

1. Water should be
   a. withheld during practices, available during games.
   b. withheld during games, available during practices.
   c. available only during participation on hot days.
   d. available at all times during practice and games.

2. Ice should always be used — after an injury occurs, unless otherwise directed by a physician or athletic trainer.
   a. after the first 48 hours
   b. during the first 48 hours
   c. during the first 24 hours only
   d. during the first 12 hours only

3. An athlete who is knocked unconscious may return to play if he or she
   a. regains consciousness within 2 minutes.
   b. presents no signs and symptoms of a head injury.
   c. is cleared by a physician.
   d. feels capable of returning to play.

4. Standard first aid for a sprained ankle does not include
   a. ice.
   b. compression.
   c. percussion.
   d. elevation.

5. Mouth guards protect an athlete against
   a. tooth fractures and tongue lacerations.
   b. jaw fractures.
   c. concussions.
   d. both a and c.

6. Which is the first step in caring for bleeding wounds?
   a. Apply direct pressure on the wound with a clean or sterile dressing.
   b. Apply pressure at a pressure point.
   c. Apply bulky dressings to reinforce blood-soaked bandages.
   d. Elevate the wound above the level of the heart.

7. An athlete's front teeth are knocked out during practice. The teeth should be
   a. washed in water and replaced in the sockets.
   b. stored in saline until dentist can replace.
   c. stored in milk until dentist can replace.
   d. any of above are acceptable.

8. The first action that should be taken when approaching a collapsed, injured athlete is to
   a. move the athlete off the playing surface.
   b. determine responsiveness.
   c. check for breathing.
   d. check for pulse.
the Game Situation Data Sheet were established by Flint and Weiss.2

We used the First-Aid Assessment, which was adapted with permission from the American Red Cross Basic First-Aid Competency Examination and from Sports Injury: Emergency First-Aid Care and Prevention Final Examination, to assess first-aid knowledge.15 The original tests are used by the American Red Cross to determine proficiency after completion of the Basic First-Aid and Sports Injury courses. This 38-item test consists of statements that require an objective response to assess competency in 6 areas identified as responsibilities of individuals who provide first aid. The 6 areas are anatomy, care and treatment, prevention, assessment, equipment, and heat/cold-related factors. A score of 80% or greater was required to pass, in accordance with American Red Cross examination guidelines.15

The Game Situation Data Sheet was used, with permission,2 to examine the decisions coaches make in hypothetical athletic situations. Nine scenarios require the coaches to indicate whether or not they would return the injured player to the game. Injured athletes are classified as starting players, first substitutes, or bench players. Game situations include winning, losing, and close competitive scores.2

We used a separate survey to obtain demographic information and identify trends as related to years of coaching experience, sport coached, and questionnaire scores. Factors evaluated were sport(s) and sex(es) of the athletes each coach oversees, teacher-coach or walk-on status, sex of coach, years of coaching experience, educational background, date (month/year) of most recent first-aid and CPR certification, and medical coverage at the high school. Verbal permission from the participating high school athletic league commissioners and school districts was obtained, and written permission was then provided. Test sessions were administered by a certified athletic trainer, who followed standardized procedures during the administration of the questionnaires. A consent form was given to each coach before the test session began. As consent forms were returned to us, we distributed questionnaires with a letter of explanation and instructions. All procedures were approved by a university institutional review board.

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<th>Game Situations</th>
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<td>1. During the last 10 minutes in the game with your team clearly losing, your 8th player (usually 3rd into the game) gets a hand in the way of a hard pass and hyperextends an elbow. It is checked and taped. The player is eager to get back on the floor.</td>
<td>Yes</td>
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<td>2. One of your starters, during a game you are winning easily, suffers a dislocated finger. After reduction (being returned to its normal position) the finger is checked for fractures. It doesn’t appear as if there are any fractures present. The finger is given some support and the player asks to return to the game.</td>
<td>Yes</td>
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<td>3. The game is close and your team is down by 4 points. You have a “bench player” on the floor replacing a tired starter when the bench player begins hyperventilating. After being helped at the bench, the player indicates everything is okay.</td>
<td>Yes</td>
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<tr>
<td>4. Your starting guard dives after a loose ball and bruises the right kneecap. The game is far out of your team’s reach at this point. The knee is slightly stiff and is showing some signs of a bruise, but the player can move fairly well without too much problem. The player indicates a readiness to return to the game.</td>
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**Statistical Analysis**

We examined 2 hypotheses: 1) that no difference exists between accredited standards of competency in basic first aid and high school coaches’ knowledge of first aid; and 2) that decisions made by coaches are not affected by a conflict of duties. We performed descriptive analysis on the demographic data and First-Aid Assessment and $x^2$ analysis at the 0.05 level of significance on the Game Situation Data Sheet. The $x^2$ analysis was used to determine the interaction between the First-Aid Assessment and the Game Situation Data Sheet. We used the Statistical Package for the Social Sciences (SPSS, version 6.1, Chicago, IL) for all analysis procedures.

**RESULTS**

Seventeen metropolitan area high schools participated in this study, and 104 athletic coaches completed questionnaires. Fifteen athletic sports were represented in this investigation. Thirty coaches (29%) worked with more than 1 athletic sport during the year. Male subjects constituted 83% (n = 85) of the sample. Years of coaching experience ranged from first-year coaches to those with more than 28 years of experience. Most, 61% (n = 63), of the coaches were teachers, and the remaining subjects were walk-on coaches.

Thirty-eight coaches (36%) achieved passing scores, with the total scores ranging from 19 to 34. For the Game Situation Data Sheet, 75% (n = 78) of the coaches selected the same response to 7 questions. Most coaches chose to return injured athletes to athletic competition. However, on 2 questions (No. 4 and No. 8), coaches were more divided between the 2 choices. On question 4, 63% (n = 65) of the coaches made the same choice in returning an injured player to a close, losing game. On question 8, 58% (n = 60) of the subjects returned the injured player to a close, winning game. Therefore, $x^2$ analysis was performed on those 2 questions at the 0.05 level of significance (Table 3).

The scenario presented in 1 question stated, “In a game in which you are only down by 5 points, your starting guard goes down with a sprained ankle. It appears to be a mild sprain and...
taping has given it some support. The player assures you everything is fine and [he] can perform cuts and turns with only minor discomfort." The significant $\chi^2$ value of 4.88 shows that a difference existed such that coaches who passed the First-Aid Assessment tended to return an injured starter to the game, whereas those who failed decided to keep the player out of the game. The second question stated, "With 10 minutes to go in a close game, and your team up by only 3, your starting guard needs a rest. The backup player at that position had earlier gone out with a strained lower back muscle. The backup player has been moving around behind the bench and appears fine. It appears to be only a mild strain and isn't causing the player a great deal of problems. The backup player wants to play again in the game." The nonsignificant $\chi^2$ value of 0.73 demonstrated no tendency for passing or failing coaches to respond differently.

**DISCUSSION**

Athletes in all sports at every level of ability are susceptible to injury during athletic competition; therefore, quality medical assistance should be readily available for all athletes. In a survey of Chicago high schools in 1980 by Porter et al., approximately 75% of responding coaches indicated that they perform the following duties: coach athletes, administer conditioning programs, educate athletes about diet and nutrition, issue and maintain equipment, provide first aid, and apply protective tape and equipment.

The duties identified by Abraham and Porter et al. are now considered standard; however, the growing demand for athletic trainers and sports medicine in the 1970s, as well as increased litigation involving coaches and school districts, served as an impetus for research specifically investigating a coach's duty to provide first aid. Generally, these studies sought to determine whether coaches were still required to perform first aid. Wrenn and Ambrose in 1980 conducted a statewide study of health care practices in 128 Maryland public high schools. According to their findings, coaches were the individuals most responsible for first-aid care for 85 percent of the schools. Bell et al. investigated medical coverage in 397 Illinois high school athletic programs in 1984 and found that coaches in 92% were responsible for performing first aid on injured athletes.

Research indicates that most high school coaches are responsible for providing first aid to their athletes. As the responsibility of coaches to provide higher standards of first-aid care increases, the potential for a duty conflict to occur increases, providing the impetus for research to determine whether a role conflict exists for coaches. Several studies have alluded to the potential for coaches to experience conflict between their duties. As early as 1970, Abraham perceived that a coach's duty to provide first aid and perform his or her other duties might result in a conflict. Suggested reasons for the role conflict include time constraints, inadequate first-aid education, and actual duty to coach. However, role conflicts were not directly investigated until the 1980s.

Flint and Weiss developed the Game Situation Data Sheet for their study of Oregon coaches. They used the questionnaire to assess the decisions made by coaches regarding injured athletes in scenarios involving various game situations and players of different abilities. Game situation and player status significantly influenced coaches' injury management decisions, and the authors concluded that a role conflict did exist between the duty to coach and the duty to provide first aid.

In addition to conflicts related to duties and time constraints, other factors have been identified that impact first-aid provision by coaches. Those factors most frequently cited are a lack of first-aid knowledge and low confidence level. Research concerned with emergency medical education and knowledge of coaches has been conducted, both separately and in conjunction with studies investigating how capable coaches feel they are to administer first aid.

Research results suggest that a low level of confidence is directly related to inadequate first-aid knowledge. In 1980, Redfearn examined the first-aid capabilities of 35 Michigan high school coaches, using a simple questionnaire to survey their education in medical care. Fifty-five percent had American Red Cross first-aid training, 30% had CPR education, and 2.7% had received emergency medical technician training. However, only 44% felt capable of managing an emergency medical situation.

Before this investigation, first-aid knowledge had been investigated in only 2 studies. Rowe and Robertson developed a first-aid test for their study investigating Alabama athletic coaches. Of the 127 respondents, only 27% (n = 34) passed the First-Aid Assessment. Rowe and Miller gave the same test to Georgia coaches and found that only 38% (n = 50) of the 130 coaches achieved passing scores, even though 89% (n = 116) had current first-aid certification. Similarly, in our study of 104 coaches, 36% (n = 38) passed the first-aid test and 92% (n = 96) were certified in first aid.

In our study, coaches' decisions on the Game Situation Data Sheet were consistent with the Flint and Weiss study for the close game scenarios. Coaches who passed the First-Aid Assessment tended to return injured starters to the game, whereas those who failed decided to keep such players out of the game. In many cases, the coaches returned the injured
athlete to play regardless of the game situation. Prior investigations found that medical decisions are based on many factors, such as the player's ability and the game situation.\textsuperscript{5,6,9,10} Given this information, it is clear that changes are necessary to ensure that coaches make sound decisions with regard to injured athletes. Coaches need basic first-aid knowledge to establish a foundation for making decisions. Also, they must understand the ramifications of returning an injured athlete to competition. We found that 8\% (n = 8) of our study sample did not have current first-aid certification, violating present California state interscholastic regulations. Requiring first-aid and CPR certification is not enough to guarantee retention or acquisition of information about athletic injury care, especially since 63\% (n = 66) of the coaches failed the First-Aid Assessment. Athletic coaches need courses that update first-aid and CPR certification and the care of athletic injuries. Additional knowledge on the treatment and rehabilitation of athletic injuries should enable coaches to make more objective decisions, as well as to provide proper first aid to the injured athlete. Another option is to have someone other than the coach provide first aid and make necessary decisions about how and when an athlete should return to athletic competition. Preferably, this individual would be a qualified medical professional, such as a physician or certified athletic trainer, who could alleviate the conflict for the coach and provide quality medical care for the athlete.

Only 16\% (n = 16) of our subjects had team physicians available for consultation, and 61\% (n = 62) had certified athletic trainers available on site for medical support. Having a qualified medical professional at all athletic events is desirable. Recognizing that caution should be observed in generalizing beyond these results, we conclude that coaches did not adequately meet first-aid standards. In the hope that future research will further explore the problem at hand, we recommend use of a broader-based population sample in further studies. Also, future research should look at how sport-specific decision-making scenarios may evoke different responses from coaches and what factors influence the decision to return an injured athlete to competition. Scenarios could be developed to identify whether the athlete's or the coach's sex, or both, influence decisions made by the coach.

REFERENCES


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Background: In June 1997, the American Academy of Pediatrics introduced a resolution asking the American Medical Association (AMA) to support efforts to place certified athletic trainers in all secondary schools. The AMA Council on Scientific Affairs studied that resolution and presented this report to the AMA House of Delegates in June 1998.

Objective: To identify the professional responsibilities, educational requirements, and current use of certified athletic trainers in the prevention and care of high school sports injuries.

Data Sources: MEDLINE and HealthSTAR databases were searched for English-language articles published from 1980 to 1998. Additional references were derived from references in pertinent articles, communication with experts, and the Internet sites of athletic training and sports medicine associations.

Data Synthesis: One in 5 of approximately 6 million adolescents who participate in high school sports each year sustains a sport-related injury. Most of these injuries are minor and occur during practices rather than competitions. Approximately 1 of every 100,000 high school athletes will sustain a catastrophic injury. About 35% of US high schools use the services of a certified athletic trainer, who, under a physician’s supervision, is responsible for the prevention and care of athletic injuries and coordination of the school athletic health program.

Conclusions/Recommendations: Emphasis should be given to ensuring the health, safety, and well-being of participants in high school sports. Whereas most high school sports injuries are minor, adequately trained personnel should be present on site to ensure that such injuries are recognized early, treated immediately, and allowed to heal properly, thereby reducing the risk of more serious injury or reinjury. For such care, team physicians and coaches should have the assistance of a certified athletic trainer.

Key Words: athletic injuries, athletic training, high school sports, injury prevention, adolescent health

Methods

Information for this report was derived from searches of the MEDLINE and HealthSTAR databases and the Internet sites of athletic training and sports medicine associations. MEDLINE and HealthSTAR were searched for English-language articles published from 1980 to 1998 using the key words “athletic injuries,” “athletic training,” “high school sports,” “injury prevention,” and “adolescent health.” Additional references were derived from a manual search of pertinent articles, journals, and sports medicine textbooks. Information also was obtained through direct inquiries with experts in sports medicine and athletic training, including representatives of the American Academy of Pediatrics, American College of Sports Medicine, Centers for Disease Control and Prevention, Joint Commission on Sports Medicine and Science, National Association for Sport and Physical Education, National Athletic Trainers’ Association, and National Federation of High School Associations. The report was reviewed externally and by the Council on Scientific Affairs.

Epidemiology of High School Sports Injuries

During the 1996–1997 school year, more than 6 million adolescents participated in high school sports programs.
Whereas injury is an inherent risk of participating in interscholastic sports, the nature and magnitude of this risk are uncertain. Currently, there are no federal or state requirements for reporting high school sports injuries. Consequently, data are lacking for a complete assessment of the epidemiology of these injuries. While some data are available to address the type and frequency of injuries in selected sports, information is limited to evaluate the risk factors involved and the effectiveness of therapeutic and preventive interventions. Data collection on these issues is hampered by nonstandardized reporting formats and a lack of consensus on definitions and terminology for documenting and reporting high school sports injuries.

Despite the lack of any state or national reporting systems, several researchers have documented the relatively high occurrence of injuries in interscholastic sports. The most comprehensive national statistics are available from surveillance studies of the National Athletic Trainers’ Association (NATA). Based on research conducted from 1986–1989, the NATA estimates that 1.3 million US high school athletes (1 in 5) are injured each year. About 70% to 75% of these injuries are minor (precluding participation for 7 days or fewer). Although they vary somewhat by sport, the most common injuries are sprains, strains, and contusions, typically to the lower extremities. More than 60% of these injuries occur during practices rather than competitions. In 1995, the NATA began a 3-year surveillance study to follow up results of the 1986–1989 study and to determine the characteristics of injuries in 10 high school sports. The 1986–1989 study projected national injury estimates from a survey of 3 sports: football, wrestling, and basketball.

Data collected over the past 15 years indicate the risk of catastrophic injury in high school sports is approximately 1 in every 100000 participants. Catastrophic injuries include fatalities, nonfatal injuries associated with permanent severe functional disability, and severe injuries with no permanent functional paralysis (eg, fractured cervical vertebra with no paralysis).

PROVIDING MEDICAL CARE FOR INJURED ATHLETES

Although most high school sports injuries are minor, adequately trained personnel should be present on site to ensure that such injuries are recognized early, treated immediately, and allowed to heal properly, thereby reducing the risk of more serious injury or reinjury. Prompt recognition and adherence to proper emergency procedures can reduce the long-term effects of an injury and shorten an athlete’s recovery time. Providing the necessary daily supervision to detect and treat sports injuries can be difficult and requires a team approach to maximize the use of available medical resources. Ideally, this involves the coordinated efforts of a team physician, certified athletic trainer, and coach, who must work together to provide quality, comprehensive care to all sports participants.

Some high schools use the services of a voluntary team physician to provide medical care to high school athletes. It is impossible, however, for this individual to meet the demands of multiple games and practices. Many team physicians attend only varsity football games; they seldom attend other school athletic contests and rarely attend practices, where an appreciable number of injuries occur. To fill this void, some school administrators employ a certified athletic trainer to provide on-site emergency health care and coordinate the school’s athletic health program. The athletic trainer also can assume an important role as a liaison to the team physician, athletes, and coaches.

Due to budget constraints, many high schools are unable to hire or contract the services of a certified athletic trainer. According to an NATA membership survey, during the 1993–1994 school year, about 7600 US high schools (35%) had some form of ongoing direct access to a certified athletic trainer (Teresa Foster Welch, Director of Marketing Communications, NATA, personal communication, December 1997). Recent surveys of the National Federation of State High School Associations found that, during the 1996–1997 school year, only 13 states reported that more than 50% of their state high schools had a certified athletic trainer on staff for football; only 6 states reported that more than 50% of their high schools had a certified athletic trainer on staff for basketball.

