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Clinical Education in Athletic Training: Behind the Times and Threatening the Future

Craig R. Denegar, PhD, ATC, PT

Certified athletic trainers are educated to care for physically active persons. In previous decades, most athletic trainers limited their professional activities to caring for high school, college, and professional athletes. However, today many other physically active people also benefit from the expertise of a certified athletic trainer in sports medicine centers, which is where most athletic trainers currently entering the job market are finding employment.

Practice in settings outside of the traditional athletic training room continues to grow and evolve on many fronts, but challenges remain—some political, some legal, and some educational. As an athletic training educator and certified athletic trainer/licensed physical therapist working in a sports medicine center, I have special concerns regarding the hands-on, practical clinical education of athletic training students.

The clinical education of athletic training students has traditionally been through practicum experiences in the athletic training rooms of the institutions that sponsor curriculum programs or through internship experiences in college settings. Students often gain little experience outside of the traditional athletic training room.

In this era of education reform, it is time to reassess clinical education. The Education Task Force has done a remarkable job of leading reform in athletic training education. I applaud their efforts and look forward to programs to improve clinical instruction. However, more must be done to develop clinical education in settings where athletic trainers entering the job market are practicing most, the sports medicine centers and high schools. Over the past 4 years, 80% of certified athletic trainers from undergraduate programs and 65% from graduate programs who were hired into athletic training positions were hired by sports medicine centers or high schools. I have yet to meet a certified athletic trainer whose pre-NATA certification clinical education was completed primarily in a sports medicine center or high school.

Why is change in order? Are the sports medicine center and junior and senior high school settings really different? While physically active children and older athletes can benefit from the services of a certified athletic trainer, they have different needs and present with different problems than collegiate or professional athletes. The physical, social, and emotional differences between these populations should be addressed as part of the academic preparation of future athletic trainers. It is the practical experience with different populations that is most often lacking. Students should gain experience with a cross section of physically active people as part of their education.

A physically active patient who receives a referral for six visits to the sports medicine center needs a different plan of care than the student-athlete who can come to the athletic training room once or twice daily. The former patients usually cannot devote as much time to their recovery as the latter and must do more on their own. Instruction and patient education are more critical to successful outcomes. In short, the athletic trainer must do more in the limited time available to work with the patient. Thus, students should work in a managed care setting as part of their education.

But change will not be easy. Confined to the athletic training room, student athletic trainers have become the labor force for, and primary providers of, athletic training services in colleges and universities. No other health care or medical profession delegates as much responsibility for patient care to students in training. The long-standing reliance on the inexpensive or free labor of student athletic trainers is detrimental to both the education of the students and the growth of the profession. If the physically active are to be cared for appropriately, if our students are to be educated adequately, and if the profession is to continue to grow, certified athletic trainers must be the primary providers of athletic training services.

New models of clinical education must be developed. Perhaps a residency model similar to that of medical and physical therapy education is needed. The solution will come from the creative efforts of program directors, practicing certified athletic trainers, and the new Education Council. The charge is clear. We, as a profession, must provide well-structured and well-supervised clinical education in settings in which new graduates will work. Failing to do so would be a disservice to both student athletic trainers and the physically active population consuming athletic training services.

Editor’s Note: Craig Denegar is an associate editor of the Journal of Athletic Training.
The Effects of Selected Ankle Appliances on Postural Control

Stephen J. Kinzey, PhD; Christopher D. Ingersoll, PhD, ATC; Kenneth L. Knight, PhD, ATC

Objective: Although ankle braces supposedly protect the ankle by providing mechanical support of the joint and enhancing proprioceptive input, their proprioceptive effects are unclear. Measuring the center of pressure during posture provides a reasonably well-controlled evaluation of proprioceptive input at the ankle. We, therefore, compared the changes in the center of pressure resulting from wearing ankle braces and wearing no brace (control).

Design and Setting: Center-of-pressure variables were measured during a one-legged modified Romberg test with six variations. The six test conditions systematically altered the three sensory modalities that control posture: visual input, vestibular input, and proprioceptive input. Subjects performed three 16-second trials of each Romberg variation for each brace condition.

Subjects: Twenty-four male volunteers (age = 18 to 26 yr) with no history of ankle injuries in the past 5 years and no difficulty with balance.

Measurements: Center of pressure, transmitted through the bottom of the foot, was monitored during each trial and transformed into total distance traveled, anterior-posterior (AP) position, and medial-lateral (ML) position.

Results: Average AP and ML center-of-pressure positions were increased only during brace wearing when all sensory modalities were functioning normally (control condition). Total center-of-pressure distance was the same for all three brace conditions.

Conclusions: Our results do not support or refute the concept that bracing enhances proprioception. The fact that subjects relocated their center of pressure only during the control condition is perplexing. If braces were to enhance proprioception, one would expect to see lower average ML and average AP center-of-pressure values when comparing the braced with the unbraced conditions. Alternatively, the relocalized position may represent a more stable position resulting from enhanced proprioception.

Key Words: ankle braces, balance, center of pressure, proprioception

Ankle injuries are among the most frequent injuries in athletes.1-3 Eighty-five percent of the ankle injuries are acute sprains, and an equally high proportion of these injuries involve the lateral ligamentous structures of the ankle. Although basketball, football, and gymnastics participants incur the greatest number of ankle injuries, virtually no sport is spared.2

Strategies for restricting the motions of the ankle joint for prophylactic purposes have been practiced for at least a century.4 The decrease in the occurrence of ankle injuries when using some type of ankle support is significant.5-9 However, strong debate exists about what type of support should be used.10-12 In addition to shoes, there are three basic ways to support an ankle: taping, ready-made lace-up stabilizers, and semirigid orthoses.7

How a brace provides protection is also becoming a debated subject. Research6,13 suggests that the mechanical support offered by tape diminishes with activity. Furthermore, after simulated activity, both tape and ready-made lace-up stabilizers provide the same amount of mechanical support.11 Firer14 suggested that tape might provide protection by increasing proprioception.

Previous researchers have not investigated the effect that ready-made stabilizers have on ankle joint proprioception. A semirigid orthosis does increase stability in an injured ankle.15 This increased stability is thought to represent an increase in proprioception. Nevertheless, the greatest amount of research focus thus far has been on the mechanical support offered by these devices.

Proprioceptive input is one of the three primary forms of sensory input that control posture.16 Those with decreased postural control are more susceptible to ankle injury than those with greater postural control.17 Stabilometry, a method of balance testing on a force plate, is a way to objectively measure and quantify postural control.15,18

Freeman et al19 suggested that the proprioception of those with ankle injuries is less than those without ankle injuries. Coordination training aimed at increasing proprioception decreases postural sway and the chance of injury.18 If ankle orthoses increase postural control, we need to learn more about their effectiveness in preventing injuries. With a modified Romberg test,20 using a one-legged stance,21 we attempted to distinguish the effects of ankle bracing on selected postural control variables: the position of the center of pressure in the anterior-posterior (AP) direction, the position of the center of pressure in the medial-lateral (ML) direction, and the total path of the center of pressure.

Stephen J. Kinzey is an assistant professor in the Department of Exercise Science and Leisure Management at the University of Mississippi, University, MS 38677. Christopher D. Ingersoll is an associate professor in, and chair of, the Athletic Training Department at Indiana State University, Terre Haute, IN. Kenneth L. Knight is a professor in the Department of Physical Education at Brigham Young University, Provo, UT.
METHODS

We compared the changes in the center of pressure resulting from wearing ankle braces and wearing no brace (control). The ankle braces used were the Active Ankle Trainer (AAT; Active Ankle Systems, Inc, Louisville, KY); the AirCast Sport Stirrup, (AC; AirCast, Summit, NJ); and the McDavid A-101 (McDavid; McDavid Knee Guard, Inc, Chicago, IL). The experimental design was a 6 x 4 factorial with repeated measures on both factors. The dependent measures were the three center-of-pressure measures: mean AP position, mean ML position, and the total path of the center of pressure. There were two independent variables: brace condition (shoe; shoe + AAT; shoe + AC; and shoe + McDavid) and bracing order. Romberg test conditions served as control variables (eyes open, eyes closed and blindfolded, visual-conflict dome, eyes open while standing on foam, eyes closed and blindfolded while standing on foam, and visual-conflict dome while standing on foam). High-density wheelchair padding (10.2 cm thick) was used for the foam. The visual-conflict dome was a Japanese lantern that had vertical lines painted on the inside. Testing order for each subject was established using a balanced latin square, which distributed the influence of extraneous variables such as fatigue.

Subjects

Twenty-four male volunteers, between the ages of 18 and 26 years (mean age = 22.7 yr), weighing between 59.02 and 111.23 kg (mean weight = 82.6 kg), having a shoe size between 9 and 13 USA, and all right-leg dominant, served as subjects. Each subject signed an informed consent form after the purpose of the study was explained. The study was approved by the Institutional Review Board at Indiana State University.

As determined by a questionnaire, the subjects had incurred no ankle trauma within the last 5 years and were free of any trouble with vestibular control or peripheral nerve control, any head injury causing unconsciousness, and any physical condition that causes difficulty with balance. The subjects were then asked to complete an orientation session that included fitting each brace and performing trials while blindfolded and standing on 10.2-cm-thick wheelchair seat foam. Before the test, screening balance strategies were explained to each subject. If the subject was unable to perform three successful trials under this condition within ten attempts, he was dropped from the study.

Instrumentation

Force plates and the associated variables are a reliable measure of postural control. The kinetic equipment consisted of a Kistler piezoelectric force plate (Kistler Instrument Corporation, Amherst, NY), a platform interfaced via an analog-to-digital converter to an Ariel Performance Analysis System (Ariel Dynamics, Inc, San Diego, CA). Eight raw voltage signals were sampled at 10 Hz, amplified by the Kistler amplifier, and electronically processed by the Ariel Performance Analysis System into center-of-pressure values relative to the base of support. A custom software program calculated the mean AP and mean ML center-of-pressure positions (in cm) and the total length of the path traveled by the center of pressure (in cm) for each trial. The same software program then calculated the means over three trials for each brace and its respective test condition.

Protocol

Each subject provided his own 3/4-cut basketball shoes for the experiment. We assumed that all basketball shoes (no matter which brand or model) provide similar support. The right ankle of each subject was then fitted with the brace according to the manufacturer's specifications.

Each subject was required to perform three successful trials for each of the six test conditions. The test conditions were always administered as follows: eyes open and normal floor conditions; eyes closed and blindfolded and normal floor conditions; a visual-conflict dome and normal floor conditions; eyes open with subject standing on foam; eyes closed and blindfolded with subject standing on foam, and a visual-conflict dome with subject standing on foam. Subjects wore the visual-conflict dome over the head and face with the goal of providing a constant visual frame of reference. The testing required a total of 18 trials for each brace for a total of 72 trials per subject. Each trial required the subject to stand on the right leg, raise the other leg by flexing at the knee, and cross the arms over the chest. A trial was successful when the subject could stand for 16 seconds without using the other foot for any type of balance aid and without touching the ground. All subjects completed the total test procedure in 1.25 to 1.75 hours.

After being fitted with the brace, the subject stepped on the force platform and assumed the correct single-legged stance. Force-plate sampling was initiated after the subject was positioned properly on the force plate and maintained the position for 16.0 seconds. The subject then stepped off the force plate and rested for 30 seconds between trials within the same brace condition and 90 seconds between test conditions. During the fitting of subsequent braces, subjects were given an unlimited amount of rest time. All subjects elected to rest less than 5 minutes between bracing conditions and then to continue testing.

The kinetic data, measured by the Ariel Performance Analysis System during force-platform contact, consisted of x and y coordinates at intervals of 0.1 seconds. Positive coordinates indicated lateral and anterior directions and negative coordinates indicated medial and posterior directions. All measurements were made with respect to the center of the base of support.

Statistical Analysis

The three mean values of center of pressure (AP, ML, and the total path of the center of pressure) were analyzed using a multivariate analysis of variance (MANOVA) with repeated measures on brace and test conditions. Univariate F tests and
the Newman-Keuls test were used for post hoc analyses. The probability was set at \( p < .05 \) for all tests.

**RESULTS**

Positive and negative AP values indicate an anterior center-of-pressure position and a posterior center-of-pressure position, respectively (Table 1). Because the subject stood on the right foot, positive and negative ML values indicate a position to the right or left, respectively. When the average AP, average ML, and total center-of-pressure values were considered simultaneously, order of brace administration did not matter (F(3,69) = 2.14, \( p = .015 \)). Bracing caused an increase in the ML average center-of-pressure position (F(3,69) = 3.23, \( p = .03 \)) and an increase in the AP average center-of-pressure position (F(3,69) = 3.18, \( p = .03 \)), but total distance traveled by the center of pressure did not change (F(3,69) = 2.14, \( p = .10 \)). When the subjects had all sensory modalities available, they exhibited a more anterior (F(3,92) = 5.47, \( p < .001 \)) and lateral (F(3,92) = 5.39, \( p < .001 \)) average center-of-pressure position when wearing braces than when wearing no brace (control).

**DISCUSSION**

Initially, we expected that wearing a brace would improve proprioception, which would be manifested as a decrease in the movement of the center of pressure. We also expected that the Romberg test conditions would amplify these differences. However, wearing a brace caused the subject's average center of pressure to increase in both the anterior and lateral directions, without increasing the total path traveled during the control condition only.

At least three reasons may provide some explanation for the results. First, the braces force the subject's ankle into a dorsiflexed and everted position. This results in the subject's feeling as if he is falling forward, so to keep from falling, the invertors and plantar flexors contract concentrically, causing the center of pressure to travel more anteriorly and laterally. This concentric contraction is met with the resistance of the brace; therefore, the subject never overcorrects and is constantly fighting the feeling of falling forward by contracting the invertors and plantar flexors.

Second, the ankle braces force the subject into a position that requires the large plantar flexors and assisting invertors to control the position via eccentric contractions. This explanation contradicts the first because the subject is comfortable in the new position and uses eccentric muscle contractions to control the center-of-pressure movement.