Without the services of an athletic trainer, coaches often must assume responsibility for the prevention, care, and rehabilitation of athletic injuries. Studies suggest that some coaches lack sufficient knowledge about these topics and may be inadequately prepared to recognize and respond to medical emergencies. Currently, only 28 states require an educational program in sports first aid and safety for high school coaches.

DUTIES AND RESPONSIBILITIES OF ATHLETIC TRAINERS

Injury prevention and the reduction of further injury are primary responsibilities of the athletic trainer. Under the supervision of the team physician, the athletic trainer designs, coordinates, and implements a comprehensive athletic training and injury prevention program. This includes providing daily treatments (eg, ultrasound, ice massage, electric stimulation) and preventive measures (eg, taping, wrapping, bracing) for athletes for practices and games. To perform these duties proficiently, athletic trainers must maintain competency in the following areas:

- prevention of athletic injuries, including assessment of an athlete’s physical readiness to participate;
- early recognition, evaluation, and care of athletic injuries, including accurate assessment of the type and severity of injuries and obtaining pertinent medical histories;
- rehabilitation and reconditioning to minimize the risk of reinjury and to return the athlete to activity as soon as possible;
- health care administration, including medical and insurance record keeping, documentation and reporting of injuries,
writing of policies and procedures, budgeting, and referral of injured athletes to appropriate medical professionals when indicated; and

- education and counseling of coaches, parents, student athletic trainers, and athletes.

EDUCATION AND CERTIFICATION OF ATHLETIC TRAINERS

Since 1991, the AMA has recognized athletic training as an allied health profession.21 Athletic trainers acquire professional skills and expertise in the prevention and care of sports-related injuries through structured academic and practical experiences. This includes extensive coursework in the basic sciences with core studies in human anatomy and physiology, kinesiology or allied health profession.21 Athletic trainers acquire professional therapeutic rehabilitation, use of treatment modalities, and prevention and evaluation of athletic injuries and illnesses, skills and expertise in the prevention and care of sports-related injuries through structured academic and practical experiences. Following core requirements as stipulated by the NATA Board of Certification (NATABOC):22

- clinical athletic training experience (at least 25% of which must be attained in actual practice and game coverage in one or more of the following sports: football, soccer, hockey, wrestling, basketball, gymnastics, lacrosse, volleyball, rugby, and rodeo);
- proof of graduation at the baccalaureate level at an accredited college or university;
- proof of current certification in cardiopulmonary resuscitation (American Red Cross, American Heart Association, National Safety Council, or Emergency Medical Technician equivalent);
- endorsement of certification application by an NATABOC-certified athletic trainer; and
- successful completion of a written examination, written simulation (an interactive and decision-making-based examination), and practical examination.

An individual may qualify for certification in 2 ways: (1) by graduating from an undergraduate or graduate institution that has an educational program accredited through the Commission on Accreditation of Allied Health Education Programs, or (2) by completing an internship (note that effective January 1, 2004, the internship route to certification will be eliminated). For each of these options, the NATABOC defines a core curriculum of subject matter and specifies the number of hours of athletic training experience that must be obtained under the supervision of an NATABOC-certified athletic trainer. Upon successful completion of these requirements, the certified athletic trainer is recognized by the designation “ATC.” Athletic trainers must also meet NATABOC-specified continuing education requirements to maintain expertise and acquire proficiency in new athletic training techniques and treatment protocols. As of 1998, more than 16000 athletic trainers were certified nationally by the NATABOC.23

REGISTRATION AND LICENSURE

Many states regulate athletic trainers to assure the public that these individuals are properly qualified to care for injured athletes. State laws establish legal parameters under which athletic trainers can operate and may define the specific clientele and services that can be provided in various work settings.10,24 More than 30 states have legislation that requires the licensure, certification, or registration of athletic trainers,25 but statutes vary regarding the qualifications and requirements for regulation.24 Despite such variation, nearly all states accept successful completion of the NATABOC examination as a basis for obtaining licensure.10

LIABILITY ISSUES

Because injury is an inherent risk of athletic competition, high school officials need to address efforts to reduce the total number and severity of sport-related injuries and to provide adequate medical support to treat these injuries. Schools that require a coach to assume the additional responsibility of caring for injured athletes should consider the potential impact on the school system and athletic program from even a single settlement in response to an injury due to improper care and management by a coach who is not appropriately trained in emergency medical procedures. To minimize liability for athletic injuries, a comprehensive risk management plan is needed to ensure that equipment is maintained properly, appropriate emergency plans are established, facilities are constructed properly, and qualified personnel are available to treat athletic injuries. Athletic trainers can have an important role in the development and implementation of this risk management plan.

As allied health professionals, athletic trainers must be aware of their duty to provide care consistent with state laws and must meet that duty of care within established policies and standards of practice.26,27 The standard of care in a sport injury situation is that of the law of negligence, which is defined as what another minimally competent individual, educated and practicing in that profession, would have done in the same or similar circumstance to protect an individual from harm or further harm. An individual responsible for providing athletic training services could be held to the standard of care expected of an NATABOC-certified athletic trainer. In states with specific registration, certification, or licensure laws, valid NATABOC certification and registration or licensure would be minimal protection against litigation for individuals providing athletic training services.10,27 Being properly licensed and practicing within established standards of practice are strong safeguards against litigation.10
RECOMMENDATIONS

In June 1998, the AMA House of Delegates adopted the following statements as policy:

1. The AMA believes that (a) the Board of Education and the Department of Health of the individual states should encourage that an adequate Athletic Medicine Unit be established in every school that mounts a sports program; (b) the Athletic Medicine Unit should be composed of an allopathic or osteopathic physician director with unlimited license to practice medicine, an athletic health coordinator (preferably an NATABOC-certified athletic trainer), and other necessary personnel; (c) the duties of the Athletic Medicine Unit should be prevention of injury, the provision of medical care with the cooperation of the family’s physician and others of the health care team of the community, and the rehabilitation of the injured; (d) except in extreme emergencies, the selection of the treating physician is the choice of the parent or guardian and any directed referral therefore requires their consent; (e) Athletic Medicine Units should be required to submit complete reports of all injuries to a designated authority; and (f) medical schools, colleges, and universities should be urged to cooperate in establishing education programs for athletic health coordinators (NATABOC-certified athletic trainers) as well as continuing medical education and graduate programs in Sports Medicine.

2. The AMA urges high school administrators, athletic directors, and coaches to work with local physicians, medical societies, and medical specialty societies, as well as government officials and community groups, to undertake appropriate measures to ensure funding to provide the services of a certified athletic trainer to all high school athletes.

3. Recognizing that not all high schools have the resources to procure the services of a certified athletic trainer and further recognizing that athletic trainers cannot be present at all practices and competitions, the AMA encourages high school administrators and athletic directors to ensure that all coaches are appropriately trained in emergency first aid and basic life support.

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REFERENCES


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Objective: To characterize the risk of injury associated with 10 popular high school sports by comparing the relative frequency of injury and selected injury rates among sports, as well as the participation conditions within each sport.

Design and Setting: A cohort observational study of high school athletes using a surveillance protocol whereby certified athletic trainers recorded data during the 1995–1997 academic years.

Subjects: Players listed on the school’s varsity team rosters for football, wrestling, baseball, field hockey, softball, boys’ volleyball, boys’ or girls’ basketball, and boys’ or girls’ soccer.

Measurements: Injuries and opportunities for injury (exposures) were recorded daily. The definition of reportable injury used in the study required that certified athletic trainers evaluate the injured players and subsequently restrict them from participation.

Results: Football had the highest injury rate per 1000 athlete-exposures at 8.1, and volleyball had the lowest rate at 1.7. Only boys’ (59.3%) and girls’ (57.0%) soccer showed a larger proportion of reported injuries for games than practices, while volleyball was the only sport to demonstrate a higher injury rate per 1000 athlete-exposures for practices than for games. More than 73% of the injuries restricted players for fewer than 8 days. The proportion of knee injuries was highest for girls’ soccer (19.4%) and lowest for baseball (10.5%). Among the studied sports, sprains and strains accounted for more than 50% of the injuries, except in field hockey (45.7%). Of the injuries requiring surgery, 60.3% were to the knee.

Conclusions: An inherent risk of injury is associated with participation in high school sports based on the nature of the game and the activities of the players. Therefore, injury prevention programs should be in place for both practices and games. Preventing re-injury through daily injury management is a critical component of an injury prevention program. Although sports injuries cannot be entirely eliminated, consistent and professional evaluation and treatment continues to be a priority for the development and evaluation of injury prevention strategies.

Key Words: injuries, risk, surveillance, epidemiology

It has been estimated that more than 6 million high school youth from approximately 20000 high schools participate in local sports programs each year. This population of young athletes accounts for more than 2 million injuries, 500000 doctor visits, and 30000 hospitalizations. Many of the more significant sport-related injuries may lead to long-term physical impairment. The sports of football and basketball (boys’ and girls’) are the most popular and are played in more than 13000 and 16000 schools, respectively. Sports injuries are not generally the result of a single causative variable but are associated with various risk factors interacting at a given time. Associations between variables may exist and can be identified, but the relationships are not necessarily cause-effect in nature.

The existing data regarding the type, nature, and frequency of high school sports injuries demonstrate that specific injury patterns occur in different sports. Each sport has its characteristic injury profile and degree of risk, and the injuries vary widely among sports. Football players commonly incur knee injuries, while wrestlers are often affected by shoulder problems. Each sport, in combination with environmental factors such as player position, activity at the time of injury, playing surface, and protective equipment, produces a specific injury pattern. One of the most important challenges for the sports medicine community is to be able to differentiate the impact of the variables among the different sports.

In 1974, a multisite and multilevel injury surveillance system was designed and implemented as the National Athletic Injury/Illness Reporting System (NAIRS). NAIRS used a cohort observational design to record the variety of injuries associated with specific sports at the high school and college levels. NAIRS’ strengths included a multidisciplinary design team, daily documentation of injuries and exposures, consistent data forms, specific definitions of reportable injury, and the NATA-certified athletic trainer as a data recorder. The NAIRS basic design was included in the development of the injury surveillance programs in the National Football League, the National Hockey League, the National Collegiate Athletic Association, and the National Athletic Trainers’ Association (NATA) project in the mid 1980s.

The NAIRS data identified specific risk factors that affect the injury patterns in selected sports. For example, player position and player activity at the time of injury in college football is associated with the risk of knee injury and concussions. NAIRS data were used to establish the concept that the number of injuries occurring in practice is higher than that occurring in games, yet
the relative risk of sustaining an injury in a game is 7 to 10 times greater than in a practice.14–16 Whitcomb17 used the NAIRS data to report the difference in incidence rates for men’s and women’s sports at the college level.

In 1985, the NATA commissioned a study of the frequency, severity, and type of injuries associated with selected high school sports. The study monitored high school football, boys’ and girls’ basketball, and wrestling in 150 schools for 3 years. The project used the strengths of the NAIRS experience and the professional preparation of the certified athletic trainer as its field data recorder.10,18 The experiences of the 1985 NATA study were incorporated into the design and operation of the current NATA injury surveillance project.

Our purpose was to describe the injury patterns in 10 high school sports and identify the injury risk as measured by the observed injury patterns. The significance of the study resides in the integration of the injury patterns with the nature of the sport and the activities of the players. This method provides a solid foundation for the continual evaluation of an injury prevention program at the high school level.

METHODS

Subjects

Subjects were high school athletes on the varsity sports rosters for any one of the following sports: football, wrestling, baseball, field hockey, softball, girls’ volleyball, boys’ or girls’ basketball, or boys’ or girls’ soccer. No effort was made to manipulate or control the athlete’s participation in any sport.

Instruments

The athletic trainers used a surveillance protocol to report daily participation and injuries within their sports program. The exposure data included the type of session and the number of participants for each day. When a reportable injury occurred (Table 1), the following types of data were recorded: date of injury, date of return, clinical impression, extremity, time of injury, action taken, type of management, nature of injury, player position, player activity, team activity, and playing surface. The injuries were identified according to a detailed clinical impression code that allowed for accurate description of the injury, eg, third-degree sprain of the anterior cruciate ligament. Injury data were linked directly to the player data that included height, weight, and age. Two data-recording procedures were used: (1) a customized version of the Sports Injury Monitoring System (SIMS) (Med Sports Systems, Iowa City, IA) for those athletic trainers with computer capability; and (2) a parallel system of paper forms for those athletic trainers without computer capability.

Procedures

School selection. More than 300 certified athletic trainers volunteered to participate in the project during the study.

Table 1. Operational Definitions Used in the NATA Injury Surveillance Study

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Reportable injury</td>
<td>Any injury that causes cessation of participation in the current game or practice and prevents the player’s return to that session.</td>
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<td>Any injury that causes cessation of a player’s customary participation on the day following the day of onset.</td>
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<td>Any fracture that occurs, even though the athlete does not miss any regularly scheduled session.</td>
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<td>Any dental injury, including fillings, luxations, and fractures.</td>
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<td>Any mild brain injury that requires cessation of a player’s participation for observation before returning, either in the current session or the next session.</td>
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<td>Athlete</td>
<td>A player is considered to be eligible as a participant if he or she is a member of the varsity roster and capable of participating without any activity restrictions.</td>
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<td>Return to participation</td>
<td>A player is fully returned when he or she is available and has been medically cleared for such participation.</td>
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<td>Exposure</td>
<td>An exposure (an opportunity for injury) is considered a coach-directed session that involves physical activity.</td>
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<td>Body category</td>
<td>Head/neck/spine: includes injuries to the skull and spinal column.</td>
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<td>Face/scalp: includes injuries about the head that are not included in the Head/neck/spine group.</td>
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<td>Shoulder/arm: includes injuries to the shoulder, clavicle, axilla, and upper arm.</td>
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<td>Forearm/wrist/hand: includes injuries from the elbow through the fingers.</td>
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<td>Trunk: includes injuries to the internal organs and muscles of the chest/back.</td>
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<td>Hip/thigh/leg: includes injuries to the hip, thigh, and lower leg.</td>
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<td>Knee: includes injuries about the knee and to the meniscus and patella.</td>
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<td>Ankle/foot: includes injuries about the ankle and foot area.</td>
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<td>Other: systemic sport-related illnesses, eg, heat illness and skin conditions.</td>
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<td>Type of injury</td>
<td>General trauma: contusions, wounds, cramps, and acute inflammations.</td>
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<td>Neurotrauma: includes the nervous system, eg, mild traumatic brain injury.</td>
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<td>Sprains: injuries to the connective ligamentous structures about the joint.</td>
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<td>Strains: includes injuries to the muscle-tendon complex.</td>
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<td>Fractures: includes all types of fractures and stress fractures.</td>
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<td>Musculoskeletal conditions: includes conditions that affect the musculoskeletal system, eg, inflammations, tumors, etc.</td>
</tr>
<tr>
<td></td>
<td>General stress: includes sport-related medical conditions, eg, heat illness and skin conditions.</td>
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period. From this group, 246 athletic trainers were selected because they (1) worked directly with high school sports programs on a daily basis, (2) fell within a geographic distribution among the 50 states, and (3) fit a broad representation from different size schools (Figure 1). These procedures created a stratified cluster sample representing high schools with small, medium, and large student enrollments (Figure 2). Each certified athletic trainer was required to obtain written permission to participate from his or her school’s athletic director and to submit the approval to our research office before submitting data. Because not all schools offered all 10 sports, the number of team-seasons (1 team in 1 season) for each sport varies. Only the data related to the varsity sport teams were included in the study.

Sample size. Within this group of athletic trainers and their athletic programs, our goal was to monitor 100 team-seasons for each of the 10 sports for each of the study years. We continually replaced athletic trainers who dropped out with recorders from similar-sized school programs and regional locations in an attempt to maintain sample consistency. We accumulated data for nearly 3200 team-seasons and more than 750000 player-seasons (1 person on 1 team in 1 season), 4.4 million athlete-exposures (sum of the number of the players’ participations in each session), and 23500 reportable injuries (Table 2).

Surveillance protocol. Before the project began, we distributed operational definitions and reporting requirements to all participants in the form of a user’s manual. As part of the instructional protocol, we created a videotape to provide the athletic trainers with a visual tool for orientation to the injury-recording software. The central data collection office maintained a 24-hour/7-day toll-free number for recorder support. The athletic trainers transferred their recorded information, either electronically or by mail, to the central office monthly. The project staff monitored all incoming data, and recorders were contacted regarding any areas identified as needing clarification. Data summary tables and project newsletters were distributed to all participating athletic trainers each month. As new athletic trainers joined the study, we worked with them to ensure a smooth transition into recording the system requirements.

Study definitions. One of the critical elements in conducting a large data-collection project is the operational definition that is used to identify reportable events. The key definitions we used (Table 1) are similar to those used in the NATA study in the 1980s, as well as other current injury surveillance programs.10,14,16

Categories. Severity categories were created based on calendar days lost due to injury and grouped as minor (<8 days lost), moderate (8 to 21 days lost), and major (>21 days lost). Reported injuries were identified as new injuries or reinjuries. Athlete-exposures, or opportunities for injury, were calculated by aggregating the number of the participants for each game or practice. Only those persons who played in the game accumulated game exposures. Individuals who dressed for games but did not play were not counted as exposures.

Coding. The project employed an extensive coding structure that provided an accurate description of each injury. These

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Figure 1. Certified athletic trainers participating in the study and membership by NATA district.
detailed clinical impressions, recorded by the athletic trainers, were recoded into categories to provide a basic comparative description. These categories were designed to provide perspective on the data and can be used to group data for more in-depth analysis.

Data Analysis

The data presented in this paper represent the findings based on the aggregate data for the 3 study years. The injury patterns among the selected sports were compared using specific incidence rates as follows: case rate/100 players = number of injuries/total number of players; player rate/100 players = number of players sustaining at least 1 injury/total number of players. The case rate per 100 players is different from the player rate per 100 players in that it includes multiple injuries to the same players. A case rate per 1000 athlete-exposures is used to describe specific conditions where not all players are participating, eg, games and practices.