The third and final explanation is that the brace provides a strong mechanical restriction that causes the subject to change the strategy used to control posture. Normal adult subjects prefer to control posture using the muscles that cross the ankle joint. This preference, referred to as the ankle strategy, allows subjects to respond to most low-level postural disturbances without much center-of-pressure displacement. However, if rapid changes in the center-of-pressure displacement are necessary, movement at the hip is often used to accomplish this task. Because it is much easier when using the hip strategy

<table>
<thead>
<tr>
<th>Condition/Type</th>
<th>Aircast</th>
<th>Active Ankle</th>
<th>McDavid</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eyes open</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total sway</td>
<td>78.55 ± 16.44</td>
<td>85.09 ± 17.87</td>
<td>77.85 ± 12.29</td>
<td>83.32 ± 24.51</td>
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<tr>
<td>AP sway</td>
<td>0.50 ± 0.44</td>
<td>0.45 ± 0.58</td>
<td>0.31 ± 0.55</td>
<td>-0.10 ± 0.71</td>
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<tr>
<td>ML sway</td>
<td>0.49 ± 0.45</td>
<td>0.44 ± 0.58</td>
<td>0.30 ± 0.55</td>
<td>-0.12 ± 0.71</td>
</tr>
<tr>
<td>Eyes closed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total sway</td>
<td>144.58 ± 33.47</td>
<td>156.91 ± 29.33</td>
<td>150.19 ± 30.52</td>
<td>156.09 ± 46.16</td>
</tr>
<tr>
<td>AP sway</td>
<td>0.38 ± 0.82</td>
<td>0.34 ± 0.87</td>
<td>0.08 ± 1.04</td>
<td>0.02 ± 0.75</td>
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<tr>
<td>ML sway</td>
<td>0.37 ± 0.82</td>
<td>0.33 ± 0.87</td>
<td>0.07 ± 1.04</td>
<td>0.01 ± 0.75</td>
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<tr>
<td>Visual-conflict dome</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total sway</td>
<td>145.00 ± 29.52</td>
<td>150.67 ± 35.55</td>
<td>145.63 ± 41.03</td>
<td>146.66 ± 44.51</td>
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<tr>
<td>AP sway</td>
<td>0.60 ± 0.93</td>
<td>0.47 ± 0.83</td>
<td>0.34 ± 0.92</td>
<td>0.02 ± 0.72</td>
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<tr>
<td>ML sway</td>
<td>0.60 ± 0.92</td>
<td>0.46 ± 0.83</td>
<td>0.33 ± 0.92</td>
<td>0.01 ± 0.72</td>
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<td>Foam</td>
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<tr>
<td>Total sway</td>
<td>94.59 ± 20.93</td>
<td>98.80 ± 19.90</td>
<td>89.40 ± 17.17</td>
<td>92.19 ± 19.33</td>
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<td>AP sway</td>
<td>1.23 ± 0.84</td>
<td>1.13 ± 0.91</td>
<td>1.30 ± 0.77</td>
<td>1.15 ± 0.72</td>
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<tr>
<td>ML sway</td>
<td>0.21 ± 0.84</td>
<td>0.12 ± 0.91</td>
<td>1.29 ± 0.77</td>
<td>1.14 ± 0.72</td>
</tr>
<tr>
<td>Eyes closed + foam</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Total sway</td>
<td>165.35 ± 34.86</td>
<td>167.25 ± 34.11</td>
<td>163.13 ± 32.99</td>
<td>167.56 ± 47.05</td>
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<tr>
<td>AP sway</td>
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<td>1.02 ± 0.92</td>
<td>1.37 ± 0.86</td>
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<td>1.01 ± 0.93</td>
<td>1.36 ± 0.86</td>
<td>1.21 ± 0.88</td>
</tr>
<tr>
<td>Visual-conflict dome + foam</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total sway</td>
<td>163.49 ± 41.59</td>
<td>164.49 ± 34.68</td>
<td>152.07 ± 29.54</td>
<td>150.84 ± 38.73</td>
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<tr>
<td>AP sway</td>
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<td>1.01 ± 0.92</td>
<td>1.48 ± 0.94</td>
<td>1.12 ± 1.10</td>
</tr>
<tr>
<td>ML sway</td>
<td>0.20 ± 0.94</td>
<td>1.00 ± 0.92</td>
<td>1.47 ± 0.94</td>
<td>1.10 ± 1.10</td>
</tr>
</tbody>
</table>

* Positive numbers indicate anterior or lateral (right) mean center-of-pressure values; negative numbers indicate posterior or medial (left) mean center-of-pressure values.
to control posture by flexing the trunk, the resulting position of the center of pressure is more anterior. Finally, when using this strategy while standing on one leg, it seems logical that subjects would orient their trunks over the support leg, causing the center of pressure to move laterally.

Proprioception, classically defined as the afferent information derived from muscles, tendons, joint capsules, and ligaments, may actually be changed by bracing. Proprioception is often measured using a joint position replication task. Using this method, Feurbach et al. found that ankle bracing has a positive effect on proprioception. Because proprioception is one of the three systems that control posture, measurement of postural control is another method used to evaluate proprioception at the ankle.

Bennell and Goldie have concluded that ankle bracing adversely affects the postural control of normal subjects. This may be true when the sensory systems (proprioceptive, visual, and vestibular) controlling posture are affected by the ankle brace alone. During the test conditions that confused or eliminated the visual and proprioceptive inputs, ankle bracing did not affect postural control. This finding suggests that the adverse effect on postural control attributed to ankle bracing is not strong enough to alter the integration of the systems controlling posture when the conditions are abnormal.

**CONCLUSIONS**

It is not known whether the change seen during this experiment is due to a change in muscle activity about the ankle joint or the mechanical properties of the braces. A study examining the muscular response to ankle bracing is warranted to provide more insight on this issue.

Ankle bracing affected postural control only when all other sensory modalities were unaffected. When the sensory modalities were challenged, no effect due to bracing was found. Therefore, the effect of bracing does not seem to interfere with the integration of the three sensory systems controlling posture.

Until further investigation is performed, the decision to use prophylactic bracing based upon its effects on proprioception may not be warranted.

Finally, an ankle brace may be a successful way to reduce injuries by providing a sufficient amount of mechanical restriction. We did not measure the amount of mechanical stability provided by the braces; therefore, no recommendation can be made on this basis.

**REFERENCES**

Conditioning Injuries Associated with Artificial Turf in Two Preseason Football Training Programs

Keith Gorse, MEd, ATC; Cheryl A. Mickey, MEd, ATC; Andrew Bierhals, MPH, ATC

Objective: To compare the occurrence of preseason football conditioning injuries in traditional and crossover conditioning programs over five preseasoons.

Design and Setting: The turf group performed all preseason conditioning by running or sprinting on artificial turf, and the turf and swim group alternated all preseason conditioning by running and sprinting on artificial turf or kickboard swimming.

Subjects: Subjects were 519 NCAA Division III physically active football players.

Measurements: Previous conditioning injuries, preseason conditioning injuries, missed practices, and missed conditioning sessions were recorded. Exact numbers and areas of injury for each year and each group were tabulated. A chi-square statistic compared the two groups and a logistic regression model was used to estimate the risk of becoming injured and the types of conditioning injuries experienced in the two groups.

Results: Prevalence of injury was significantly different in the two groups. In the turf group, 35% of subjects developed a conditioning injury; in the turf and swim group, 13% developed a conditioning injury ($\chi^2 = 33.16, p < .0001$). No significant difference in missed practices or missed conditioning sessions was found.

Conclusions: The turf and swim group experienced significantly fewer football preseason conditioning injuries than the turf group. The crossover effects of a running and swimming program may decrease the number of overuse injuries associated with repetitive running on artificial turf in traditional preseason conditioning programs.

Key Words: Omni turf, running, swimming, overuse injuries, crossover effect

Traditional preseason football conditioning consists of extensive, repetitive running and sprinting to train the cardiovascular and musculoskeletal systems. Under taken after practices on hard surfaces when the body is already fatigued, this training causes overuse injuries. Research on overuse injuries acquired during preseason camp is limited to one study, which did not report any significant trends.

According to Zemper, 20% of college football injuries for the 1986–1987 season consisted of strained muscles, tendinitis, bursitis, and stress fractures in a 2-year study of injury rates from a national sample of college football teams. Sprinting, running, and gradual onset accounted for 14% of the mechanisms of injury. Zemper concluded that, despite many exposures to contact, approximately 20% of the injuries occurred in the noncontact category (sprinting, running, no evidence of contact, overuse/gradual onset, and lifting weights) and that these injuries may be avoided with proper conditioning, stretching, and technique.