The incidence density ratio (IDR) is calculated as follows: IDR = game injury rate/practice injury rate. An IDR of 1 indicates no difference in the injury rates. An IDR greater than 1 indicates that the games have the higher injury rates, and an IDR less than 1 indicates higher injury rates in practice.

Using the case rates per 100 players for the 3 data years, the individual seasons were statistically tested to determine whether the year of recording showed variation in the injury rates, ie, a test for heterogeneity within the database. The wrestling, boys’ and girls’ basketball, girls’ soccer, softball, baseball, field hockey, and volleyball data represent homogeneous populations. The football ($\chi^2 = 29.3, P < .001$) and boys’ soccer ($\chi^2 = 12.7, P < .01$) data represent heterogeneous populations. This finding results from the influence of the 1995 season. The data for the 1996 and 1997 seasons are homogeneous. If the injury data are partitioned to include fractures, dental and brain injuries, and injuries with >1 day lost, all sports are homogeneous over the 3 seasons. The variation lies in the reporting of injuries from practice condi-

![Percentage of Total](image-url)
RESULTS

We collected data from 3195 team-seasons and 75298 player-seasons among the 10 study sports. During the study, 23566 reportable injuries occurred, and an average of 6000 people were injured at least once each year (Table 2). Among the study sports, the girls’ teams accounted for 44.5% of the exposures. The data included in this review reflect injuries and exposure for practices and games that adhere to the established definitions for reporting displayed in Table 1.

Football had the highest player rate per 100 players, case rate per 1000 athlete-exposures. Baseball had the lowest player rate per 100 players, and volleyball had the lowest case rate per 1000 athlete-exposures (Table 3). The risk of injury differed according to whether the player was participating in a practice session or in a game/competition. An average of 55.5% of the reported injuries occurred in practice sessions, with a range of 68.8% in volleyball to 40.7% in boys’ soccer (Table 4). When the injury rates per 1000 athlete-exposures and session were compared, the IDR for 9 sports showed a higher injury rate per 1000 athlete-exposures for game conditions (range, 1.5 to 5.0). Volleyball was the exception and showed an injury rate for practice 2.3 (IDR = 0.4) times greater than for games.

The lower extremity area (hip/thigh/leg, knee, and ankle/foot) showed a higher percentage of injuries within the reported cases (mean = 59.9%) than the upper extremity (mean = 20.8%), except in the case of wrestling (22.2% versus 32.3%) (Table 5). Hip/thigh/leg injury percentages were similar for field hockey (21.8%) and boys’ (28.0%) and girls’ (25.8%) soccer, whereas ankle/foot injuries were highest in boys’ (39.3%) and girls’ (36.4%) basketball and boys’ (33.5%) and girls’ (35.5%) soccer. Football accounted for more head/neck/spine injuries (13.3%) than any other sport (range, 1.9% to 9.5%).

The largest proportion of injuries in the fracture category came from boys’ baseball (8.8%), basketball (8.6%), and soccer (8.5%) and softball (8.4%) (Table 6). For both boys’ (44.8%) and girls’ (45.2%) basketball, sprains were the most frequent type of injury, accounting for the largest proportion of reported injuries for baseball (31.2%) and softball (32.2%).

Among the 10 study sports, an average of 73.5% (range, 67.3% in wrestling to 79.6% in field hockey) of the reportable injuries resulted in a time loss from participation of fewer than

Table 3. Reportable Injuries, Injured Players, and Injury Rates for Selected High School Sports

<table>
<thead>
<tr>
<th>Boys’ Sports</th>
<th>Girls’ Sports</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reportable injuries</td>
<td>Baseball</td>
</tr>
<tr>
<td>Injured players</td>
<td>861</td>
</tr>
<tr>
<td>Player rate/100 players</td>
<td>765</td>
</tr>
<tr>
<td>Case rate/100 players</td>
<td>11.8</td>
</tr>
<tr>
<td>Case rate/1000 athlete-exposures</td>
<td>13.2</td>
</tr>
</tbody>
</table>

Table 4. Percentages of Reported Injuries and Injury Rates by Type of Session for Selected High School Sports

<table>
<thead>
<tr>
<th>Boys’ Sports</th>
<th>Girls’ Sports</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practice</td>
<td>Baseball</td>
</tr>
<tr>
<td>Percentages of injuries</td>
<td>49.4</td>
</tr>
<tr>
<td>Case rate/1000 athlete-exposures</td>
<td>1.8</td>
</tr>
<tr>
<td>Game</td>
<td>Baseball</td>
</tr>
<tr>
<td>Percentages of injuries</td>
<td>50.6</td>
</tr>
<tr>
<td>Case rate/1000 athlete-exposures</td>
<td>5.6</td>
</tr>
<tr>
<td>Incidence density ratio</td>
<td>3.1</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>0.20</td>
</tr>
</tbody>
</table>
Table 5. Percentages of Reported Injuries by Body Category for Selected High School Sports

<table>
<thead>
<tr>
<th></th>
<th>Boys' Sports</th>
<th></th>
<th>Girls' Sports</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseball</td>
<td>Basketball</td>
<td>Football</td>
<td>Soccer</td>
</tr>
<tr>
<td>Head/neck/spine</td>
<td>1.9</td>
<td>3.3</td>
<td>13.3</td>
<td>4.1</td>
</tr>
<tr>
<td>Face/scalp</td>
<td>8.9</td>
<td>10.0</td>
<td>2.2</td>
<td>4.6</td>
</tr>
<tr>
<td>Shoulder/arm</td>
<td>19.7</td>
<td>2.4</td>
<td>12.0</td>
<td>2.4</td>
</tr>
<tr>
<td>Forearm/wrist/ hand</td>
<td>24.6</td>
<td>11.4</td>
<td>14.2</td>
<td>5.8</td>
</tr>
<tr>
<td>Trunk</td>
<td>7.2</td>
<td>7.7</td>
<td>8.6</td>
<td>6.5</td>
</tr>
<tr>
<td>Hip/thigh/leg</td>
<td>14.5</td>
<td>14.4</td>
<td>16.7</td>
<td>28.0</td>
</tr>
<tr>
<td>Knee</td>
<td>10.5</td>
<td>11.1</td>
<td>15.1</td>
<td>15.1</td>
</tr>
<tr>
<td>Other</td>
<td>0.1</td>
<td>0.4</td>
<td>2.0</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Table 6. Percentage of Reported Injuries by Type of Injury

<table>
<thead>
<tr>
<th></th>
<th>Boys' Sports</th>
<th></th>
<th>Girls' Sports</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseball</td>
<td>Basketball</td>
<td>Football</td>
<td>Soccer</td>
</tr>
<tr>
<td>General trauma</td>
<td>30.7</td>
<td>24.8</td>
<td>25.2</td>
<td>29.9</td>
</tr>
<tr>
<td>Sprains</td>
<td>20.6</td>
<td>44.8</td>
<td>31.7</td>
<td>32.4</td>
</tr>
<tr>
<td>Strains</td>
<td>31.2</td>
<td>15.1</td>
<td>21.0</td>
<td>22.8</td>
</tr>
<tr>
<td>Fractures</td>
<td>8.8</td>
<td>8.6</td>
<td>7.5</td>
<td>8.5</td>
</tr>
<tr>
<td>Musculoskeletal</td>
<td>6.6</td>
<td>2.2</td>
<td>1.8</td>
<td>1.8</td>
</tr>
<tr>
<td>Neurotrauma</td>
<td>1.7</td>
<td>2.8</td>
<td>10.3</td>
<td>3.9</td>
</tr>
<tr>
<td>General stress</td>
<td>0.3</td>
<td>1.4</td>
<td>2.4</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Table 7. Percentages of Reported Injuries by Severity Category

<table>
<thead>
<tr>
<th></th>
<th>Boys' Sports</th>
<th></th>
<th>Girls' Sports</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseball</td>
<td>Basketball</td>
<td>Football</td>
<td>Soccer</td>
</tr>
<tr>
<td>Minor</td>
<td>69.0</td>
<td>75.5</td>
<td>72.5</td>
<td>74.6</td>
</tr>
<tr>
<td>Moderate</td>
<td>18.5</td>
<td>14.5</td>
<td>16.3</td>
<td>15.0</td>
</tr>
<tr>
<td>Major</td>
<td>12.5</td>
<td>9.9</td>
<td>11.2</td>
<td>10.4</td>
</tr>
</tbody>
</table>

DISCUSSION

The information on high school sports injuries included in the NATA database was recorded and reported by certified athletic trainers who volunteered to participate in the study. Their daily presence at the high school allowed the accumulation of a great deal of information regarding the exposure (opportunities for injury), the nature of the injury, and the sport-related circumstances at the time of injury. The system provided data regarding the frequency patterns for the injuries that were recognized early and managed with little time lost from participation. An evaluation of an injury prevention program would include comparisons of these minimal time-loss injury patterns with the patterns for the more serious injuries. The data in this study reflect the injury patterns associated with school programs that have placed injury prevention as a high priority by employing the services of a certified athletic trainer.
The NATA conducted a study from 1986 through 1988 that examined the injury patterns for school programs for football, boys’ and girls’ basketball, and wrestling.\textsuperscript{9,20} We compared these injury proportions with the proportions and variables presented in our study. For example, an examination of the severity categories between the study done in the 1980s and our study shows very similar proportions for minor, moderate, and major injuries for football and boys’ and girls’ basketball. The wrestling data showed a similar proportion of moderate injuries, with fewer minor injuries (72.3% to 67.4%) and more major injuries (11.5% to 14.8%) in our study. Among the 4 sports, very similar proportions of cases resulted in surgery in the 2 studies. The 4 sports showed a consistently higher proportion of injuries in the head/neck/spine category in both studies. In addition, a comparison between the 2 decades shows an increase in the proportion of injuries in the neurotrauma category. When considered together, these increases may be attributable to a heightened awareness of concussion among members of the sports medicine community.

In many cases, high school sports programs represent the first opportunity of the young athlete to play a specific sport. High school practice sessions are the prime classroom for teaching the skills of the game to the otherwise unskilled player. Often this means that practices must simulate game conditions in order to prepare the players for competition. In addition, there are always many more practices than games. The data from the NATA study in the 1980s and from our study show that more than half of the injuries occurred under practice conditions. When the 2 studies are compared, there were fewer practice-related injuries in our study for football (60% to 57.4%) and girls’ basketball (59% to 53.4%) and no difference for boys’ basketball and wrestling. The injury rates per 1000 athlete-exposures in our study support the concept that the risk of injury for most sports is higher in a game than in a practice. The exception to this trend is volleyball, where the injury rate per 1000 athlete-exposures was 2.3 times higher in practice than in games. The higher frequency of injury during practices is related to the high number of practice sessions, and, therefore, a large amount of exposure. On a practical basis, this relationship implies the need for a strong program of early recognition and management of practice-related injuries. Managing the practice injury may keep the player from becoming a game-injury statistic.

The idea of injury prevention is to reduce the frequency of injury. Regardless of the strength of the injury prevention program, there will always be injuries in sports, and those injured players will most likely return to participation. Injury prevention programs must focus on the issues of reinjury and acute injury.\textsuperscript{2} The care and rehabilitation of the initial injury constitutes an important aspect of injury prevention, ie, minimizing the risk of reinjury. It is interesting to note that, among the sports in our study, 10% (range, 8.4% to 13.9%) of the reported cases were identified as reinjuries. These reinjuries reflect multiple injuries to the same area for the same player. When the reinjury proportions in our study are compared with the data from the NATA study in the 1980s, boys’ basketball shows a drop (15.5% to 8.4%) compared with the earlier study.\textsuperscript{9,20} The other sports show no difference in the reinjury proportion. The consistency of the reinjury proportion for the 2 studies may be an indicator of a positive influence that the certified athletic trainer has on the reinjury pattern.

There has been a great deal of discussion regarding the comparisons of the incidence of knee injuries that occur in boys’ and girls’ sports.\textsuperscript{21,22} From our data, it is clear that girls’ basketball and girls’ soccer players sustained a higher proportion of knee injuries than their male counterparts. We found the frequency of knee surgery for girls’ basketball to be about 1 case per 8 team-seasons, and for girls’ soccer, about 1 case per 5 team-seasons. The boys’ basketball and boys’ soccer players demonstrated about 1 case for 18 team-seasons and 1 case for 18 team-seasons, respectively. This finding is consistent with the current belief that girls are at a higher risk for knee surgery.
in basketball and soccer than boys. Baseball and softball showed a lower incidence of knee surgery than basketball and soccer. The sex differences seen in basketball and soccer do not exist when we compare baseball (1 in 25 team-seasons) and softball (1 in 39 team-seasons). Knee surgery is more likely in baseball players than in softball players. The sex differences for knee surgery are probably related to an interaction between sport and sex. Future projects will focus on the in-depth examination of this question.

CONCLUSIONS

Our data stimulate questions and discussion regarding programs to reduce the number of injuries to high school athletes and establish 4 important points:

1. Each sport has an inherent risk of injury based on the nature of the game and the activities of the players.
2. Injury prevention programs should be in place for practice sessions as well as games.
3. The prevention of reinjury through daily injury management is a critical component of an injury prevention program.
4. Sex differences in knee surgery patterns are specific to the sport being considered.

While not all sports injuries can be eliminated, consistent and professional evaluation of the yearly injury patterns can help to focus the task of developing and evaluating injury prevention strategies. The best way to minimize the risk of injury in the young athlete is to provide participation opportunities that are under the blanket of a well-designed and operational injury prevention program.

ACKNOWLEDGMENTS

The development, implementation, management, and data analysis for this project were supported by the National Athletic Trainers' Association, Inc (Dallas, TX) in the form of a contract with Med Sports Systems (John W. Powell, Iowa City, IA). The computer software used by the athletic trainers in this project was customized to meet the needs of the project from the Sports Injury Monitoring System (SIMS) produced by Med Sports Systems of Iowa City, IA. We express sincere appreciation for the hard work and dedication shown by the certified athletic trainers who volunteered to participate in this project. Their patience and professionalism made the process of collecting and maintaining the project data very efficient. Without their participation, the project could not have been done. Finally, a heartfelt thank you to Mario Schootman, PhD, injury epidemiologist for the Iowa Public Health Department, for his counsel and advice regarding the analysis and presentation of the findings in this report.
Milestones in Athletic Trainer Certification

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Project Management Institute, Newtown Square, PA

Objective: To summarize the history of athletic trainer certification.

Background: The single most significant public pronouncement a professional society or organization can bestow upon an individual is certification. One of the underlying goals of professional societies or organizations that certify individuals is to promote the public's reliance on the credential and the individuals who hold that credential. In this paper, I will identify the significant milestones the National Athletic Trainers' Association (NATA) and the NATA Board of Certification (NATABOC) have achieved for the athletic training profession, promoting and sustaining the public's reliance on the certified athletic trainer.

Description: This paper presents the significant milestones in the certification of athletic trainers by the NATA and the NATABOC.

Advantages: The milestones related to athletic trainer certification that I present in this paper will enhance the reader's understanding of the underlying reasons for the initiation of athletic trainer certification and the development and recognition of the athletic training profession as a credentialing agency for the athletic training profession.

Key Words: Committee on Professional Advancement, Board of Certification, National Commission for Health Certifying Agencies (NCHCA), National Organization for Competency Assurance (NOCA), NATA Board of Certification (NATABOC), National Athletic Trainers' Association (NATA)

The growth and development of and reliance on athletic trainer certification can be linked to the explosion in membership and recognition of the National Athletic Trainers' Association (NATA). During the 1980s, especially during the presidential term of Robert Barton, PhD, ATC, the NATA committed itself to a public relations effort to introduce athletic training to new audiences and strengthen existing relationships with longstanding partners. Many of the entities that now employ the services of certified athletic trainers were first introduced to the profession during this time. Concurrent with the NATA's efforts to increase public awareness about athletic training was the emergence of athletic training as an allied health profession.

The growth and recognition the NATA enjoyed during this period would have been limited had it not been for a group of volunteers who met in the late 1960s to discuss, plan, and implement programs designed to advance the profession in the areas of certification and education. The incremental steps that positioned the NATA Board of Certification (NATABOC) for its leadership role today in the allied health certification field are beyond the scope and intent of this paper. However, it must be noted that the roots of our current stature are founded in the leadership and vision of Lindsy McLean, the first chair of the NATABOC, whose committee established the foundation for future accomplishments in NATA certification.

THE FIRST MILESTONE: THE DECISION TO BEGIN CERTIFYING ATHLETIC TRAINERS

In a 1969 article titled “Does the National Athletic Trainers' Association Need a Certification Examination?” Lindsy McLean outlined reasons why the NATA should proceed with the development of a certification examination for athletic trainers, a concept that was put forth by the NATA's Professional Advancement Committee in 1968. In his article, McLean cited the accomplishments of the NATA since 1950 but asked, “Do these past accomplishments mean that the NATA has ‘arrived’ or just initiated its climb to responsibility and respectability as a paramedical profession?” He also described the state of the profession in terms of employment opportunities for young athletic trainers, employment issues, and a limited number of colleges having athletic training curriculums. A possible solution McLean offered was for the NATA to develop a written and practical certification examination to address professional preparation issues facing the profession and the NATA.