The certified athletic trainer’s primary objective in preseason practices is injury prevention. An easy method of injury prevention involves a sufficient amount of rest and recovery between practices, as well as a gradual progression of conditioning exercises. Taking advantage of a crossover effect, which decreases the amount of repetitive forces while continuing to condition the cardiovascular system, is another option for injury prevention but is not often utilized. Studies report that biking and swimming carry over the central cardiovascular effects for a running sport.

The number of overuse injuries and the type of conditioning performed after long practices on artificial turf concerned us. Therefore, the purpose of this study was to investigate the occurrence of preseason football conditioning and overuse injuries in traditional and crossover conditioning programs over the course of 5 years at an NCAA Division III college.

METHODS

Subjects

All physically active participants, 519 athletes (ht = 180 ± 5.1 cm, wt = 80.2 ± 27.5 kg) on the Carnegie Mellon University varsity football team from 1991–1995 served as subjects in this study. During the 1991 and 1992 preseasoons, all athletes participated in the turf group. During the 1993–1995 preseasoons, all athletes participated in the turf and swim group. We recorded class, height, weight, and previous injuries.

Conditioning Programs

The turf group practiced and conditioned on an artificial surface called Omni turf (All Pro Athletic Surfaces, Dallas,
The mechanism of an overuse injury is described as a “cascade to overload injuries” because the degree of overload placed upon the body and the degree of recovery before the next overload session become cyclical. Furthermore, this
cascade leads to muscular damage, which is primarily due to fatigue, muscle soreness, and the force of three to five times the athlete’s body weight on the legs when jogging, running, or sprinting on hard surfaces.3,10–12 Adversely stressing the connective tissue weakens structures over time and slows the ability to recover.2,3,12 Thus, stress fractures, stress syndromes, nonacute muscle strains, tendinitis, and bursitis are common overuse injuries in athletes who run and jump repeatedly.1,3,11

Literature is available regarding a wide variety of football injuries sustained on artificial turf versus grass surfaces.13–17 Other studies of football injuries focused on knee injuries16 and other common injuries.18,19 Studies20,21 concluded that synthetic surfaces lose shock absorption capabilities as they age. However, to our knowledge, no one has attempted to use the crossover effect to reduce preseason conditioning injuries. The artificial turf at Carnegie Mellon University was new in the fall of 1990 and approximately one year old at the start of this study. Since the crossover effect decreases the amount of repetitive forces while cardiovascular conditioning is continued,5,7,8 we decided to apply it to our preseason program.

Table 2. Turf and Swim Group Preseason Conditioning Program*

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
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<td>0</td>
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<tr>
<td>Mild strain</td>
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<td>6</td>
<td>12</td>
<td>2</td>
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<td>1</td>
<td>6</td>
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<td>Stress fracture</td>
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<td>6</td>
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<tr>
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<td>0</td>
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<td>1</td>
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<td>0</td>
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<td>Mild tendinitis</td>
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<td>Muscle spasm</td>
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<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
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<tr>
<td>Shin</td>
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<tr>
<td>Medial tibial stress syndrome</td>
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<td>7</td>
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<td>2</td>
<td>3</td>
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<tr>
<td>Patellar tendinitis</td>
<td>3</td>
<td>4</td>
<td>7</td>
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<tr>
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<td>1</td>
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<td>0</td>
<td>0</td>
<td>1</td>
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<td>2</td>
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<td>Quadriceps</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>7</td>
<td>13</td>
<td>3</td>
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<tr>
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<td>11</td>
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<td>8</td>
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<td>36</td>
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<td>59</td>
<td>15</td>
<td>13</td>
<td>14</td>
<td>42</td>
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Table 3. Frequency of Preseason Conditioning Injuries

<table>
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<tr>
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<tr>
<td>OFFENSE</td>
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<td>swim</td>
<td>sprint</td>
<td>swim</td>
<td>swim</td>
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<tr>
<td>OL</td>
<td></td>
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<tr>
<td>TE</td>
<td></td>
<td>swim</td>
<td>WR</td>
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<td>WR</td>
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<td>QB</td>
<td>WR</td>
<td>swim</td>
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</tr>
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<td>WR</td>
<td>swim</td>
<td></td>
<td></td>
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<tr>
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<td>WR</td>
<td>swim</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>DL</td>
<td>swim</td>
<td>WR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LB</td>
<td>swim</td>
<td>WR</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

* The 4-day format continued throughout the 2-week camp. Turf and swim group conditioning description: WR, sprint, and run were as described for the turf group. Swim: 12 to 14 lengths (25 yards each) of kickboard kicking as fast as possible (pool yards specifically related to sprint yards on field); each group of six had 1 minute to complete a length and received a 30-second rest, which did not include walking to the start; those who could not swim conditioned on Stair Masters (Stair Master Co, Newburgh, NY) or Air Dyne bikes (Schwinn Co, Chicago, IL); a lifeguard was on duty at all swimming sessions. After all conditioning sessions, athletes performed a 5-minute cool-down and stretching routine. SE = split end; WR = weight room.
Table 4. Unstandardized Regression Coefficients and Relative Risks of Predictors of Injury*

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Group</th>
<th>Class</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injury resulting in missed practices</td>
<td>β</td>
<td>SE</td>
<td>RR</td>
</tr>
<tr>
<td>Foot</td>
<td>0.13</td>
<td>0.44</td>
<td>1.14</td>
</tr>
<tr>
<td>Ankle</td>
<td>-0.88</td>
<td>1.12</td>
<td>0.41</td>
</tr>
<tr>
<td>Shin</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Quadriceps</td>
<td>0.46</td>
<td>0.83</td>
<td>1.58</td>
</tr>
<tr>
<td>Hamstrings</td>
<td>0.52</td>
<td>1.01</td>
<td>1.68</td>
</tr>
</tbody>
</table>

* All models controlled for height, weight, previous injury, and position; β = unstandardized regression coefficient; SE = standard error; RR = relative risk; df = degrees of freedom; b = insufficient number of events to estimate.

† p < .05.

The primary difference between the groups was in the total number of injuries. In the turf group, 35% (71/205) were injured, while only 13% (42/314) of the turf and swim group were injured. If we include one additional year of data (potential injured players), the turf and swim group experienced a decline in injury rate of more than half when compared with the turf group. To determine the necessary sample size for detection of an existing difference, we calculated the power to be 0.99 at an alpha level of 0.05, indicating a 99% chance of detecting a difference if it did, in fact, exist. Thus, the sample size was sufficient to detect a difference between the two groups.

The decreased amount of running on the artificial surface resulted in the turf and swim group experiencing significantly fewer injuries than the turf group. The fact that the groups showed no significant differences in the number of practices missed allows for interesting speculation. We believe that controlling for previous history of injury possibly skewed the results because the same injured athletes may have participated in both groups. We also speculate that this finding was due to the possibility of more serious injuries occurring in the turf group, in combination with the different numbers of athletes in the groups. The turf group had 205 athletes and possibly more serious injuries, as opposed to the turf and swim group with 314 athletes and possibly fewer serious injuries.

The turf group experienced significantly more quadriceps and hamstrings conditioning injuries than the turf and swim group. Some of the injuries consisted of minor strains and sprains (Tables 3 and 4), which were classified as overuse injuries from running on artificial turf. These athletes suffered from strain/sprain pain only during the conditioning sessions and typically had no problems during practices. Only a few of the injuries were severe enough to remove an athlete from 1 to 3 days of practice. As the results suggested, we observed that most of these conditioning injuries occurred to underclassmen. We speculated that this was primarily due to the athletes’ unfamiliarity with the turf, as well as the high volume of conditioning sessions and practices performed on the turf.