During its June 6, 1969 meeting, the Professional Advancement Committee approved and presented to the NATA Board...
of Directors the "Procedures of Certification for Active Members of the National Athletic Trainers' Association" (Table I) and the following resolution:

"Since we have selected a target date for Certification, as of December 31, 1969, we recommend that all districts review

Table 1. The Initial 5 Pathways to Certification

Section 1. Athletic trainers actively engaged* within the profession but not yet certified may become certified by:
- Proof of 5 years' athletic training experiences, beyond that as a student athletic trainer on the secondary school level
- Passing an examination that included the basic principles of athletic training
- Proof of graduation from an accredited 4-year college or university
- Having 2 years' consecutive NATA membership in the active classification prior to application for certification

Section 2. Students who have graduated from an NATA-approved undergraduate or graduate program may become certified by:
- Completing the athletic training curriculum requirements and (graduating) from an NATA-approved college or university program
- Having spent a minimum of 2 years under the direct supervision of NATA-approved supervisors
- Passing an examination that included the basic principles of athletic training
- Having 2 years' consecutive NATA membership in the active classification prior to application for certification

Section 3. A physical therapy degree graduate may become certified by:
- Having a minimum of 2 years' experience in athletic training beyond that as a student athletic trainer at the secondary school level under direct NATA-approved supervision
- Passing an examination that included the basic principles of athletic training
- Having 2 years' consecutive NATA membership in the active classification prior to application for certification

Section 4. Apprenticeship: Students of athletic training may qualify by:
- On-the-job training (minimum of 1800 hours) under the direct supervision of a certified NATA member
- Proof of graduation from an accredited 4-year college or university
- Presentation of a letter of recommendation by his NATA immediate supervisor
- Presentation of a letter of recommendation by his acting team physician
- Passing an examination that included the basic principles of athletic training
- Having 2 years' consecutive NATA membership in the active classification prior to application for certification

Section 5. Special Consideration
Any member who has successfully passed an athletic training course, who satisfies the requirements for a state teaching license with at least a minor in physical or health education or presents evidence of successful completion of an NATA-approved workshop for credit may also be endorsed as a secondary school athletic trainer. Endorsement may be extended to full certification when the requirements of any other Section (1-4) are met. Application for full certification must be initiated within 5 years of the initial endorsement or endorsement shall be terminated.

A questionnaire designed to solicit membership input into the development of the certification examination was developed by the Certification Examination Subcommittee of the Professional Advancement Committee in 1968. Within 3 categories (basic science, theory of athletic training, and practical application of athletic training), members were asked to indicate whether a particular subject should be included on the certification examination, what the emphasis on each subject should be by percentage, and the ranking of each (Table 2). After reviewing the survey results and after further discussion, the Certification Examination Subcommittee reported to the Professional Advancement Committee the content areas of the 2-section examination. The first section, "Basic and Clinical Sciences," consisted of 75 questions assessing candidates' knowledge of anatomy, physiology, mechanics and pathology of athletic injury, and the principles of injury prevention. The second section, "Theory and Practical Application of Athletic Training" consisted of 75 questions plus 5 questions on the oral-practical section of the examination. Questions were developed to assess candidates' knowledge of recognition of specific injury conditions, emergency first aid, principles and application of therapeutic modalities,

Table 2. Categorical Proposals for the First Certification Examination

<table>
<thead>
<tr>
<th>Category</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic science background</td>
<td>General human anatomy and physiology, Local joint and muscle anatomy</td>
</tr>
<tr>
<td>Physiology of exercise</td>
<td>Psychology</td>
</tr>
<tr>
<td>Basic physics and chemistry</td>
<td>Basic pharmacology</td>
</tr>
<tr>
<td>Basic medical pathology</td>
<td>Theory of athletic training</td>
</tr>
<tr>
<td>Applied kinesiology and anatomy</td>
<td>Principles of fitness and conditioning</td>
</tr>
<tr>
<td>Standard nomenclature of athletic injuries</td>
<td>Principles of nutrition and weight control</td>
</tr>
<tr>
<td>Basic injury prevention techniques</td>
<td>Principles of remedial exercise</td>
</tr>
<tr>
<td>Specific mechanisms of athletic injury</td>
<td>NATA by-laws and Code of Ethics</td>
</tr>
<tr>
<td>Coaching techniques in specific sports</td>
<td>Practical application of athletic training</td>
</tr>
<tr>
<td>Emergency first-aid procedures</td>
<td>Recognition of specific injury conditions</td>
</tr>
<tr>
<td>Nursing techniques (blood pressure reading, etc)</td>
<td>Use of electrotherapy equipment</td>
</tr>
<tr>
<td>Use of hydrotherapy equipment</td>
<td>Principles and application of massage</td>
</tr>
<tr>
<td>Evaluation and fitting of protective equipment</td>
<td>Adhesive strapping techniques</td>
</tr>
</tbody>
</table>

* Actively engaged: a person who is on a salary basis (not fee) employed by an educational institution, professional athletic organization, or other bona fide athletic organization for the duration of the institution's school year or length of the athletic organization's season and who performs the duties of athletic trainer as a major responsibility of his employment.
principles and application of rehabilitation exercises, supportive bandaging and adhesive strapping techniques, and miscellaneous athletic training theory and techniques (eg, nutrition and ethics). The oral-practical section consisted of questions to assess the candidates’ skill in recognizing specific injury conditions, demonstrating adhesive strapping, and evaluating and fitting of protective equipment.

In 1969, the subcommittee conducted a final survey of the members to determine (a) who should be eligible to sit for the examination and (b) what title certificants should be granted.7 The members responded that active members and associate members who met the educational and apprenticeship requirements for active membership should be eligible to take the examination. The response by the members to the second question has, I believe, had a profound impact on the profession. Lindsay McLean prefaced this question with the statement, “Another important question concerns the terminology associated with certifying our membership. Is there a term more descriptive of our work than ‘athletic trainer?’ Would such a change in terminology in conjunction with certification at this time be more beneficial to our future professional advancement than continuing our present professional designation?”7 The members responded that those certified by passing the NATA examination should be called “athletic trainer, certified.” The response receiving the second highest vote was “athletic therapist, certified.”

In 1969, the NATA contracted with Professional Examination Services to assist and provide direction to the NATA on developing and scoring the athletic trainer certification examination.8 The work of the Subcommittee on Certification by Examination and subsequently that of the Board of Certification became a reality when the first certification examination was administered to 15 candidates in Waco, TX, in August 1969. Midyear (January) certification examination administrations were held in 4 cities in 1971. Twenty-four candidates took the first examination administered at the NATA Annual Meeting in Baltimore, MD, in June 1971. The first female candidate to take the examination did so at the second national examination in St. Louis, MO, in June 1972.9 During the 1970s, 1600 athletic trainers were certified by examination; during the 1980s, 5600 were certified. As of December 1, 1998, 15000 athletic trainers had been certified during this decade by NATABOC.10

THE SECOND MILESTONE: EXTERNAL RECOGNITION OF THE BOARD OF CERTIFICATION

The 1960s and 1970s saw a significant increase in the numbers and types of certifications being offered by professional associations. It was also during this time period that some states initiated a freeze on licensing of professions, eliminated existing licensing programs, and used the certification programs that had been developed by professional associations. In 1978, the Carter administration, through the Department of Health, Education, and Welfare, spearheaded an initiative to organize and support a private sector-driven organization that would develop and administer criteria for certifying agencies.11 The National Commission for Health Certifying Agencies (NCHCA) was established to develop criteria to ensure that the certification credential and program that an organization administered was developed and maintained using acceptable testing, psychometric, and legal principles.12 As the public and private sectors began to rely on certification sponsored by organizations or societies, obtaining NCHCA accreditation became critical in distinguishing one similar certification program from another and in ensuring compliance with established credentialing procedures and policies.

During the 1980s, a number of state athletic training associations initiated licensing efforts. Although many of the licensing bills varied with regard to scope-of-practice issues and supervision, most licensing acts recognized NATA certification as the standard to enter professional practice. To ensure the quality and fairness of the certification program and to obtain recognition for the certification program, the NATA applied for NCHCA accreditation in 1981.

To obtain accreditation, the NATA had to demonstrate compliance by providing materials and responding in writing to a strict set of criteria (Table 3).13 To be eligible for accreditation, the NATA Board of Directors had to modify the NATA’s governance with regard to the Board of Certification to comply with the Commission’s criterion 2e: “... [the Board] shall be independent in decision-making for all matters pertaining to certification whether or not it is a legal entity in and of itself, shall have control over all matters related to the certification and recertification programs, without being subject to approval by any other body.”

During the 1982 Winter NATA Board of Directors Meeting, the NATA Board of Directors granted the NATABOC administrative independence for certification matters in order to comply with NCHCA accreditation criteria.14 Before this decision, the Board of Certification had to obtain the NATA Board of Directors’ approval for all matters related to the certification of athletic trainers. The Board of Certification had to demonstrate to the NCHCA’s Review Committee that the Board was granted the authority to establish and implement certification and recertification programs (continuing education requirements) without the oversight of the membership agency (the NATA). The decision by the NATA Board of Directors transferred responsibility and accountability of the association’s certification program to the Board of Certification, and the mechanism by which certified athletic trainers were appointed to the Board of Certification was also changed. Like other NATA committees, the Board of Directors was responsible for approving the recommendations of the NATA president for committee appointments. When the Board of Certification was granted administrative independence, the appointment process had to be modified to satisfy NCHCA criteria. Each NATA district had 1 representative appointed to the Board.
Table 3. Standards for Accreditation of National Certification Organizations

1. Purpose of certification organization
   a. shall be to evaluate individuals who wish to enter, continue and/or advance in their discipline through a certification process, and to
   issue a credential to individuals who demonstrate the required level of competence

2. Structure of certification organization
   a. shall conduct certification activities that are national in scope
   b. shall be incorporated as a legal entity (applies to the parent organization if the certification organization is a subsidiary of another organization)
   c. shall be independent in decision-making for all matters pertaining to certification whether or not it is a legal entity in and of itself,
   shall have control over all matters related to the certification and recertification programs, without being subject to approval by any other body
   d. shall have a governing body which includes individuals from the discipline being certified and whose composition addresses the needs
   of the users of the certification program(s) (eg, consumers, public, employers, regulators)
   e. shall require that members of the certification organization governing body who represent the certified discipline be selected by the
   certificants or by the members of an organization(s) of the certified discipline
   f. shall utilize formal procedures for the selection of members of the governing body which prohibit the governing body from selecting a
   majority of its successors
   g. shall have at least one voting public member with full board privileges and responsibilities on the governing body to represent the
   interests of consumers and protect the interests of the public at large. The public member shall not be a member of the discipline or
   derive significant income from the discipline, its related organizations or the certification organization.
   h. shall be separate from the accreditation and education function(s) of the discipline

3. Resources of certification organization
   a. shall demonstrate the availability of financial resources to effectively and thoroughly conduct regular and ongoing certification and
   recertification activities
   b. shall demonstrate that staff possesses the knowledge and skills necessary to conduct the certification and recertification programs
   or has available and makes use of non-staff consultants and professionals to sufficiently supplement staff knowledge and skill

4. Candidate testing mechanism(s) of certification program
   a. shall utilize a reliable testing mechanism(s) to evaluate individual competence that is objective, fair to all candidates, job-related, and
   based on the knowledge and skills needed to function in the discipline
   b. shall implement a formal policy of periodic review of the testing mechanism(s) to ensure ongoing relevance of the mechanism(s) to knowledge
   and skills needed in the discipline
   c. shall utilize policies and procedures to assure that all test administration and development materials are secure and demonstrate that
   these policies and procedures are consistently implemented
   d. shall establish pass/fail levels that protect the public with a method that is based on competence and generally accepted in the
   psychometric community as being fair and reasonable
   e. shall conduct ongoing studies to substantiate the reliability and validity of the testing mechanism(s)
   f. shall utilize policies and procedures that govern how long examination records are kept in their original format (eg, answer sheets,
   videotapes, product fabrications)
   g. shall demonstrate that different forms of the testing mechanism(s) assess equivalent content and that candidates are not penalized for
   taking forms of varying difficulty

5. Public information about the certification program
   a. shall publish and make available a document which clearly defines the certification responsibilities of the organization and outlines any
   other activities of the organization which are not directly related to certification or recertification
   b. shall publish and make available general descriptive materials on the procedures used in examination construction and validation. All
   eligibility requirements and determination procedures, and the procedures of examination administration including exam dates and
   locations, fees, reporting of results, recertification requirements, disciplinary and grievance procedures,
   c. shall publish and make available a comprehensive summary or outline of the information, knowledge, or functions covered by the
   examination
   d. shall publish and make available at least annually a summary of certification activities for each program including, at least, number of
   examination administrations, number examined, number passed, number failed, number certified, and number recertified

6. Responsibilities to applicants for certification and recertification
   a. shall not discriminate among applicants as to age, sex, race, religion, national origin, disability, or marital status and shall include a
   statement of nondiscrimination in announcements of the certification and recertification programs
   b. shall comply with all requirements of applicable federal and state laws (eg, Americans with Disabilities Act of 1990) with respect to all
   certification and recertification activities and shall require compliance of all contractors and/or providers of services for the certification
   and recertification programs
   c. shall provide all applicants with copies of formalized procedures for application for, and attainment of, certification and recertification and
   shall uniformly follow and enforce such procedures for all applicants
   d. shall implement a formal policy for the periodic review of eligibility criteria and application procedures to ensure that they are fair and equitable
   e. shall provide competently proctored examination sites at least once annually
   f. shall utilize a means for individuals who have obtained a skill or knowledge outside the formal educational setting to be evaluated and
   judged eligible to seek certification or, in the absence of such means, provide reasonable justification for exclusion
   g. shall uniformly report examination results to applicants in a timely manner
   h. shall give applicants failing the examination information on general content areas of deficiency
   i. shall implement policies and procedures to assure that each applicant’s examination results are held confidential and delineate the
   circumstances under which the applicant’s certification status may be made public
   j. shall have formal policies and procedures on due process for applicants questioning eligibility determination, examination results, and
   certification status, and shall publish this information
trainers that are linked to each domain—and characterized by a primary task performed by entry-level athletic trainers in each performance domain, the panel developed task statements that define the tasks. After identifying the primary tasks, the panel developed task statements that define the tasks. The panel also focused on how important each task is, how frequently it is performed, and how critical the task is to safe practice. The Role Delineation Panel’s work was validated by a national sample of certified athletic trainers. The results of this study established the certification examination test specifications. The significance of the 1982 Role Delineation Study for the Entry-Level Athletic Trainer Certification Examination was that a defensible linkage could be demonstrated between the examination’s content and the tasks performed by entry-level certified athletic trainers.

In August 1982, the NCHCA granted the Board of Certification accreditation. The significance of this accomplishment was that the NATA’s certification program demonstrated compliance with governmental and credentialing industry certification standards. The NATABOC was the first allied health organization in the sports medicine arena to achieve this recognition by the NCHCA. By achieving NCHCA recognition, the NATA could provide state licensing agencies the assurance these agencies required to recognize NATA-certified athletic trainers for licensing purposes. The Role Delineation Study served as a resource document for the first version of the Competencies in Athletic Training that was developed by the NATA Professional Education Committee. The Competencies serve as the foundation document for athletic trainer curriculum development and approval. To ensure that the certification examination represents the current state of practice, the Board of Certification has conducted 3 subsequent role delineation studies.

Additionally, at least 2 members who were not athletic trainers had to be appointed to the Board of Certification. A physician director was appointed because physicians are considered the “supervisory profession” for certified athletic trainers. A consumer or public director was appointed to ensure that those who used the services of the certified athletic trainers were represented on the board. The chair of the Board of Certification appointed the athletic trainer directors. Each NATA district director sent the names of 3 certified athletic trainers to the chair, who then would select 1 certified athletic trainer for appointment. The Board of Certification appointed the public and physician directors.

Criterion 4a states that the certifying agency “shall utilize a reliable testing mechanism(s) to evaluate individual competence that is objective, fair to all candidates, job-related, and based on the knowledge and skills needed to function in the discipline.” To comply with criterion 4a, the Board of Certification conducted a role delineation study to ensure that the certification examination measured the knowledge and skill needed for entry-level certification. The NCHCA required that the validity of the examination be established for accreditation. The Board of Certification assembled the Role Delineation Panel of certified athletic trainers who met in Rutherford, NJ, in March 1982. This panel identified the performance domains that broadly define the profession: prevention of athletic injuries; recognition and evaluation of athletic injuries; management, treatment, and disposition of athletic injuries; rehabilitation of athletic injuries; and organization and administration. After identifying the performance domains, the panel developed task statements that are linked to each domain—and characterized by the knowledge and skills that an entry-level certified athletic trainer would need to perform the task. In addition to identifying the tasks, the panel also focused on how important each task is, how frequently it is performed, and how critical the task is to safe practice. The Role Delineation Panel’s work was validated by a national sample of certified athletic trainers. The results of this study established the certification examination test specifications. The significance of the 1982 Role Delineation Study for the Entry-Level Athletic Trainer Certification Examination was that a defensible linkage could be demonstrated between the examination’s content and the tasks performed by entry-level certified athletic trainers.

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Table 3. Continued

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<tr>
<th>7. Responsibilities to the public and to employers of certified practitioners</th>
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<tr>
<td>a. shall demonstrate that the testing mechanism(s) adequately measures the knowledge and skill required for entry, maintenance and/or advancement in the profession</td>
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<tr>
<td>b. shall award certification and recertification only after the skill and knowledge of the individuals have been evaluated and determined to be acceptable</td>
</tr>
<tr>
<td>c. shall periodically publish or maintain in an electronic format, a current list of those persons certified in the program(s) and have policies and procedures that delineate what information about a certificant may be made public and under what circumstances</td>
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<tr>
<td>d. shall have formal policy and procedures for discipline of certificants, including the sanction or revocation of the certificate, for conduct deemed harmful to the public or inappropriate to the discipline (eg, incompetence, unethical behavior, physical or mental impairment affecting performance). These procedures shall incorporate due process.</td>
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<tr>
<td>e. shall demonstrate that any title or credential awarded for the certification program reflects the practitioners’ daily occupational or professional duties and is not confusing to employers, consumers, regulators, related professions and/or other interested parties</td>
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8. Recertification program

a. shall implement a program for periodic recertification

b. shall demonstrate that the recertification program is designed to measure continued competence and/or to enhance the continued competence of the individual

9. Criteria for maintaining accreditation

a. shall annually complete and submit to the Commission information requested on the current status of the certification organization and its program(s)

b. shall advise the Commission of any change in purpose, structure or activities of the certification organization program

c. shall advise the Commission of any substantive change in examination administration procedures

d. shall advise the Commission of any major changes in examination techniques or in the scope or objectives of the examination

e. shall undergo reevaluation at up to 5-year intervals

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As I noted previously, the NATA experienced growth in all facets of the association during the 1980s. Public understanding of and confidence in the certified athletic trainer as a health care provider paralleled this growth. Reliance by employers on the ATC credential made it a prerequisite for employment as an athletic trainer. To avoid any potential for misrepresentation by another organization, to protect athletic trainers who were awarded the credential from misrepresentation, and most importantly, to prevent confusion in the marketplace about a potential similar credential, the NATA registered with the US Patent Office the certification marks “ATC” and “CAT” in 1987. In the event that another organization issued a certification mark using any combination of the letters “ATC,” the NATA could seek to prevent such action because, for the purposes of athletic trainer certification, “ATC” is assigned to the NATA.