The subjective opinion of the athletes regarding the turf and swim conditioning program was positive because they experienced less soreness and “wear and tear” on their lower extremities without sacrificing cardiovascular conditioning, as well as a break from the August heat. Most players enjoyed the new program because it allowed recovery time and added novelty. The coaches believed in traditional methods of conditioning but were completely satisfied with the program because of the decreased number of injuries; also the players seemed to work harder and were mentally fresher during preseason practices. More space in the weight room during a single conditioning session was an additional surprise benefit of the new program. The athletic training staff supported the new conditioning program, not only for the decline in injuries but also because it increased the available time for various other athletic training duties.

Athletic trainers who encounter similar conditioning and overuse injuries during football preseason may use this study to convince coaches who believe in traditional methods of conditioning that alternating running and swimming may benefit all parties. Serving as a model, this study may also assist those who are attempting to change their current conditioning program for the benefit of athletes. Finally, we hope this study will add to the limited research involving preseason football conditioning injuries associated with artificial turf.

CONCLUSION

The turf and swim group experienced significantly fewer football preseason conditioning injuries and significantly fewer quadriceps and hamstrings conditioning injuries than the turf group. Due to the novelty of the artificial turf, there was a higher risk of injury for each lower class as compared with the next higher class. In terms of the rate of missed practices resulting from injuries, there were no significant differences between the two groups.

A running and swimming program using the crossover effect may be the program of choice over traditional running during football preseason conditioning to decrease the number of overuse injuries associated with repetitive conditioning on artificial turf. To decrease the number of conditioning and overuse injuries in traditional football preseason programs, further research on conditioning alternatives is needed.

REFERENCES


Effects of Viral Upper Respiratory Illness on Running Gait

Thomas G. Weidner, PhD, ATC; Gale Gehlsen, PhD; Terry Schurr, PhD; Gregory B. Dwyer, PhD

Objective: To determine the kinematic changes that may occur during running with a cold of known etiology and to assess the impact of select accompanying upper respiratory illness symptoms.

Design and Setting: In this nonrandomized study, subjects with colds and subjects without colds were videotaped while exercising on a treadmill. Three weeks later, the trials were repeated.

Subjects: Eighteen young adults (5 females, 13 males; mean age = 20.4 ± 2.4 yr) with naturally acquired moderate to severe (total symptom score) colds were screened and selected for inclusion in the illness group (ILL). A control group (CRL) of 20 subjects (2 females, 18 males) was also examined. Virologic confirmation of specific viral infections, unprecedented in this line of research, revealed that 12 of the 18 subjects in the ILL group (67%) were infected with human rhinoviruses. None of the subjects had a fever.

Measurements: All subjects exercised on a treadmill for 5 minutes at a heart rate of approximately 85% of their age-predicted maximum. Both groups were videotaped kinematically during two running trials 3 weeks apart. All subjects in the ILL group displayed upper respiratory illness symptoms for the first running trial and were asymptomatic by the second.

Results: We identified significant differences in mean changes between the ILL and CRL group stride lengths (p < .01), stride frequencies (p < .05), and ankle maximum angle displacement (p < .01). Mean changes in stride length (p < .03) and in stride frequency (p < .04) were larger for ILL subjects who felt feverish.

Conclusions: Alterations in running gait during a rhinovirus-caused upper respiratory illness, and possibly increases in injury incidence, may be associated with feeling feverish. Gait alterations may increase injury incidence or decrease athletic performance, or both.

Key Words: kinematics, stride length, stride frequency, human rhinovirus

Viruses are the most common infectious agents affecting humans. Some authors contend that viral upper respiratory illness (URI) causes more frequent acute disability among athletes than all other diseases combined. Disease patterns among Summer and Winter Olympic athletes are remarkably consistent, with respiratory infections heading the list, followed by gastrointestinal disorders and skin infections. In the 1992 Winter Olympics, some of the world’s greatest athletes were unable to compete or did not perform strongly because of a URI, and several athletes were reportedly unable to compete in the 1988 Summer Olympic games due to infectious illness. The average adult has from one to six colds each year, with human rhinoviruses (HRV) accounting for 40% to 50% of these infections. Rhinovirus infections are most prevalent in the fall and spring months. Athletes and exercise enthusiasts, however, commonly continue to participate in competitive and recreational sports during URIs. Unfortunately, little information related to kinematic changes that may occur during exercise with a rhinovirus-caused URI is available.

Detectable abnormalities in pulmonary functional capacity, such as forced expiratory volume and forced vital capacity, are known to occur during infectious illness, including URI. The authors of these studies concluded that weakness in the inspiratory muscles may contribute to breathlessness during exertion. They added that this weakness may explain why athletic performance tends to be reduced during viral illness, suggesting that perhaps strenuous exercise should be avoided during such infections. Also, URI caused by rhinoviruses can produce transient peripheral airway abnormalities.

Alterations in muscle ultrastructure and enzyme activity have been identified during viral and mycoplasma infections. Roberts suggested that a decrease in muscle glycogen utilization occurs during viral illness, while Ardawi and Newsholme reported that a decrease in muscle glutamine release occurs with URI during prolonged physical training. Since viral infections can affect the heart, the lungs, and the muscles, it is important to quantify the effect that a URI may have on kinematic performance during exercise or labor. It behooves physically active individuals and those who provide health care and safety recommendations for them to realize that changes in kinematic performance may alter the mechanical and functional aspects of performance during exercise or labor and possibly increase the risk for musculoskeletal injury.

The purposes of this study were twofold. The main purpose was to examine the effects of a URI of known etiology on selected kinematic variables during treadmill running. A secondary purpose was to investigate if the effects of a URI on the kinematic variables were different for individuals reporting symptoms often associated with URI than for individuals not reporting the symptoms. The symptoms looked at in this study were feverishness, laryngitis, and aching muscles or joints.

Thomas G. Weidner, Gale Gehlsen, and Gregory B. Dwyer are affiliated with the School of Physical Education, and Terry Schurr is affiliated with University Computing Services, at Ball State University, Muncie, IN 47306.

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METHODS

Physically active subjects with naturally acquired episodes of URI were recruited through the university student health center and through written announcements. This study could not be restricted to a homogenous group (eg, elite runners), because such a study, though interesting, would have required extending the period of the study indefinitely while waiting for a select group of individuals to become ill with a cold. Eighteen experimental subjects (5 females, 13 males) were screened and selected for inclusion in the illness (ILL) group for this study. Subjects met the following criteria: All were currently suffering (within 1 to 2 days of onset) from a moderate or severe upper respiratory illness. None reported symptoms of nausea, vomiting, or diarrhea. All were 18 to 28 years of age, moderate exercisers (five 30-minute aerobic exercise sessions per week), and nonsmokers with no history of alcohol or drug abuse. Subjects were not currently using medications (except oral contraceptives) or suffering from hypertension, heart murmur, hepatitis, kidney disease, hay fever or allergies, asthma, lung disease, chronic respiratory illnesses, or diabetes. Subjects' URI episodes were confirmed through laboratory diagnosis.1,4,11,13

All subjects agreed to refrain from self-treating their colds (eg, no over-the-counter medications) during the initial 3 days of evaluation of the URI. A control group (CRL) was also assembled, consisting of 20 subjects (2 females, 18 males) who met the selection criteria and guidelines except for the presence of URI. All subjects signed an informed consent form approved by the Ball State University Institutional Review Board, and those subjects with a URI who completed the study received modest remuneration for their efforts. Table 1 summarizes the physical characteristics of the study participants in each group.