THE THIRD MILESTONE: THE INCORPORATION OF THE NATA BOARD OF CERTIFICATION

From 1982 until 1989, the Board of Certification was an administratively independent component of the NATA’s governance structure. Although the Board of Directors granted the Board of Certification the necessary authority to comply with the accreditation criteria of the NCHCA, the Board of Certification continued to be part of the NATA’s governance structure. Concerned about potential antitrust and other liabilities for its involvement in certifying practitioners while also providing membership services, the NATA decided to withdraw from all certification activities. In June 1989, the Board of Directors elected to create a separate organization, the NATABOC, with the power and responsibility of certifying practitioners. Pursuant to its creation of the NATABOC, the NATA transferred relevant certification documents and materials to the NATABOC. The NATA then ceased any responsibility for certification. The motion that was adopted by the NATA Board of Directors was as follows:

"Resolved, that the NATA, Incorporated Board of Certification is authorized by this NATA, Incorporated Board of Directors, to separately incorporate, with Article of Incorporation substantially in the form attached. Upon incorporation of the Board of Certification, Incorporated, accounts shall be transferred to the same and authority of the NATA Board of Certification, Incorporated. That the NATA Board of Certification, Incorporated shall have full authority to conduct all NATA certification processes, including but not limited to establishing standards, procedures, rules, examinations, recertification, continuing education, review of eligibility and certification and communication and actions with respect to candidates, certificants and others, concerning the use of the ATC, the CAT designation. The Executive Director, on behalf of the NATA, Incorporated, shall execute agreements as appropriate with the NATABOC Board of Certification, Incorporated and the Executive Director, will provide for any appropriate revisions of NATA, Incorporated, documents, publications, and rules upon consultation with legal counsel."17

As more states became active in regulatory efforts, having an independent athletic trainer credentialing body became the norm, not the exception, that state regulators expected. Practice acts proposed by state associations referenced the ATC credential. State regulators expressed concern about certification programs that were administered as part of the membership association. The potential for state regulatory arguments regarding conflicts of interest and antitrust liability matters between the association’s membership interests and public protection interests with regard to the state’s reliance on the ATC credential was eliminated with the separate incorporation of the NATABOC.

SUMMARY

The athletic trainer, certified (ATC) credential is the gateway credential for allied health professionals who desire to practice in sports medicine. The development of this credential is not the result of a single event or of one individual’s effort, but of many people working together over time. To sustain the value of this credential, the certification program is constantly being improved. In recent years, revisions have been made to the NATABOC’s governance structure, eligibility requirements, examinations and examination formats, test administration policies and procedures, discipline, and continuing education program. These revisions are linked to one or more of the milestones that I have described in this paper. These milestones would not have occurred had it not been for the efforts, insights, and passion for the profession of the countless member-volunteers who for the past 30 years have constructed test questions, administered the oral-practical examinations, participated on task forces and committees, and served on the Board of Certification. The ongoing legacy of these member-volunteers is their contribution to improvements in the delivery of health care to individuals who request that their athletic health care be provided by an NATABOC athletic trainer, certified.

ACKNOWLEDGMENTS

I thank Denise Fandel, ATC; Susan Briggs, ATC; and Chad Starkey, PhD, ATC, for their assistance while I wrote this paper.

REFERENCES

2. Newell W. NATA Professional Advancement Committee Meeting Minutes, June 8, 1968.
6. McLean L. Results on Questionnaire on NATA Certification by Examination. NATA Professional Advancement Committee, Subcommittee on Certification by Examination. May 1969.


Does the National Athletic Trainers’ Association Need A Certification Examination?

J. Lindsy McLean, Jr

Michigan University, Ann Arbor, MI

Athletic training as a profession has come a long way in the years since the National Athletic Trainers’ Association was founded in 1950. The active membership requirement for a college degree and apprenticeship under an active member as well as suggested academic curriculums certainly are marks of professional advancement of which we can all be justly proud. This steady amelioration was recognized officially by the American Medical Association’s Board of Delegates in 1967, and it is a tribute indeed to the many untiring leaders in the profession during the critical initial two decades of organization.

THE PROBLEM

Do these past accomplishments mean that the NATA has “arrived” or just initiated its climb to responsibility and respectability as a paramedical profession? Critical self-evaluation most likely indicates that we have only made a good sound beginning.

Each year some of the best qualified trainers leave the profession for either financial reasons or due to unfavorable working conditions unconsidered and, therefore, uncorrected by superiors. Annually, many graduating young trainers of exceptional potential are denied opportunities for employment because their qualifications go unrecognized. In some instances, employment still depends upon whom you know—not what you know. The continued existence of such situations obviously does not reflect a truly mature profession in need of no further advancement or re-examination. Realistically, athletic training still has a long way to go if it is to become the profession most of us hope it will.

Education always is one of the most pressing problems to be analyzed as any profession attempts to advance. This certainly is true in the field of athletic training. Certification in physical therapy has many advantages, but it has become obvious that it is not a realistic or perhaps desirable goal for all trainers to pursue. A master’s degree likewise should appeal to many, but not all, members of such a highly diversified profession. To adequately prepare trainers for teaching positions on the secondary and collegiate level as well as specialized positions on the university and professional levels, flexibility in educational objectives must always be recognized and encouraged. The value of apprenticeship as an educational experience has been recognized, and it is perhaps the one present evaluation of professional competence all trainers currently approve and recommend.

A POSSIBLE SOLUTION

In recent years there has been much discussion of a possible certification examination for the NATA. Many feel that such a practical and written evaluation is the best answer for the immediate problems of professional preparation within the association when all alternatives are considered. With such an evaluation of competence, the individual student trainer could plan his academic curriculum with the aid of his undergraduate advisor (and head athletic trainer) in such a manner that he could take such an examination with confidence upon graduation. Since all present active members of the NATA will be certified in 1972, only future applicants for active membership would face such an evaluation.

The content of the examination would obviously require careful consideration. The course of study as recommended by the Professional Advancement Committee should logically be evaluated first for the excellent guidelines it contains. Certainly such topics as anatomy, physiology, and kinesiology should be well covered. Questions concerning recognition of serious injury, first aid, physical therapy techniques, reconditioning exercise, diet, and the prevention of injury all have obvious merit. A short practical demonstration of elementary adhesive strapping ability, massage techniques, etc., might also be
included. The test should not be so difficult as to preclude a variety of academic backgrounds. It should, however, be of sufficient specialty to require definite curriculum planning and more than casual intellectual pursuit. As our educational standards improve, this could be reflected in a gradual upgrading of the "athletic training boards." Those unable to satisfactorily complete the test on the initial try could be accorded associate membership until such time as they were successful. Likewise, long time associate members of exceptional ability but who do not qualify for active membership under the present by-laws might be allowed to use such an examination to elevate their membership status.

The mechanics of preparing and administering such an examination could easily be worked out. Perhaps an organization such as the Professional Examination Service (American Public Health Association) might be contracted to prepare and grade the test to ensure complete fairness and professional conduct. The cost of this service would be borne by the applicant. The examination could be given regionally each year under supervision of district directors within the NATA as well as at the national convention each June. These, of course, are only possibilities.

IMMEDIATE AND LONG RANGE BENEFITS

The results of a certification examination for trainers might be immediate and dramatic. What if the National Federation of High School Athletic Associations looked to the NATA exam as minimum standard of competence for all secondary school athletic programs? On the collegiate level, team physicians and administrators would then have a firm basis for demanding that only certified NATA members be hired, much as hospitals will consider only "registered" nurses. At present there is no basis on which such a demand can be logically founded. The growth of athletic training curriculums on the collegiate level would be stimulated since they would be the most logical way to prepare for such an exam. To put it mildly, both the immediate and future potential of an "athletic training board examination" offers exciting possible benefits to our profession.

CONCLUSIONS

The idea of a professional examination for trainers is not new. Most athletic and medical authorities would agree as to its eventual inevitability. Most arguments and discussion on this subject presently concern priorities. Is such an exam needed now or ten years from now?

Even with immediate concentrated efforts toward establishing an early national examination, many months would be required before it could become a reality. At a time when the membership is divided and uncertain regarding which direction our future should be, few members would object to the immediate consideration of such an examination.

Such an examination would give our association a unity of purpose and direction at a time it is sorely needed. Let us proceed now!

REFERENCES
Nutrition for Sport & Exercise
Jacqueline Berning, Suzanne Nelson Steen
Aspen Publishers, Gaithersburg, MD 1998
297 pages
Price: $52.00

Nutrition for Sport & Exercise is a credible resource and reference book for not only sports nutritionists, but also athletic trainers and other health professionals interested in sports nutrition theory and application. It would also be an excellent graduate-level textbook. Nutrition for Sport & Exercise comprises 14 chapters written by noted nutritionists and exercise scientists who are experts in their fields. Each author brings a wealth of scientific and practical information to his or her chapter.

The titles of the chapters reflect the scope of the book: "Exercise Physiology: Implications for Sports Nutrition"; "Carbohydrate: The Master Fuel"; "Protein Requirement of Athletes"; "Fat as a Fuel During Exercise"; "Minerals and Trace Minerals"; "Antioxidant Supplementation for Persons Who Are Physically Active"; "Nutritional Ergogenic Aids"; "Fluid Needs of Athletes"; "Body Composition Assessment and Relationship to Athletic Performance"; "Energy Balance"; "Eating Disorders"; "Female Athletes and Bone"; "Nutrition for the School-Age Child Athlete"; and "Eating while Traveling." If these topics are of interest to you, this book will provide comprehensive and accurate information.

Each chapter is well referenced and includes a summary or conclusion for quick and easy reference. Many chapters include clinical applications and case studies, along with appropriate charts and sidebar information. Overall, the material flows well and provides a solid text and reference source that will answer your questions about nutrition and exercise.

Nancy Clark, MS, RD
SportsMedicine Brookline
Brookline, MA

Advances in Exercise Immunology, 2nd edition
Laurel T. Mackinnon

First Aid and CPR
National Safety Council

High-Powered Plyometrics
James C. Radcliffe and Robert C. Farentinos

Physiology of Sport and Exercise
Jack H. Wilmore and David L. Costill

Videotape
Flexibility for Sport and Fitness
Human Kinetics

CD-ROM
Instructor's Toolkit for Concepts of Athletic Training, 2nd edition
Ronald P. Pfeiffer

Laboratory Activities for Therapeutic Modalities
Sara D. Brown and Chad Starkey
FA Davis Co, Philadelphia, PA

Laboratory Activities for Therapeutic Modalities is intended to be used in conjunction with the text Therapeutic Modalities for Athletic Trainers. In this second edition, several laboratory experiences have been added or updated. As an adjunct manual, it provides a well-organized plan that the instructor of a therapeutic modalities course can use not only to introduce students to the various modalities, but also to provide students opportunities to promote critical thinking and to make practical applications. Further, this laboratory manual provides opportunities for students to begin thinking about the process of scientific inquiry through labs such as "The effects of cooling on speed, agility and proprioception." In this lab, students take pretest and posttest measures for speed, agility, and proprioception, with a cryotherapy treatment intervention. Similarly, the lab entitled "Effect of heat, cold and static stretch on tissue elasticity" allows students to begin to develop tools that will enhance their ability to explore the field of research in athletic training, by causing them to question current practices. Again, students take measurements before and after a treatment protocol. In this case, up to 5 different treatments groups can be assigned. Students then have the opportunity to compare results from each group.

I found the labs pertaining to electric stimulation particularly useful. The 7 labs devoted to this modality provide opportunities for students to experience a
wide variety of parameters and settings. Some of the more useful activities include how to find motor points and trigger points; how an increased or decreased area of impedance feels to the individual receiving the treatment; the effect of increased current density, various pad placement protocols including monopolar and bipolar, and the use of water as a medium; and strength of an electrically induced contraction.

The lab manual provides a variety of clinical applications and serves to guide instructors in further developing their own lab experiences. The only thing I would change about the lab manual would be to remove the answers to the activity questions and exercises, which are found in Appendix E. Once the students discover this, they put little of their own thought into the homework assignments.

As an instructor of therapeutic modalities, I have used this lab manual to enhance my laboratory activities and to guide my students’ learning since the first edition became available. I have found it to be a valuable tool.

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The Patella: A Team Approach
Ronald P. Grelsamer and Jenny McConnell
Aspen Publishers, Gaithersburg, MD
1998
273 pages
Price: $65.00

The Patella: A Team Approach is a multidisciplinary text on the evaluation and treatment of patellofemoral pain and instability. This text would be suitable for any advanced athletic training class dealing in the rehabilitation of athletes with patellofemoral pain. It could be used as a primary text if the class is studying the subject in sufficient depth or as a supplemental text for anyone wanting a thorough review of the evaluation and treatment of patellofemoral dysfunction.

The text is divided into 15 chapters. Chapter 1 gives an introduction to patellofemoral pain and defines the nomenclature used in subsequent chapters. Since the meanings of terms commonly used to describe patellofemoral dysfunction vary among authors and texts, I was pleased to note that the common terms used in this book are operationally defined. A careful reading of chapter 1 will help the reader to fully understand subsequent chapters. Chapters 2 and 3 provide a clear and easy-to-read anatomical and biomechanical review of the patellofemoral joint.

The next 6 chapters cover different aspects of the evaluation of patellofemoral pain and instability from the perspective of the orthopedic surgeon, as written by Ronald P. Grelsamer, MD. Chapters 10 and 11, by Jenny McConnell, PT, discuss the evaluation and treatment of patellofemoral dysfunction from the physical therapist’s perspective. Chapter 12 discusses surface electromyography and its use in the treatment of patellofemoral pain. Chapter 13 deals with foot mechanics and the use of foot orthoses in the treatment of patellofemoral pain. Written by a podiatrist (John E. McNerney, DPM), this chapter provides an excellent view of the research linking foot pronation to patellofemoral pain. Chapter 14 deals with the surgical treatment of patellofemoral pain and instability. The last chapter discusses possible causes of “failed” treatment.

One of the strong points of the text is that its coverage of the evaluation and treatment of patellofemoral dysfunction is presented from the perspectives of different health care providers, yet it flows better than many other multiple-author books. The figures, which include excellent photographs of surgeries, taping techniques, foot orthoses, and technical imaging, are clear and very helpful. The book is easy to read and follow, with topics flowing logically from one to another. Chapter topics are repeated as necessary, to show the contrasts between the physician’s and the therapist’s perspective.

I enjoyed this text more than other texts I have read that deal specifically with patellofemoral dysfunction. I recommend this book to anyone who wants to learn more about this commonly injured joint. At $65.00, this book is well worth the cost. I have paid much more for books I’ve liked less.

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The Knee: Problems and Prevention—A Self-Help Guide
Vivian Grisogono
Trafalgar Square, North Pomfret, VT
1998
224 pages
ISBN: 0-7195-5538-8
Price: $24.95

The Knee: Problems and Prevention—A Self-Help Guide provides a very basic survey of knee injuries, diagnosis and treatment, and rehabilitation. This book could be used as a supplemental text to an introductory course in athletic training or physical therapy. The information is directed toward students at the early undergraduate level. This material is rather superficial and will be covered in more depth and detail in an athletic training, physical therapy, or premed curriculum. I don’t feel the material would be very useful to anyone above the introductory level; some of it appears to be designed for the lay public.

Although I didn’t really find anything unique about the book, the information provided is accurate. The material flows smoothly and is quite easy to read, with adequate illustrations throughout. Among the strongest points of the book are the knee exercises, which are accompanied by extremely helpful photographs.

I feel that the usefulness of this book is somewhat limited by the author’s bias in her presentation of the material, with too much dependence on personal anecdotes involving her patients and her cases. At times, she seems to be advertising. Overall, the information is accurate, but I would recommend the text only as a supplement to early course material.

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Clinical Applications in Surface Electromyography: Chronic Musculoskeletal Pain
Glenn S. Kasman, Jeffery R. Cram, and Steven L. Wolf
Aspen Publishers, Gaithersburg, MD 1998
415 pages
ISBN: 0-8342-0752-4
Price: $52.00

Clinical Applications in Surface Electromyography: Chronic Musculoskeletal Pain offers extensive reference material on the use of surface electromyography (SEMG) in the clinical setting. This book is best suited as a clinical reference, but it could also serve as a supplemental text for an advanced course on the evaluation of orthopaedic conditions.

I found the text to be well organized, with the first chapter dedicated to the physical and behavioral components that constitute a model for chronic musculoskeletal pain. Chapter 2 outlines a generic SEMG assessment. Chapters 3 through 7 explore both the practical and theoretical concepts related to the use of SEMG in evaluating chronic pain conditions. The remainder of the book reviews the literature on SEMG assessment of each body region, followed by an application guide for that assessment. The application guides serve as pragmatic outlines for the evaluation and treatment of commonly encountered clinical presentations. It should be noted that these are outlines only, rather than a cookbook-type format describing every detail. The authors suggest that outlines help the clinician understand the "why" as well as the "how." This format is especially helpful in allowing the reader to customize the treatment or evaluation to the specific pathology.