Clinical and Etiologic Evaluation of URI

A symptom score questionnaire, used by Dick et al14 for more than 20 years (Figure), assisted the physician in selecting subjects with moderate or severe colds. Nasal wash and blood specimens were taken from the subjects at the Ball State University Laboratories and were transported on ice by a delivery service to the Virus Section of the Wisconsin State Laboratory of Hygiene, usually arriving the day after collection. Viral cultures were performed as described in previous literature.14,15 Human rhinoviruses were identified by cytopathic effect, cell spectrum, and acid lability, and they were serotyped by neutralization tests that used intersecting pools of monospecific antibody to 87 of the more than 100 known HRV types.16 Pool HRV identification was confirmed by virus neutralization to high titer with serial dilutions of the indicated serotype. HRV serologic diagnosis (neutralization test) was performed on subjects' acute and convalescent sera obtained at least 3 weeks apart in a mycoplasma-free strain of Ohio State HeLa cells; virus challenge was 20 to 50 TCID50 (tissue culture 50% infective dose).

Heart Rate

Heart rates were measured using a CM-5 electrocardiogram (ECG) lead setup with a Hewlett-Packard ECG Unit (model #1500B, Hewlett-Packard, Waltham, MA). All exercise sessions were conducted on a Quinton motorized treadmill (Quinton Instruments, Seattle, WA).

Kinematic Video Recording

Subjects ran on a treadmill, and each one's exercise gait was monitored using a stationary digital shuttered video camera. The camera was located perpendicular to the sagittal plane of movement at a distance of 10 meters. A wide-angle lens

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Table 1. Physical Characteristics of the ILL and CRL Group Subjects (Means and Standard Deviations)

<table>
<thead>
<tr>
<th>Group</th>
<th>Height (m)</th>
<th>Weight (kg)</th>
<th>Age (yr)</th>
<th>Heart Rate (bpm)</th>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Trial 1</td>
<td>Trial 2</td>
</tr>
<tr>
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<td>1.74</td>
<td>69.7</td>
<td>20.4</td>
<td>166.0</td>
</tr>
<tr>
<td></td>
<td>(0.09)*</td>
<td>(11.6)</td>
<td>(2.4)</td>
<td>(13.2)</td>
</tr>
<tr>
<td></td>
<td>1.82</td>
<td>71.2</td>
<td>18.4</td>
<td>167.0</td>
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<tr>
<td></td>
<td>(0.10)</td>
<td>(12.8)</td>
<td>(4.2)</td>
<td>(8.2)</td>
</tr>
</tbody>
</table>

* Standard deviations are shown in parentheses.
allowed the entire movement to be viewed. A 386 computer
with a BCE-associated video control board was interfaced with a
video playback system monitor and a video cassette recorder.
A computer program (Peak Performance, Peak Performance
Technologies, Inc, Englewood, CO) was used to encode
sequentially every field on the tape. The time between any two
given frames was determined with an accuracy of 1/60 second.
To facilitate the location of segmental endpoints during the
film analysis, contrasting markers were placed on the joint
centers of each subject. Black and white plastic tape was
placed on the following anatomical landmarks: 5th metatarsal,
lateral malleolus, lateral condyle of the knee, and greater
trochanter. An accelerometer was used to determine the num­
ber of running foot impacts per second (stride frequency).
Stride length (SL) was calculated from impact frequency (IF)
and treadmill velocity (V) parameters (SL = V/IF).

Experimental Design

Each ILL subject reported to the biomechanics laboratory
for testing. The physician evaluated each subject’s URI symp­
tom severity inventory17 and health history. The following
measurements were taken for each subject: height, weight,
resting heart rate, blood pressure, and oral temperature. In
addition, a nasal wash was performed to isolate rhinoviruses,
and blood was drawn from each subject to determine antibody
titters against rhinoviruses. CM-5 ECG electrodes for the heart
rate determination were then placed on each subject. The
subjects were familiarized with the treadmill and began walk­
ing at 2 mph. Treadmill work loads were adjusted by 0.5 mph
every minute to achieve a heart rate response of approxi­
mately 85% of age-predicted maximal heart rate (PMHR). The ECG
was recorded every 30 seconds of exercise; heart rates were
measured from these ECGs. The treadmill speed at 85% of
PMHR was recorded and the subject ran at that speed for 5
minutes. During the 5-minute run at 85% of PMHR, the
subjects were videotaped.

The ILL subjects reported to the laboratory at 7:30 AM the
two mornings after the initial treadmill run for further cold
evaluations (ie, nasal wash and URI symptom inventory
updates). The exercise bouts and videotaping were repeated 3
weeks later when the subjects were asymptomatic and pre­
sumed to be healthy. The control group completed identical
exercise bouts and accompanying videotaping for two trials 3
weeks apart.

Data Analysis

A multivariate analysis of variance (MANOVA) with re­
peated measures on the trial condition was used to determine
the effect of URI on the kinematic variables. Two factors were
specified in the MANOVA: an experimental/control between­
subjects grouping factor and a within-subjects (ie, repeated­
measures) trial factor. Trial conditions for ILL subjects were
having and not having URI symptoms. Trial conditions for
CRL subjects were two replications in the absence of URI
symptoms. Results for the group-by-trial interaction were the
foci of this study, that is, differences in mean values of the two
groups under the two trial conditions.

Two separate MANOVA procedures were performed: one
for stride length and stride frequency under the two trial
conditions (values for the two variables under each condition)
and one for the maximum and minimum ankle, knee, and hip
joint angles under the two conditions (for a total of six
variables under each condition). Bonferroni procedures were
used to adjust the required R values for the group-by-treatment
analyses of the separate variables in order to maintain an
overall alpha level of 0.05. The p values were evenly divided
between the two MANOVAs (p = .025), resulting in required
Bonferroni univariate p values of .0125 for the stride data and
.0042 for the joint angle data. Complete data for 18 experi­
mental subjects were available for the stride frequency and
length analyses. Complete joint angle data were available for
13 ILL subjects. The CRL group provided complete data for all
20 subjects in both analyses.

Separate ANOVAs with repeated measures on the trial
condition were used to determine the effects that the URI
feverish feeling, laryngitis, and aching muscles or joints
symptoms had on the stride length and stride frequency
kinematic variables. Only the experimental group was used in
these analyses. Two factors were specified in the ANOVA: the
presence or absence of a symptom during the illness trial
(between-subjects grouping factor) and a within-subjects (re­
peted-measures) trial factor. Results for the group-by-trial
interaction were the foci of the analyses, that is, differences in
mean values of the kinematic variables for the two groups
under the two trial conditions.

RESULTS

Episodes of URI

Rhinoviruses were cultivated from 6 of the 18 ILL subjects
(Table 2). Because there are more than 100 individual HRV
strains, it was not possible economically to thoroughly type the
isolates. Using 87 strain-specific sera, three isolates were
identified as HRV15, HRV23, and HRV43, and three were
untypeable. Serodiagnosis was performed with the isolates
against a substantial segment of the paired (acute and conva­
lescent) sera, and this yielded an additional six diagnoses for a
total of 12 of the 18, a very high diagnosis rate (67%) despite
the necessary diagnostic economies.18,19

Stride Length and Stride Frequency

The MANOVA yielded an F(2,38) of 4.55 for the interactive
effect of group by trial on the stride length and frequency
variables that had a p = .017. The p value was smaller than the
required Bonferroni p value for both stride frequency and stride
length. The mean differences for the groups under the two trials
and the univariate ANOVA statistics are shown in Table 3.

The mean difference in stride length between the illness and
control trials for the ILL group was −0.08 m. In contrast, the
mean difference in stride length for the two trials of the CRL
group (illness absent for both test periods) was 0.01 m. These differences for the two trials indicated that subjects had longer strides when they had URIs than when they did not have URIs ($F(1,19) = 7.32, p < .01$).