Throughout the text, the material is well referenced to the most current literature available. The authors clearly expended painstaking time to review the pertinent information. Such a comprehensive reference list alone makes the text worthwhile, by giving the reader a starting point for further research on specific SEMG assessments.

The particularly helpful illustrations throughout the text offer numerous visual examples of SEMG records for various clinical conditions, helping the reader to better understand the sources of clinical impairment. The illustrations would be especially beneficial to a student or clinician who is just beginning to use SEMG for the assessment of chronic musculoskeletal pain.

This publication is unique in the area of clinical SEMG applications. Considering the amount of information presented on the use of SEMG for clinical applications, it is well worth the purchase price of $52.00. The text is not appropriate for the entry-level athletic trainer; however, it is a wonderful reference for the beginning clinician who plans to use SEMG in assessing orthopaedic conditions or who has previously implemented SEMG techniques for clinical procedures.

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Progress in Motor Control: Bernstein's Traditions in Movement Studies
Mark L. Latash, Editor
Human Kinetics, Champaign, IL 1998
Volume 1
398 pages
ISBN: 0-88011-674-9
Price: $49.00

Mark Latash has compiled a superb collection of writings relating to motor control and focusing on the works of Nikolai A. Bernstein. Bernstein is generally credited as being the “father of motor control” in humans, especially in regard to naturally occurring movements. The 16 chapters contained in this volume were produced by the speakers at an international conference entitled “Bernstein’s Traditions in Motor Control.” Although the chapter authors are united in their acknowledgments of Bernstein’s contributions to this rapidly evolving field, each chapter presents either new insights into Bernstein’s work or contemporary thoughts about its evolution during the 20th century.

This would be an ideal text in movement studies for graduate students in a variety of specialties. It provides important historical information, blended with discussions of the progress leading to our current theories. Each author addresses an important topic in motor control by skillfully weaving the work of Bernstein, which spans more than 70 years, into discussions of current research and future problems in motor control.

The book begins with a review by Victor Garfinkel and Paul Cordo of the scientific legacy of Nikolai Bernstein, viewed from 30 years after his death. This chapter alone should be a “must read” for all scholars of the human movement sciences. Many of our current theories in motor control are attributable to Bernstein, including hierarchic control of coordination and the parallel structure of movement. I feel, however, that one of this book’s greatest contributions is in awakening our appreciation of Bernstein’s contributions to the rehabilitation sciences. Many readers will be surprised to learn that Bernstein spent a great deal of his career studying and designing prostheses, especially for the lower extremity. He felt that a good prosthetic should mimic the natural musculoskeletal system, and he demonstrated a thorough knowledge of biomechanics, physiology, and mathematical modeling in his research and analyses in this area.

Most of the chapters in this text include comprehensive reviews of Bernstein’s work, followed by discussions of current issues. For example, the chapter on locomotion by Douglas Stuart and Jennifer McDonagh contains a thorough discussion of the role of descending command signals, sensory feedback, and spinal pattern-generating circuitry. This chapter in particular presents interdisciplinary information about the control of locomotion across many species and provides excellent examples of research methodology.

For professionals in athletic training and sports medicine, the array of chapters includes an excellent discussion of the coordinated control of posture, reaching movements in children, bimanual control, and explosive movements. For instance, Bernstein’s early use of cyclogrammetry for the study of kinematics laid the groundwork for many current techniques used to analyze complex, nonautomatic movements. Given that his research was conducted almost 70 years ago, his ability to analyze complex voluntary movements was a great contribu-
tion, especially in contrast to Sherrington's strategy of studying the simplest automatic movements.

Esther Thelen's chapter on Bernstein's legacy for motor development captures the essential message of this text, in her wonderment at the wisdom of this Russian scientist. She suggests (with tongue in cheek) that there should be a "day of atonement" in which all contemporary researchers "could then recall all the times during the past year when we thought we had an original idea only to be reminded of the encompassing legacy of Bernstein's genius" (p. 267). As an example of his innovative thinking, Thelen points out how Bernstein's notion that the biomechanics of the environment sculpt the brain was in stark contrast to other developmental researchers, such as McGraw and Gesell, who conceptually discussed brain maturation as the precursor to motor control. This was yet another example of Bernstein's revolutionary thinking, which differed so much from other western researchers of the day. Not only is this an excellent chapter about Bernstein, but it is also a succinct discussion of dynamic systems theory that should be read by all graduate students to help them begin to understand the complex interactions among perception, action, and cognition.

The contents of this edited volume clearly reflect the conceptual outline envisioned by the editor, Mark Latash. Authors were asked to focus on the work of Bernstein and to integrate it with contemporary thought. Unlike many edited volumes, this text is not inundated with authors' discussions of their own research at the expense of a broad-based perspective. Rather, the authors have skillfully woven their own knowledge into an appreciation for the legacy of Nikolai A. Bernstein. At $49.00, this book is well worth the price, given the extensive historical appreciation and "food for thought" that can be gained by devouring its 16 chapters and over 100 figures and tables.

Linda K. Bunker, PhD
University of Virginia
Charlottesville, VA

High-Powered Plyometrics
James C. Radcliffe and Robert C. Farentinos
Human Kinetics, Champaign, IL
1999
170 pages
Price: $19.95

High-Powered Plyometrics provides a systematic, comprehensive, and practical approach to plyometric training for clinicians associated with functional rehabilitation and/or the strength and conditioning of athletes. The material in the text is well organized and effectively covers both the basic science and clinical applications of plyometric exercise. The use of sequential illustrations and sample training protocols is excellent and facilitates clinical application of these techniques.

I don't feel this material would be suitable as a primary textbook for an athletic training course, but it would be very beneficial as a complement to a primary text in rehabilitation or strength and conditioning. It would fit nicely into a course on therapeutic exercise or functional rehabilitation and conditioning of athletes. The illustrations and charts are a welcome addition to the traditional didactic information on plyometric activity.

The first 3 chapters provide a basic understanding of the complex neuromuscular mechanisms of plyometrics and their application in the clinical setting. However, chapter 1 fails to explore the neuromuscular aspects of plyometrics thoroughly enough, so I don't recommend this as a primary text in this area. I feel that students in athletic training need an in-depth understanding of these mechanisms before attempting to convey these principles to their athletes. A basic background in exercise physiology would facilitate the application of this text. I feel this material is very beneficial and appropriate for a variety of professionals involved in the rehabilitation and conditioning of athletes.

The sequential illustrations are the strength of this text and can be useful for incorporating plyometrics into strength and conditioning programs and functional rehabilitation settings. Along with the written explanations of the exercises, the illustrations provide a clear, progressive guide through the different body parts. The illustrations are more comprehensive than those I have observed in many other plyometrics texts. This format seems especially appropriate for specialists developing comprehensive strength and conditioning programs. In chapter 6, the sample charts for each body part are a very nice feature and can be readily used by strength and conditioning specialists.

From an athletic training perspective, I feel this text could be improved by more emphasis on the rehabilitative process and by showing how plyometric exercise could be integrated into functional rehabilitation. This might make the text more appropriate for the athletic training student or rehabilitation specialist. Also, I think that a reference list at the end of each chapter would be more useful to the reader; presently, the references appear at the end of the text.

The cost of the book is reasonable, considering the many benefits that it offers. High-Powered Plyometrics should be considered a valuable supplement for use by rehabilitation specialists and athletic training students. It is informative, well presented, and easy to understand.

Timothy J. Henry, PhD, ATC
State University of New York
at Brockport
Brockport, NY

Advances in Exercise Immunology
Laurel T. Mackinnon
Human Kinetics, Champaign, IL
1999
2nd edition
362 pages
Price: $49.00

Publications on the topic of exercise immunology date from late in the 19th century, but it was not until the mid 1980s that a significant number of researchers worldwide devoted their resources to this area. From 1900 to 1999, just over 1000 papers on exercise immunology were published, with 80% of these appearing in the 1990s.

Several books have been published on exercise immunology. Mackinnon's first edition appeared in 1992 and had only 113 pages. The second edition, published
7 years later, has more than 3 times the number of pages, reflecting the tremendous growth in the number of exercise immunology publications during the 1990s. This edition does a good job of summarizing what is currently known.

Mackinnon presents an overview of research in all the important areas of exercise immunology: acute and chronic immune responses to exercise, with an emphasis on basic immune cell responses; immunoglobulins, cytokines, and underlying mechanisms; and the relationship of exercise and immunity to upper respiratory tract infection, HIV, cancer, aging, and nutrition.

In comparison with the other books on this topic, Mackinnon’s is the most comprehensive and logically organized. However, chapter 8, “Immune Response to Exercise: Potential Clinical Applications,” could have been divided into separate chapters on nutrition, aging, cancer, and HIV. Research in each of these areas continues to grow, and extensive review papers have already been published on each topic. Exercise immunology’s biggest challenge for the future is in formulating practical guidelines for each of the topics covered in chapter 8.

Mackinnon’s greatest contribution is in the area of acute and chronic responses of the immune system to exercise and infection. She has conducted research in these areas, and it is obvious she feels most comfortable writing on this core area of exercise immunology.

Chapter 9, “Exercise and Immunology: Current State and Future Directions,” is insightful, thought provoking, and succinct. I feel that it is one of the strongest chapters in the book. The tables and figures are very helpful, and Mackinnon has done an excellent job of summarizing the research in them. The reference list is comprehensive and current. Her selection of studies within the text, chosen to represent a certain area of research endeavor, reflects her knowledge of data and research design.

Advances in Exercise and Immunology is an important reference book for all health professionals who work with athletes or provide exercise prescriptions.

David C. Nieman, DrPH, FACSM
Appalachian State University
Boone, NC

First Aid and CPR
National Safety Council
Jones and Bartlett, Sudbury, MA
1999
468 pages
Price: $35.75

This well-organized text contains a wealth of information on a very basic level. The text is supplemented by FirstAidNet, an integral Web site that allows students access to additional and updated information online. A CD-ROM is also available.

Virtually every emergency, including emergency childbirth, is covered in this book. Chapters 1 through 4 provide an overview of anatomy and patient assessment, with guidelines for responding to an emergency. Chapters 5 and 6 describe the latest cardiopulmonary resuscitation standards and the treatment of shock. Chapters 12 and 13 provide a good overview of extremity injuries, including some of the most common athletic injuries. I found chapter 22, on wilderness first aid, to be especially interesting. This chapter offers helpful guidelines for reducing finger, shoulder, and patellar dislocations in wilderness situations. Also included are useful topics such as facing medical emergencies in the wilderness, dealing with poisonous insect bites, and managing environmental conditions. The appendixes provide current information on the use of automatic external defibrillators and the administration of a patient’s emergency medications, such as nitroglycerin and epinephrine.

The illustrations are informative, and the numerous tables list not only what to do in an emergency, but also what not to do, thereby debunking many “old wives’ tales.” One down side in the text is the use of “hero citations,” which are short paragraphs describing a situation in which someone saved another’s life. These citations serve no real purpose.

This book is well written and easy to follow. It is clearly the best first-aid text on this level that I have seen and would make a good supplemental text for beginning students. Experienced certified or student athletic trainers will gain little from this text and are better off taking a paramedic course if they want additional knowledge in emergency medical care.

Francis Feld, MS, CRNA, ATC,
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Mercy Hospital
Pittsburgh, PA

Physiology of Sport and Exercise
Jack H. Wilmore and David L. Costill
Human Kinetics, Champaign, IL
1999
2nd edition
710 pages
ISBN: 0-7360-0084-4
Price: $59.00

Wilmore and Costill’s second edition is an excellent text for use in undergraduate physiology of exercise courses. The text not only introduces the fields of sport and exercise physiology but also builds upon the knowledge gained through basic coursework in human anatomy and physiology. The major focus of the book is the body’s performance, response, and adaptation to long-term exposure to all forms of exercise, under multiple environmental conditions. The book begins with a historical overview of sport and exercise physiology. Following the overview are 7 major sections: essentials of movement; energy for movement; cardiorespiratory function and performance; environmental influences on performance; optimizing performance in sport; age and sex considerations in sport and exercise; and physical activity for health and fitness. The sections are divided into chapters. Each chapter includes a short overview, an outline with page numbers for easy reference, and colorful sections with helpful tables and figures. At the end of each chapter is a list of important key terms, study questions, references, and selected reading suggestions. A special feature to help the reader is the use of color coding at the edge of the pages, making the chapters easy to locate. The text includes common scientific abbreviations, units and conversions, and an extensive glossary of terms. This would be an excellent required text for a physiology of exercise course and a useful and practical reference for anyone pursuing a career in sport science. This reasonably priced hardcover book provides useful information on how the body adapts to stressful situations and on
how to become more active, healthy, and physically fit.

James M. Manning, PhD, ATC
William Paterson University
Wayne, NJ

Flexibility for Sport and Fitness
Human Kinetics, Champaign, IL
1997
Videotape, 40 minutes
Price: $19.95

Human Kinetics' Flexibility for Sport and Fitness video is appropriate for the physically active population, including athletes and fitness participants. The video is informative and thorough as it directs viewers in assessing their range of motion and flexibility. Fourteen stretches are presented for the major muscle groups of the body. A “Quick Reference Guide” insert provides photographs and describes range-of-motion tests and the stretching routine.

The viewer is first introduced to the proposed benefits of flexibility, including improved sport performance and injury prevention. The effects on flexibility of such factors as age, sex, joint laxity, muscle balance, type of activity, and stretching are discussed. The information on tissue response to stretching is well presented. Illustrations and detailed descriptions of basic anatomy (muscle, joint capsule, tendon, ligament, and fascia) and physiology (eg, elastic and plastic deformation) will help nonmedical readers to understand the structures and how each is affected by stretching. Thirteen range-of-motion tests are described and demonstrated, for the neck, shoulders, back, hips, knees, and ankles. The use of a mirror or partner is recommended for range-of-motion assessment. General principles of stretching, including contraindications, frequency, repetitions, and duration (30 seconds), are reviewed, followed by demonstrations and descriptions of specific stretches.

The material presented in this video is understandable and appropriate for the targeted audience, with few exceptions. However, the video commentator's use of the undefined word “antagonistic” before the range-of-motion tests might confuse the layperson. Additionally, in describing the shoulder rotation range-of-motion tests (the model demonstrates 1 arm in combined flexion, abduction, and external rotation and the opposite arm in combined extension, adduction, and internal rotation), the commentator incorrectly identifies lateral rotator tightness as restricting the overhead-positioned arm and medial rotator tightness as restricting the behind-the-back-positioned arm. Neither of these minor weaknesses should detract significantly from this well-made video.

I recommend Flexibility for Sport and Fitness as a welcome addition to the athletic trainer's or sports physical therapist's patient education video library. The video provides an understanding of the physiology and principles of stretching for physically active patients and athletes. Clinicians may choose to have their clients view and perform all 14 stretches as a general flexibility routine or they may prefer to select specific stretches for each client.

William G. Webright, MEd, ATC, PT
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Charlottesville, VA

Instructor's Toolkit for Concepts of Athletic Training
Ronald P. Pfeiffer
Jones and Bartlett, Sudbury, MA
1998
2nd edition
CD-ROM

PC Requirements: 486 processor with 16 MB of RAM, quad speed CD-ROM, Windows 3.1 or Windows 95. Macintosh requirements: PowerPC or greater, 16 MB of RAM, dual speed CD-ROM, System 7.01.
Price: $395.00

The Instructor's Toolkit for Concepts of Athletic Training is structured so that each chapter in the text has supplemental Web sites established, which allows valuable information to be easily accessed by the user. This CD-ROM would be an excellent complementary resource for an introduction to an athletic training course. The content is directed at the introductory level; however, it would be a valuable resource for all levels. It allows the user access to informative athletic training-related Web sites at the click of a mouse. It makes the Internet user friendly, especially for the beginner; the overall CD-ROM is also user friendly, because it walks you through step by step. Topic searches provide numerous locations for valuable information.

For example, chapter 1, “The Concepts of Sport Injury,” is linked to NCAA Online and the Consumer Product Safety Commission home page. Chapter 2, “The Sports Medicine Team,” is linked to the NATA home page and the ACSM home page. The remaining chapters deal with the law of sports injury; sports injury protection; the psychology of injury; nutrition considerations; emergency plan and initial injury evaluation; the injury process; injuries to the head, neck, and face; injuries to the thoracic through coccygeal spine; injuries to the shoulder region; injuries to the arm, wrist, and hand; injuries to the thorax and abdomen; injuries to the hip and pelvis; injuries to the thigh, leg, and knee; injuries to the lower leg, ankle, and foot; skin conditions; thermal injuries; and other medical concerns.

In my opinion, this is an excellent pedagogic aid. I would like to see every book adopt this concept, which allows the student to become more interactive with the learning process. It is a far better approach than just reading a text or sitting through a lecture. I highly recommend the use of this tool and similar tools to spark interest in the classroom and ultimately increase the retention of information. The price may seem overwhelming; however, for what this tool provides, it is very cost efficient.

Mark R. Casterline, MS, ATC
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Canton, NY
Background

Historically, physicians – particularly orthopedic surgeons – have used injury-specific, objective evaluation systems to assess the results of their treatment and to evaluate patient function, e.g., International Knee Documentation Committee (IKDC) evaluation form, the American Shoulder and Elbow Surgeons' Shoulder evaluation form. In the last decade, generic measures of the patient’s assessment of his or her behavioral functioning, subjective sense of well-being and perception of health have been developed and used to assess the health status of patients with general and chronic diseases, e.g., SF-36. These evaluative tools inquire about the patient’s vitality, level of general and mental health and levels of physical and social functioning following illness or injury.