The mean difference in stride frequency between the illness and control trials for the ILL group was 0.18 Hz. In contrast, the mean difference in stride frequency for the two trials of the CRL group was $-0.03$ Hz. These differences for the two trials indicated that stride frequency was less when the subjects had URIs than when they did not have URIs ($F(1,39) = 5.12, p < .03$). Concomitantly, the mean value for the stride frequency of subjects reporting feverishness was 0.34 Hz less under the illness condition than under the control condition, while the mean difference under the two conditions was only 0.04 m for subjects not reporting feverishness ($F(1,19) = 5.12, p < .03$). The results of this study indicated that individuals suffering from a URI use longer and slower strides than do individuals not suffering from a URI. Additionally, when subjects in the ILL group recovered from their URIs, their gait was identical to that of well controls. Some caution should be used, however, in interpreting these results. It would be of interest to determine if a group of experienced runners who have had extensive practice on the treadmill before acquiring a URI would yield similar results.

Weidner22 studied the reporting behaviors, activity levels, and perceived physical performance levels of 290 intercollegiate athletes (165 males, 125 females) with URIs. Respondents rated the severity of 14 cold symptoms and indicated to whom they reported their cold and within how many days. Respondents were asked to indicate whether they self-treated their illness, whether they missed a practice or game due to the cold, and whether the cold affected their performance. Of the respondents, 67% of subjects who had a URI reported a change in their physical activity level, while 54% reported a change in their perception of physical performance. The results of this study indicated that individuals suffering from a URI use longer and slower strides than do individuals not suffering from a URI. Additionally, when subjects in the ILL group recovered from their URIs, their gait was identical to that of well controls. Some caution should be used, however, in interpreting these results. It would be of interest to determine if a group of experienced runners who have had extensive practice on the treadmill before acquiring a URI would yield similar results.

### Illness Group Symptoms and Stride Length and Frequency

Significant differences in the stride length and stride frequency means for the ILL group under the illness and control conditions were found for only the feverishness symptom. The mean value for the stride length of subjects reporting feverishness was 0.16 m higher under the illness condition than under the control condition, while the mean difference under the two conditions was only 0.04 m for subjects not reporting feverishness ($F(1,19) = 5.12, p < .03$). The results of this study indicated that individuals suffering from a URI use longer and slower strides than do individuals not suffering from a URI. Additionally, when subjects in the ILL group recovered from their URIs, their gait was identical to that of well controls. Some caution should be used, however, in interpreting these results. It would be of interest to determine if a group of experienced runners who have had extensive practice on the treadmill before acquiring a URI would yield similar results.

### DISCUSSION

This is the first study to measure kinematic changes during exercise with a URI. Also, to the best of our knowledge, this is the only study in sports medicine to confirm the etiology of URI episodes or to study the effects of a nonviremic viral URI on exercise performance. Furthermore, this study focused primarily on the effects of only a single virus (HRV) infection on exercise performance. We were able to determine the specific viruses that caused colds in 12 of our 18 subjects (67%). All these viruses were associated with HRV, a frequent cause of colds, especially in the early fall months. The results of this study indicated that individuals suffering from a URI use longer and slower strides than do individuals not suffering from a URI. Additionally, when subjects in the ILL group recovered from their URIs, their gait was identical to that of well controls. Some caution should be used, however, in interpreting these results. It would be of interest to determine if a group of experienced runners who have had extensive practice on the treadmill before acquiring a URI would yield similar results.

### Joint Displacement

The MANOVA yielded an $F(6,26)$ of 2.70 for the interactive effect of group by trial on the six joint angle variables that had a $p = .036$. The $p$ value was smaller than the required Bonferroni $p$ value for only the maximum angle of the ankle joint ($F(1,31) = 13.38, p < .001$). The mean differences of the groups under the two trials and the univariate ANOVA statistics are shown in Table 3. The difference in the maximum ankle angle for the experimental group under the illness and control conditions was $-5.6$ degrees, while the difference for the two trials of the control group was 0.30 degrees. These differences indicated greater extension when URI was present.
Table 3. Stride Length, Stride Frequency, and Joint Angle Mean Differences Between Trial 1 and Trial 2

<table>
<thead>
<tr>
<th></th>
<th>Mean (Standard Deviation)</th>
<th>ANOVA*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ILL</td>
<td>CRL</td>
</tr>
<tr>
<td>Stride length (m)</td>
<td>-0.08 (0.3)</td>
<td>0.01 (0.02)</td>
</tr>
<tr>
<td>Stride frequency (Hz)</td>
<td>0.18 (0.06)</td>
<td>-0.03 (0.04)</td>
</tr>
<tr>
<td>Ankle joint maximum angle (deg)</td>
<td>-5.6 (6.8)</td>
<td>0.3 (5.2)</td>
</tr>
<tr>
<td>Ankle joint minimum angle (deg)</td>
<td>-2.1 (10.0)</td>
<td>-0.9 (5.2)</td>
</tr>
<tr>
<td>Knee joint maximum angle (deg)</td>
<td>1.1 (6.3)</td>
<td>-2.8 (6.9)</td>
</tr>
<tr>
<td>Knee joint minimum angle (deg)</td>
<td>1.5 (9.7)</td>
<td>0.6 (4.8)</td>
</tr>
<tr>
<td>Hip joint maximum angle (deg)</td>
<td>-1.4 (5.6)</td>
<td>0.6 (4.2)</td>
</tr>
<tr>
<td>Hip joint minimum angle (deg)</td>
<td>-4.2 (8.9)</td>
<td>-0.3 (4.8)</td>
</tr>
</tbody>
</table>

* ANOVA statistics are for the group-by-trial interaction. Df for the stride length and frequency variables were 1,39. Df for the ankle, knee, and hip joint variables were 1,31.

Results of Weidner’s study appear to be supported by our study. The ILL subjects altered their freely chosen stride length and stride frequency (ie, increased stride length and decreased stride frequency) between illness and convalescent running trials. Stride length and stride frequency are generally described in terms of velocity and physical stature, both of which were controlled in this study. It is reasonable to believe that a general feeling of feverishness, as perceived by the subjects, may have affected kinematic performance. When the subjects were ill, they chose to move the lower limbs more slowly, while increasing the range of the ankle and hip. However, a general feeling of fatigue also may have influenced performance. Other studies have similarly indicated that the stride rate of sprinters decreases as a result of fatigue, sometimes with an increase in stride length. Further research is necessary to substantiate our results.

CONCLUSIONS

In this study, kinematics of running were altered during an HRV-caused URI. In particular, stride length and stride frequency changed significantly between illness and convalescent running trials. Perhaps due to these changes and others that may occur but were not measured (eg, endurance, power), athletes may be susceptible to injuries or declines in athletic performance, or both, during a URI. Although the perception of feverishness may be an important indicator for alterations in kinematic performance, further examination of kinematic performance during an HRV-caused URI, as well as from other etiologies, such as enteroviruses, appears to be a fertile field for research.

ACKNOWLEDGMENTS

We thank Elliot C. Dick, PhD, and Peter A. Shult, PhD, of the University of Wisconsin-Madison Department of Preventive Medicine, and the Wisconsin State Laboratory of Hygiene for conducting the virology for this study. We also thank Stuart Walker, PhD, for writing assistance, Thomas L. Sevier, MD, for providing medical support, and Professor Roland Rueckert of the University of Wisconsin Molecular Virology Laboratory, who kindly furnished a mycoplasma-free strain of Ohio State HeLa cells.