The responsibility for treatment and rehabilitation of musculoskeletal injuries among the physically active is shared by a growing number of allied health practitioners. Certified athletic trainers are well positioned in clinics and hospitals, secondary schools, colleges and universities and industrial settings to provide needed physical medicine services to these patients. Outcomes of treatment in athletic training and sports medicine include but are not limited to:

(a) patient assessment of a particular treatment intended to eliminate his/her specific physical impairment;

(b) patient-reported evaluation of function and functional limitations experienced during activities of daily living, work, sport and/or recreational activity;

(c) patient assessment of his/her ability to perform sport, recreational or work at pre-injury activity levels.

Studies are needed to evaluate the utilization of health care resources, e.g., the number of visits the patient made to the certified athletic trainer, the equipment and/or supplies issued to the patient in the course of treatment. Of similar importance is the level of satisfaction the patient has with the caregiver and/or the support staff and with the overall results of treatment.

Outcomes research is needed in athletic training and sports medicine to determine the effectiveness of a particular intervention, treatment methodology or rehabilitation protocol for sports-related injuries.

Moreover, outcomes research is needed to validate the quality of care provided by certified athletic trainers in comparison with reported patients’ evaluations of their outcomes for treatment provided by physiatrists; board-certified physical therapists, specifically specialists compared with non-specialists; physical therapist assistants; and/or non-licensed clinical staff members.

Where and When to Apply

The NATA Research and Education Foundation, through its Research Committee, is acting as gatekeeper for the database from the nationwide 1996-1998 Athletic Training Outcomes Assessment. Preliminary reports from the Outcomes Assessment have been published at regular intervals in the monthly newsletter of the National Athletic Trainers’ Association, NATA News. Now available for further analysis is the raw data from more than 6,000 patients who received 90 percent or more of their care from certified athletic trainers. These outcomes data were collected at numerous venues throughout the United States, including sports medicine clinics, high schools, colleges, universities and industrial settings.

Access to the 1996-1998 Athletic Training Outcomes Assessment database will be limited to principal investigators who have submitted research proposals approved and funded by the NATA Research and Education Foundation. The Foundation accepts grant proposals in two funding cycles per year, March 1 and September 1, with notification in July and January, respectively.

Procedure

To receive a copy of the Research Grant Application, write to the NATA Research and Education Foundation; 2952 Stemmons; Dallas, TX 75247; call 800-TRY-NATA, ext. 121; or e-mail <barbaran@nata.org>.
Introduction

The National Athletic Trainers’ Association Research and Education Foundation is acting as gatekeeper of the data recorded through an NATA-funded, three-year, nationwide high school injury surveillance study. These data, collected for 10 sports during the 1995-96, 1996-97 and 1997-98 sports seasons, describe the rate and type of injuries suffered by athletes at the high school level. The data from this epidemiological study could be used to help pinpoint causes of injuries as well as means for prevention, and the Foundation’s Research Committee is seeking proposals for research projects that utilize this unique injury data base. Data from this exclusive NATA high school injury surveillance study could be used to help identify high-risk activities and/or situations, such as practices versus competitions. Findings could, in turn, be applied to injury prevention efforts or be used to enhance the safety of student athletes’ participation in high school sports.

Background

Each year, an estimated six million high school students participate in interscholastic sports in the United States. Few studies exist currently that address the real safety risks to the adolescents involved in such endeavors. The current NATA study is an extension of a previous three-year high school injury research effort undertaken by the NATA in 1986, which provided a benchmark for high school injury rates and severity in the United States.

The 1995-1998 NATA high school injury surveillance study tracked injuries that occurred in football, boys’ and girls’ basketball, baseball, softball, volleyball, wrestling, boys’ and girls’ soccer and field hockey. A cross-section of high schools from 45 states – including private and public schools from rural and metropolitan areas of the country – participated in the study, with certified athletic trainers acting as the primary record keepers. More than 235 secondary schools were affiliated with this research project, collectively submitting epidemiological data and injury records for nearly 76,000 high school athletes.

Objectives

The Research and Education Foundation advocates top-caliber research proposals that will use the national high school injury data in a constructive and enlightening manner to help attain the goal of utmost safety for all student athletes. To this end, the Research and Education Foundation offers access to the NATA High School Injury Surveillance data base to investigators studying safety risks in pediatric and adolescent sports participation. The Foundation seeks proposals that can effectively utilize the data base to initiate new studies or support existing research in this area.

Procedure

Access to the data will be limited to principal investigators. Deadlines for proposals to access the NATA High School Injury Surveillance data base are March 1 and September 1. To receive an application for this RFP, please write to the NATA Research and Education Foundation; 2952 Stemmons; Dallas, TX 75247; call 800-TRY-NATA, ext. 121; or e-mail <barbaran@nata.org>.
Introduction

The NATA Research and Education Foundation announces that $250,000 is available to support research on pediatric sports health care. The primary goal is to encourage epidemiological study that will have clinical relevance to the development of the pediatric athlete and the prevention, treatment and rehabilitation of injuries sustained by the physically active pediatric participant.

Background

The incidence of sports participation by preadolescents and adolescents has increased dramatically in the past two decades. It is estimated that more than 30 million children and adolescents are participating in organized sports in the United States. Consequently, they represent the largest group of individuals engaging in such activities in this country. However, this recent growth of children’s participation in sport has outpaced efforts to clearly understand the consequences of intense physical activity on the development of young adults.

It is assumed that exercise and sports participation have positive effects on children, and increasing evidence shows regular exercise is important to their physical and psychological well-being. Yet, participation in sport does pose risks. Increasing sports specialization at younger and younger ages has placed a high premium for athletic success. However, little is known about the incidence and severity of injuries associated with child or adolescent participation in these activities. Therefore, a great need exists for epidemiological studies to determine pediatric injury patterns and specific populations at risk. Furthermore, types of intervention strategies to reduce the incidence and severity of pediatric injuries in sport need to be developed as well as the measures of their effectiveness.

Objectives

The Research and Education Foundation, therefore, encourages high quality research proposals emphasizing the epidemiology of athletic injuries in children and adolescents, which will help establish a firm scientific foundation for basic and applied programs in pediatric sports health care.

Procedure

To receive a copy of the Research Grant Application, contact:

NATA Research and Education Foundation
2952 Stemmons
Dallas, TX 75247
phone (800) TRY-NATA, ext.121
fax (214) 637-2206
e-mail <barbaran@nata.org>
Request for Proposal

The NATA Task Force on Appropriate Medical Coverage for Intercollegiate Athletics, in cooperation with the NATA Research & Education Foundation, invites qualified researchers to assist in the collection of treatment and injury data for sports at all collegiate levels. These data are needed to further substantiate and establish a scientific rationale for the recommendation of medical coverage needs for student-athletes in this setting.

Background
In February 1998, NATA created a task force to address concerns of increased exposure to injury from the expansion of traditional seasons, non-traditional practices and competitions, skill instruction sessions and year-round strength and conditioning. Of additional concern have been the high numbers of injuries, serious injuries and deaths of student-athletes at the collegiate level.

The objective of the task force is to establish guidelines for appropriate medical coverage, providing the best possible health care for all student-athletes based on accepted medical criteria (e.g., injury risk and treatment demands) rather than gender, sport revenue or level of competition.

In determining the appropriate level of medical coverage for each sport, the task force has devised a rating system utilizing injury rates, the potential for catastrophic injury, and treatment/rehabilitation demands for both time loss and non-time loss injuries per sport.

Rates have been assigned based on current literature and relevant injury rate data available, which the task force has reviewed thoroughly. Where scientific data does not exist, recommendations have been based on non-peer reviewed injury tracking data and the professional expertise and consensus of opinion of task force members.

Currently, the NCAA tracks injury rate data for time loss injuries on 15 sports. Catastrophic injury rate data are available on all sports through the National Center for Catastrophic Sports Injury. However, no peer-reviewed research exists on any sport with regard to injury rates, illness rates or treatment demands for non-time loss injuries. Therefore, the task force desires and strongly encourages the collection of these missing data to further substantiate and ensure a firm scientific rationale for the rating system set forth for each collegiate sport.

Level of Funding
Up to $175,000 is available for this research.

Timeline
Optimally, the goal is to have data collection commence no later than August 2000, with one full year of data collection completed by the end of the 2000-01 academic year.

Application Process
Interested and qualified persons are invited to submit a research proposal consistent with the application process set forth by the Foundation. To receive a copy of the Research Grant Application, write to the
Foundation; 2952 Stemmons; Dallas, TX 75247; call (800) TRY-NATA, ext. 121; or email <barbara@nata.org>.

Application deadline: Jan. 1, 2000

Questions regarding the desired data and information requested in this proposal should be directed to:

Sandra J. Shultz, PhD, ATC
University of Virginia
203 Memorial Gymnasium
Charlottesville, VA 22901
(804) 243-8673
<sjs3n@virginia.edu>

All other questions regarding general proposal guidelines and the application process should be directed to the NATA Research & Education Foundation c/o:

Chris Ingersoll, PhD, ATC
Chair, Research Committee
Athletic Training Department
Indiana State University
Terre Haute, IN 47809
(812) 237-2881
<c-ingersoll@indstate.edu>

Continued
Objectives

To further substantiate and determine the medical coverage needs of intercollegiate athletes, the task force needs the following data and information:

1. Injury rates per 1000 exposures, including severity (i.e., length of time loss per injury) for each of these intercollegiate sports:

<table>
<thead>
<tr>
<th>Sports</th>
<th>Sports</th>
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</thead>
<tbody>
<tr>
<td>Cross country (men’s and women’s)</td>
<td>Rowing (M &amp; W)</td>
</tr>
<tr>
<td>Cheerleading</td>
<td>Skiing</td>
</tr>
<tr>
<td>Diving</td>
<td>Swimming (M &amp; W)</td>
</tr>
<tr>
<td>Fencing</td>
<td>Tennis (M &amp; W)</td>
</tr>
<tr>
<td>Golf (M &amp; W)</td>
<td>Track and Field (M &amp; W)</td>
</tr>
<tr>
<td>Ice Hockey (women’s)</td>
<td>Volleyball (men’s)</td>
</tr>
<tr>
<td>Rifle</td>
<td>Water Polo (M &amp; W)</td>
</tr>
</tbody>
</table>

2. Injury and illness rates per 1000 exposures for non-time loss injuries in these sports:

<table>
<thead>
<tr>
<th>Sports</th>
<th>Sports</th>
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</thead>
<tbody>
<tr>
<td>Baseball</td>
<td>Rifle</td>
</tr>
<tr>
<td>Basketball (M &amp; W)</td>
<td>Rowing (M &amp; W)</td>
</tr>
<tr>
<td>Cross Country (M &amp; W)</td>
<td>Skiing</td>
</tr>
<tr>
<td>Cheerleading</td>
<td>Soccer (M &amp; W)</td>
</tr>
<tr>
<td>Diving</td>
<td>Softball</td>
</tr>
<tr>
<td>Fencing</td>
<td>Swimming (M &amp; W)</td>
</tr>
<tr>
<td>Field Hockey</td>
<td>Tennis (M &amp; W)</td>
</tr>
<tr>
<td>Football</td>
<td>Track (M &amp; W)</td>
</tr>
<tr>
<td>Golf (M &amp; W)</td>
<td>Volleyball (M &amp; W)</td>
</tr>
<tr>
<td>Gymnastics (M &amp; W)</td>
<td>Water Polo (M &amp; W)</td>
</tr>
<tr>
<td>Ice Hockey (M &amp; W)</td>
<td>Wrestling</td>
</tr>
<tr>
<td>Lacrosse (M &amp; W)</td>
<td></td>
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</tbody>
</table>

3. The number of treatments per injury, or time spent in treatment and/or rehabilitation per injury for these sports (data in either format are acceptable):

<table>
<thead>
<tr>
<th>Sports</th>
<th>Sports</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseball</td>
<td>Rifle</td>
</tr>
<tr>
<td>Basketball (M &amp; W)</td>
<td>Rowing (M &amp; W)</td>
</tr>
<tr>
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<td>Skiing</td>
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<tr>
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<td>Tennis (M &amp; W)</td>
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<tr>
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<tr>
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<td>Volleyball (M &amp; W)</td>
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<td>Water Polo (M &amp; W)</td>
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<tr>
<td>Ice Hockey (M &amp; W)</td>
<td>Wrestling</td>
</tr>
<tr>
<td>Lacrosse (M &amp; W)</td>
<td></td>
</tr>
</tbody>
</table>

Submitted proposals comprehensively addressing at least one of the major objectives stated above will be considered. Data that reflect national representation of all collegiate levels (i.e., NCAA Div. I, II, III, NAIA and jr. college) are highly desirable. However, individual proposals providing comprehensive regional or national representation at a single college or division level will also be considered.
Instructions for Submission of Abstracts and Process for Review of All Submissions

Please read all instructions before preparing the abstract. Individuals may submit only one abstract or clinical case report as primary (presenting) author, but may submit unlimited abstracts or clinical case reports as a co-author. All abstracts will undergo blind review.

FREE COMMUNICATIONS ABSTRACTS

Specific Content Requirements
Abstracts in this category must include the purpose of the study or hypothesis, a description of the subjects, the experimental methods and materials, the type(s) of data analysis, the results of the study, and the conclusion(s). Authors are asked to indicate a preference for oral or poster presentation of their abstracts. Authors of free communications are required to categorize their abstracts in one of the five specific areas of research funded by the NATA Research and Education Foundation:

- **Basic Science** - includes controlled laboratory studies in the sub disciplines of exercise physiology, biomechanics, and motor behavior, among others, which relate to athletic training and sports medicine.
- **Clinical Studies** - includes assessment of the validity, reliability, and efficacy of clinical procedures, rehabilitation protocols, injury prevention programs, surgical techniques, and so on.
- **Educational Research** - a broad category ranging from basic surveys to detailed athletic training/sports medicine curricular development. An abstract in this category will generally include assessment of student learning, teaching effectiveness (didactic or clinical), educational materials and curricular development.
- **Sports Injury Epidemiology** - includes studies of injury patterns among athletes. These studies will generally encompass large-scale data collection and analysis. Surveys and questionnaires may be classified in this category but are more likely to come under the Observation/Informational Studies category.
- **Observation/Informational Studies** - includes studies involving surveys, questionnaires, and descriptive programs, among others, which relate to athletic training and sports medicine.

Instructions for Preparing the Abstract
1. Provide all information requested on the Abstract Author Information Form. Abstracts should be typed or word processed using a letter-quality printer with no smaller than elite (12 cpi) or 10-point typeface. Do not use a dot matrix printer.

CLINICAL CASE REPORTS

Specific Content Requirements
This category of abstracts involves the presentation of unique individual athletic injury cases of general interest to our membership. This year, no form is provided so that authors may use their own word-processing software to format and submit the following information using a two-page format. Abstracts in this category must include the following information. A maximum of one paragraph should be presented for each of the following required content area headings:

1) Personal data
2) Physical signs and symptoms
3) Differential diagnosis
4) Results of diagnostic imaging/laboratory tests
5) Clinical course
6) Deviation from the expected

Instructions for Preparing the Abstract
1. An individual may submit only one clinical case report abstract as primary (presenting) author; however, there is no limit to the number of abstracts (free communications or case reports) listing an individual as co-author.

2. Clinical case report abstracts are to be word processed or typed using a letter-quality printer with no smaller than elite (12 cpi) or 10-point typeface. Do not use a dot matrix printer.

3. Top, bottom, right, and left margins should be set at 1.5" using a standard 8.5" x 11" sheet of paper. Type the title of the paper or project starting at the left margin.

4. On the next line, indent 3 spaces and type the names of all authors, with the author who will make the presentation listed first. Type the last name, then initials (without periods), followed by a comma; continue with the other authors (if any), ending with a colon.

5. Indicate the institution (including the city and state) where the research or case report was conducted on the same line following the name(s) of the author(s).

6. Double space and begin typing the text of the abstract flush left in a single paragraph with no indentations. Do not justify the right margin. Do not include tables.

6. The abstract must not exceed 400 words.
5. The title of the clinical case report should not contain information that may reveal the identity of the individual nor the specific nature of the medical problem to the reader. An example of a proper title for a clinical case report is “Chronic Shoulder Pain in a Collegiate Wrestler.”

6. Complete the six different categories of information as required for a clinical case report abstract. These categories are:
   a. Personal Data/Pertinent Medical History (age, sex, sport/occupation of individual, primary complaint, and pertinent aspects of his/her medical history)
   b. Physical Signs and Symptoms (a brief summary of the physical findings)
   c. Differential Diagnosis (array of possible injuries/conditions)
   d. Results of Diagnostic Imaging/Laboratory Tests
   e. Clinical Course (e.g., diagnosis, treatment, surgical technique, rehabilitation program, final outcome)
   f. Deviation From the Expected (a brief description of what makes this case unique)

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NATA Research & Education Foundation Call for Reviewers

The NATA Research & Education Foundation presents the Free Communication Sessions at the NATA Annual Meeting & Clinical Symposia. The Joe W. King Orthopedic Institute sponsors the Student Poster Awards Program. These events offer NATA members the opportunity to present and learn about the latest developments in athletic training.

The Foundation is currently recruiting individuals interested in reviewing the abstracts submitted for inclusion in these oral and poster research presentations. The abstracts fall under the following categories: basic science, clinical studies, educational research, observational studies, sports injury epidemiology, and clinical case reports (unique injury cases).

Abstracts are due January 5 of each year. During the month of February, reviewers are asked to submit written evaluations of blind abstracts within their interest or expertise area.

Those interested in volunteering to become an abstract reviewer should send a curriculum vitae or resume, a preferred review category, and a letter of application to:

Christopher D. Ingersoll, PhD, ATC
Athletic Training Department
Indiana State University
Terre Haute, IN 47809

Responses preferred by December 1, 1999

---

Instructions for Submitting Abstracts (either Free Communications or Clinical Case Reports)

Complete the form and mail it, the original abstract, two photocopies of the original abstract, six (6) blind copies (showing no information about the authors or institution) of the abstract and a labeled 3.5" DISKETTE copy (preferably in WordPerfect or ASCII format; if you must send it in Macintosh format, please use a high-density diskette) of your abstract to:

NATA Research & Education Foundation
Free Communications
2952 Stemmons Freeway
Dallas, TX 75247

---

ABSTRACTS POSTMARKED AFTER JANUARY 5, 2000, WILL NOT BE ACCEPTED.

---

Abstract Author Information Form
Mailing Address of Presenting Author:
(Please type; provide full name rather than initials)

- [ ] I was a student at the time of this study.

Name______________________________
Credentials __________________________
Institution __________________________
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NATA Membership Number__________
e-mail ________________

Key Words: (two to six words that identify your abstract)

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Indicate the most appropriate TYPE for the presentation: (check one only)
- [ ] Clinical Case Report  [ ] Free Communication

IF FREE COMMUNICATION, indicate the most appropriate CATEGORY for your presentation: (check one only)
- [ ] Basic Science  [ ] Clinical Studies
- [ ] Educational Research  [ ] Sports Injury
- [ ] Observation/Informational Epidemiology Studies

Indicate your presentation preference: (check one only; choice does not influence acceptance)
- [ ] Poster  [ ] Oral  [ ] Indifferent
SESSION 22 Integrating Technology into the Athletic Training Profession
- Fundamental Issues, Problems and Solutions
- Related to Technology - K Wright; S Barker; V Wright
- Development and Application of Multimedia for the Educational Setting - D Wiksten
- Distance Education and Future Trends in Multimedia Technology - S Barker; V Wright; K Wright
- Quality Issues in Designing an Athletic Training Home Page - M Newman

SESSION 23 Evolution of the Profession
- Association Development - O Davis
- Professional Education - R Behnke
- Certification - P Grace
- Governmental Affairs - D Campbell
- Journal/Publication - D H Perrin
- Research and Education Foundation - M J Albom

SESSION 24 Performance Enhancing and Ergogenic Agents
- Fueling and Cooling - E F Coyle
- Nutritional Ergogenic Aids: General Overview and Applications to Sport - M Williams
- Nutritional Ergogenic Aids: The Creatine Frenzy - J F Clark
- Performance Enhancing Pharmacological Agents - The Role of Anabolic Steroids, Hormones - G Wadler

SESSION 25 Evolution of Change and Rehabilitation Compliance Success
- Athlete/Certified Athletic Trainer Relationship: Importance in Rehabilitation - J Gieck
- Innovations in Equipment for Rehabilitation - F Hoover
- Coach Input and Rehabilitation - J Rhea
- Rehabilitation Considerations for the Clinic - P Donley
- Rehabilitation Considerations & the Professional Athlete - L McLean
- The Importance of the Physician in Rehabilitation - F George

SESSION 26 Biomechanical and Clinical Aspects of Ankle and Knee Bracing in Sports Medicine
- Biomechanics of Prophylactic Ankle Bracing - I Kimura
- Clinical & Performance Aspects of Prophylactic Ankle Bracing - M Stiler
- Biomechanics of Functional Knee Bracing - B Beynon
- Role of Functional Bracing in the ACL Deficient and Reconstructed Knee - J C Vivas
- Biomechanics & Efficacy of Lateral Prophylactic Knee Bracing - M Horodyski

SESSION 27 Training and Conditioning
- Cardiorespiratory Adaptations to Training - R Pate
- Strength by Design - S Fleck
- The Finer Points of Training: Implications for Injury Prevention - T Decker
- Changing Body Weight/Body Composition in Athletes - J Walberg-Rankin

SESSION 28 Therapeutic Modalities
- What Modality Should I Use & When Should I Use It? - W Prentice
- The ATC's Legal Ability to Apply Therapeutic Modalities in Traditional and Non-Traditional Settings - C Starkey
- Role of Laboratory Research in Determining Efficacy of Therapeutic Modalities - D Draper
- Determining Treatment Effects and Outcomes Efficacy in Rehabilitation - T W Worrell
- Integrating Therapeutic Modalities into a Rehabilitation Plan of Care - C Denegar

MINICOURSE A Managing Your Collegiate Managed Care Student Athletes - J Entriken & R M Suico

MINICOURSE B Current Concepts in Functional Core Stabilization Training - M Clark

MINICOURSE C Current Concepts in Diagnosis and Management of Stress Fractures - W Romani

MINICOURSE D Current Concepts in Proprioceptive Neuromuscular Facilitation (PNF) Techniques - R Moore

MINICOURSE E Establishing a Disordered Eating Response Team (DERT) - J Grossman

MINICOURSE F Fair Labor Standards Act and its Implications in the Athletic Training Setting - B Wissen

MINICOURSE G Use of the Standardized Assessment for Concussion (SAC) - M McCrea

MINICOURSE H Athletic Training Room Design and Layout - J Sabo

MINICOURSE I Non-Contact ACL Tears in the Female Athlete - T Scerpella


MINICOURSE K Development of an Emergency Action Plan - K Walsh

MINICOURSE L Initial Management and Transport of Athletes with Head and Spinal Injuries - D E Cooper

MINICOURSE M How to Evaluate a Position in Athletic Training - M Padgett

MINICOURSE N Interview Skills - R Meador

MINICOURSE O Resume Writing Skills - M Tsuchiya

SESSION 29 Initial Management and Transport
- AMSSM Lecture Exchange - M LaBotz
- Kevin P Speer, MD New Investigator Award - K Guskiewicz
- William G Clancy Jr., MD Medal for Distinguished Athletic Training Research Award - D H Perrin
- Kevin P Speer, MD New Investigator Award - K Guskiewicz
- *AMCSS Lecture Exchange - M L Ireland
- *AMCSS Lecture Exchange - M LaBotz
- *AMCSS Lecture Exchange - P Renstrom
- *AMCSS Lecture Exchange - P Renstrom

SESSION 30 Town Hall Meeting
- JOHNSON & JOHNSON SYMPOSIUM
- The Young Athlete: Variations, Risks and Transitions
- Normal Variation in Growth and Maturation - A Rogol
- Behavioral Transitions in the Careers of Young Athletes - M Ewing
- Trainability of Young Athletes - R Malina
- Risk for Injury Unique to the Young Athlete - S J Anderson

SESSION 31 JOHNSON & JOHNSON KEYNOTE ADDRESS
- Greg Gumbel, Sportscaster, CBS Television Network

SESSION 32 JOHNSON & JOHNSON SYMPOSIUM
- The Young Athlete: Variations, Risks and Transitions
- Normal Variation in Growth and Maturation - A Rogol
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- Greg Gumbel, Sportscaster, CBS Television Network

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- Greg Gumbel, Sportscaster, CBS Television Network

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Look in the NATA News.

The CEU Quiz, formerly placed in the *Journal of Athletic Training*, now appears in the *NATA News*, a monthly magazine for NATA members. The quiz schedule for 1999 is:

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The CEU Quiz also is posted on the NATA Fax-on-Demand Service. Access the quiz by dialing toll-free (888) ASK-NATA or 214-353-6130 from a touch-tone telephone. Follow the automated instructions, requesting Document #1112. Deadlines for submitting each quiz are posted in the *NATA News*.

For more information about the *Journal of Athletic Training*, visit <http://www.nata.org/jat>

■ 22nd Annual NATA Student Writing Contest ■

In an effort to promote scholarship among young athletic trainers, the National Athletic Trainers’ Association, Inc sponsors an annual writing contest.

1. The contest is open to all undergraduate members of the NATA.
2. Papers (e.g., original research articles, literature reviews, case reports, or clinical techniques articles) must be on topics germane to the profession of athletic training.
3. Entries must neither have been published by, nor be under consideration for publication by, any journal.
4. The winning entrant will receive a cash award and recognition as the winner of the Annual NATA Student Writing Contest. The winning paper will follow the normal process of submission and review for possible publication in the *Journal of Athletic Training*. One or more other entries may be given honorable mention.
5. Entries must conform to the *Journal’s* Authors’ Guide, which provides the most current information on format and style. For advice about writing, we suggest that authors consult Kenneth L. Knight and Christopher D. Ingersoll’s “Structure of a Scholarly Manuscript: 66 Tips for What Goes Where” (*J Athl Train*. 1996;31:201–206) and “Optimizing Scholarly Communications: 30 Tips for Writing Clearly” (*J Athl Train*. 1996;31:209–213).
6. Entries must be received by March 1, 2000. The winner will be announced at the Annual Meeting and Clinical Symposia in June.
7. The Writing Contest Committee reserves the right to make no awards if, in its opinion, none of the entries is of sufficient quality to merit recognition.
8. An original and 2 copies of each entry must be received at the following address by March 1, 2000:

NATA Student Writing Contest  
Deloss Brubaker, EdD, ATC  
Life College  
1269 Barclay Circle  
Marietta, GA 30060
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• Helpful hints for writers
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• Table of contents for past and present issues
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Authors' Guide

(Revised January 1999)

The mission of the Journal of Athletic Training is to enhance communication among professionals interested in the science, art, and business of athletic training. The Journal is committed to providing a forum for the advancement of the discipline of athletic training.

SUBMISSION POLICIES

1. Submit 1 original and 5 copies of the entire manuscript (including figures and tables) to: Journal of Athletic Training Submissions, Houghton Sports Medicine Foundation, Inc., 6262 Veterans Parkway, PO Box 9517, Columbus, GA 31908. The term figure refers to items that are not editable, either halftones (photographs) or line art (charts, graphs, tracings, schematic drawings), or combinations of the two. A table is an editable item that needs to be typeset.

2. All manuscripts must be accompanied by a letter signed by each author and must contain the following statements: "This manuscript 1) contains original unpublished material that has been submitted solely to the Journal of Athletic Training, 2) is not under simultaneous review by any other publication, and 3) will not be submitted elsewhere until a decision has been made concerning its suitability for publication by the Journal of Athletic Training. In consideration of the NATA's taking action in reviewing and editing my submission, I, the undersigned author hereby transfer, assign, or otherwise convey all copyright ownership to the NATA, in the event that such work is published by the NATA. Further, I verify that I have contributed substantially to this manuscript as outlined in item #3 of the current Author's Guide." By signing the letter, the authors agree to comply with all statements. Manuscripts that are not accompanied by such a letter will not be reviewed. Accepted manuscripts must be submitted in electronic format.

3. Each author is required to contribute to the article. This means that all coauthors should be given, along with the city and state in which it is located. If individual authors were the recipients of funds, their names should be listed parenthetically.

4. Authors must specify whether they have any commercial or proprietary interest in any device, equipment, instrument, or drug that is the subject of the article in question. Authors must also reveal if they have any financial interest (as a consultant, reviewer, or evaluator) in a drug or device described in the article.

5. For experimental investigations of human or animal subjects included in the methods section of the manuscript that an appropriate institutional review board approved the project. For those investigators who do not have formal ethics review committees (institutional or regional), the principles outlined in the Declaration of Helsinki should be followed (41st World Medical Assembly. Declaration of Helsinki: revisions of guidelines regulating physicians in biomedical research involving human subjects. Bull Pan Am Health Organ.

6. The results should be summarized using specific statements and reference them.

7. Signed releases are required to verify permission of JAMA 1997;278:68, copyright 1997, American Medical Association.)

8. The Journal of Athletic Training uses a double-blind review process. Authors should not be identified in any way except on the title page.

9. Manuscripts are edited to improve the effectiveness of communication between author and readers and to aid the author in presenting a work that is compatible with the style policies found in the AMA Manual of Style, 9th ed. (Williams & Wilkins), 1998. Page proofs are sent to the author for proofreading when the article is typeset for publication. It is important that they be returned within 48 hours. Important changes are permitted, but authors will be charged for excessive alterations.

10. Manuscripts are accompanied work cannot be returned. Unused manuscripts will be returned if submitted with a stamped, self-addressed envelope.

STYLE POLICIES

11. Each page must be printed on 1 side of 9½-by-11-inch paper, double spaced, with 1-inch margins in a font no smaller than 10 points. Each page should include line counts to facilitate the review process. Do not right justify any text.

12. Manuscripts should contain the following, organized in the order listed below, with each section beginning on a separate page:

a. Title
b. Acknowledgments
c. Abstract and Key Words (first numbered page)
d. Text (body of manuscript)
e. References
f. Tables (each on a separate page)
g. Legends to figures
h. Figures
i. Conclusions
j. Data Sources, Data Synthesis, Conclusions/Recommendations, and Key Words

13. Begin numbering the pages of your manuscript with the abstract page as #1, then consecutively number all successive pages.

14. Units of measurement shall be recorded as SI units, as specified in the AMA Manual of Style, except for angular displacement, which should be measured in degrees rather than radians. Examples include mass in kilograms (kg), height in centimeters (cm), velocity in meters per second (m/s) or (m/s$^2$), angular velocity in degrees per second (°/s$^2$), force in Newtons (N), and complex rates (mL/kg per minute).

15. Titles should be brief within descriptive limits (a 16-word maximum is recommended). If a disability is the focus of the article, the name of the disability should be included in the title. If a technique is the principal reason for the report, it should be in the title. Often both should appear. Often both should appear.

16. The title page should also include the name, title, and affiliation of each author, and the name, address, phone number, fax number, and E-mail address of the author to whom correspondence is to be directed.

17. A structured abstract is on no other than 250 words must accompany all manuscripts. Type the complete title (but not the authors' names) at the top, skip 2 lines, and begin the abstract. In the title for the Journal (1) of article.

18. Begin the text of the manuscript with an introductory paragraph or two in which the purpose hypothesis of the article is clearly stated and developed. Tell why the study needed to be done or the article written and end with a statement of the problem or controversy. Highlights of the most prominent works as related to your subject are often appropriate for the introduction, but a detailed review of the literature should be reserved for the discussion section. In a 1- to 2-paragraph review of the literature, identify and develop the magnitude and significance of the controversy, pointing out differences among others' results, conclusions, and/or opinions. The introduction is not the place for great detail; state the facts in brief specific statements without excessive detail. The detail belongs in the discussion. Also, an overview of the manuscript is part of the abstract, not the introduction. Writing should be in the active voice (for example, instead of "Subjects were selected...", use "We selected...") and in the first person (for example, instead of "The results of this study showed...", use "Our results showed...").

19. The body or main part of the manuscript varies according to the type of article (example: research article). It should include a discussion section in which the importance of the material presented is addressed and related to other pertinent literature. Liberal use of headings and subheadings, charts, graphs, and figures is recommended.

a. The body of an Original Research article consists of a methods section, a presentation of the results, and a discussion of the results. The methods section should contain sufficient detail concerning the methods, procedures, and apparatus employed so that others can reproduce the results. The results should be summarized using descriptive and inferential statistics and a few well-planned and carefully constructed illustrations.

b. The body of a Literature Review article should be organized into subsections in which the review of others is presented, summarized, and referenced. Each subsection should have a heading and brief summary, possibly one sentence. Sections must be arranged to intensively focus on the problem or question posed in the introduction.

c. The body of a Case Report should include the following: both medical data (age, sex, race, marital status, and occupation when relevant—but not name), chief
**Authors’ Guide**

complaint, history of present complaint (including symptoms), results of physical examination (example: "Physical findings relevant to the rehabilitation program were . . ."), medical history (surgery, laboratory results, examination, etc), diagnosis, treatment and clinical course (rehabilitation until and after return to competition), criteria for return to competition, and deviation from expectations (what makes this case unique).

d. The body of a Clinical Techniques article should include both the how and why of the technique: a step-by-step explanation of how to perform the technique, supplemented by photographs or illustrations, and an explanation of why the technique should be used. The discussion concerning the why of the technique should review similar techniques, point out how the new technique differs, and explain the advantages and disadvantages of the technique in comparison with other techniques.

Percentages should be accompanied by the numbers used to calculate them.

20. **Communications** articles, including official Position Statements and Policy Statements from the NATA Pronouncements Committee; technical notes on such topics as research design and statistics; and articles on other professional issues of interest to the readership are solicited by the Journal. An author who has a suggestion for such a paper is advised to contact the Editorial Office for instructions.

21. The manuscript should not have a separate summary section—the abstract serves as a summary. It is appropriate, however, to tie the article together with a summary paragraph or list of conclusions at the end of the discussion section.

22. References should be numbered consecutively, using superscripted arabic numerals, in the order in which they are cited in the text. References should be used liberally. It is unethical to present others’ ideas as your own. Also, use references so that readers who desire further information on the topic can benefit from your scholarship.

23. References to articles or books, published or accepted for publication, or to papers presented at professional meetings are listed in numerical order at the end of the manuscript. Journal title abbreviations conform to *Index Medicus* style. Examples of references are illustrated below. See the *AMA Manual of Style* for other examples.

**Journals:**


**Books:**


**Presentations:**


**Internet Sources:**


24. **Table Style:** 1) Title is bold; body and column headings are roman type; 2) units are set above rules in parentheses; 3) numbers are aligned in columns by decimal; 4) footnotes are indicated by symbols (order of symbols: *, †, ‖, §, ¶); 5) capitalize the first letter of each major word in titles; for each column or row entry, capitalize the first word only. See a current issue of the *Journal* for examples.

25. All black and white line art should be submitted in camera-ready form. Line art should be of good quality; should be clearly presented on white paper with black ink, sans serif typeface, and no box; and should be printed on a laser printer—no dot matrix. Figures that require reduction for publication must remain readable at their final size (either 1 column or 2 columns wide). Photographs should be glossy black and white prints. Do not use paper clips, write on photographs, or attach photographs to sheets of paper. On the reverse of each figure attach a write-on label with the figure number, name of the author, and an arrow indicating the top. (Note: Prepare the label before affixing it to the figure.) Authors must submit original of each figure and 5 copies for review.

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Jack Kaeufer with two friends, John Norwig and Lindsy McLean.

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