REFERENCES


Hepatitis B Immunization of Athletic Trainers in NATA District IX

Jason W. Coorts, MS, ATC; Timothy J. Michael, PhD; William R. Whitehill, EdD, ATC; John D. Winborn, EdD

Objective: Preventive measures for transmission of bloodborne pathogens in athletic training should include hepatitis B virus (HBV) immunization of all certified athletic training staff and all student athletic trainers. Previously, no research has been undertaken to examine if athletic training programs follow these recommendations. The intent of this study was to investigate the number of certified athletic trainers (ATCs) and student athletic trainers (SATs) in the collegiate athletic training setting who have been immunized against HBV.

Design and Setting: Surveys were sent to all four-year institutions (n = 173) in the National Athletic Trainers’ Association (NATA) District IX. Both certified and student athletic trainers at each institution were instructed to complete and return surveys.

Subjects: Certified and student athletic trainers working in four-year colleges and universities in the states (n = 7) belonging to NATA District IX.

The hepatitis B virus (HBV) is a major infectious bloodborne pathogen that infects an estimated 300,000 Americans annually, adding to the pool of 1 to 1.25 million people who have chronic HBV infection in the United States.1,2 HBV is a leading cause of acute and chronic hepatitis, cirrhosis, and hepatocellular carcinoma.3-5 Treating cuts and lacerations and handling bodily fluids place athletic trainers at risk of exposure to bloodborne pathogens.6

In addition to frequent contact with blood, the population of athletes under the care of collegiate athletic trainers have a relatively high incidence of HBV infection. Compared across age groups, the rate of reported cases in the United States is the highest in young adults age 20 to 29 years.7 This high incidence rate has largely been attributed to infection from heterosexual activity.8

Even though a safe and effective vaccine against HBV has been available since 1982, the incidence of HBV infection in the general population has increased by 40% in the last decade.9 Due to an increasing HBV epidemic among health care workers and the availability of a proved vaccine, the United States government took action. On December 6, 1991, the Occupational Safety and Health Administration (OSHA) of the US Department of Labor handed down the Occupational Exposure to Bloodborne Pathogens: Final Rule.10 The purpose of this regulation was to eliminate or minimize occupational exposure to HBV, human immunodeficiency virus, and other bloodborne pathogens. The deadline for compliance with all provisions of the OSHA regulations by those under its jurisdiction was set for July 6, 1992.11 These regulations include the following:

1. The employer is to make available the HBV vaccine and vaccination series to all employees who have occupational exposure to bloodborne pathogens.
2. The HBV vaccine is to be made available at no cost to the employee.
3. The employee has the right to decline the HBV vaccination offered by the employer but can decide to accept the vaccination at a later time.
4. HBV vaccination shall be made available within 10 working days of initial assignment to all employees who have occupational exposure, unless the employee has previously received the complete HBV vaccination series.10 The responsibility for treating lacerations, abrasions, and other injuries involving blood and bodily fluids that occur during athletic competition normally lies with the certified athletic trainer (ATC). In the collegiate athletic training setting, student athletic trainers (SATs) usually take part in treating these injuries. Many SATs receive a stipend or tuition waiver for their work, while others receive little or no financial assistance. Thus, whether SATs are considered “employees” of the institution according to OSHA rules or not is a gray area.

HBV immunization and education are essential to preventing HBV infection in the athletic training environment.12 The NATA states that “athletic trainers should encourage HBV...

Measurements: Returned surveys were evaluated by simple descriptive statistics for prevalence of ATC and SAT immunization. Other variables examined on surveys were how immunizations were paid for, amount of contact with bloodborne pathogens, use of protective barriers when in contact with bodily fluids, and differences in immunization practices according to athletic affiliation.

Results: One hundred and six (61%) institutions returned 599 surveys. Of 375 SATs returning surveys, 189 (50%) identified themselves as immunized, while 168 of 223 (75%) ATCs claimed to be immunized.

Conclusions: According to the findings of this study, more emphasis should be placed on HBV immunization in the collegiate athletic training setting for the prevention of infection, especially with regard to SATs.

Key Words: athletic training, bloodborne pathogens, prevention

Jason W. Coorts was at the time of this study a graduate assistant athletic trainer at Middle Tennessee State University. Timothy J. Michael is an assistant professor; William R. Whitehill is an assistant professor and Director of the Athletic Training Program; and John D. Winborn is an assistant professor in the Department of Health, Physical Education, Recreation, and Safety at Middle Tennessee State University, Murfreesboro, TN 37132.

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The purpose of this survey is to examine the prevalence of collegiate athletic trainers immunized against the hepatitis B virus and availability of immunization for them. Complete confidentiality will be kept for each institution and individual. The data you provide are coded for group purposes only. Please do not write your name on this survey. Answer the appropriate questions on both sides of this survey. Thank you for your cooperation.

1. What is your employment status?

___ CERTIFIED ATHLETIC TRAINER ___ STUDENT ATHLETIC TRAINER

2. Gender: ___ MALE ___ FEMALE

3. Mark the appropriate category for your age.

___ 18-24 ___ 25-34 ___ 35-44 ___ 45-54 ___ 55+

4. How often do you treat any kind of open wound or come in contact with blood or body fluids of athletes?

___ DAILY ___ WEEKLY ___ MONTHLY ___ NEVER ___ OTHER

5. How often do you wear a protective barrier (example: latex gloves) when in contact with blood or body fluids of athletes?

___ 100% ___ 99-75% ___ 74-50% ___ 49-25% ___ 24-1% ___ NEVER

6. Does your athletic training department have a policy regarding hepatitis B immunization of athletic trainers?

___ YES ___ NO ___ I DON'T KNOW

(If you answered 'YES' to question #6 please answer question #6a.)

6a. Mark all appropriate groups that are immunized for the hepatitis B virus under your immunization policy.

___ Head and assistant athletic trainers ___ Graduate assistant athletic trainers ___ All student athletic trainers ___ Some student athletic trainers ___ Others (explain): _______________________

___ I Don't Know

7. Have you been immunized against the hepatitis B virus or have you received at least one injection of the three-injection hepatitis B immunization series?

___ YES ___ NO

(If you replied "YES" to question No. 7, answer only question No. 8 of the remaining three questions. If you replied "NO" to question No. 7, answer only questions No. 9 and No. 10 of the remaining three questions.)

8. How was your hepatitis immunization paid for?

___ Athletic training budget ___ Your own money ___ Employer (college/university) ___ Different employer (clinic, hospital, etc. not part of Athletic Training program) ___ I don't know ___ Other (explain): _______________________

9. Have you been offered the opportunity to become immunized at no cost to yourself?

___ YES ___ NO

10. Do you plan to be immunized in the future?

___ YES ___ NO ___ Never thought about it

If "NO," indicate reason: _______________________

Hepatitis B virus immunization questionnaire.
vaccinations for all employees at risk, in accordance with OSHA guidelines."\(^{12}\) In a review of literature on the prevention of HBV in athletic training, Buxton et al\(^{9}\) concluded: "It is imperative that information concerning the prevention of HBV in the athletic training setting be disseminated to all athletic training staff and students, through in-service training sessions, symposia, and lectures. Furthermore, institutions sponsoring student athletic trainers should provide immunization for those students."

The purpose of this study was to determine the prevalence of HBV immunization among ATCs and SATs; how the immunizations of SATs are being funded; the amount of contact athletic trainers have with bloodborne pathogens; the amount of protection afforded athletic trainers when in contact with blood; and differences in immunization practices according to athletic program size and budget.

**METHODS**

HBV immunization in athletic training was investigated in collegiate athletic training programs in NATA District IX, which consists of Alabama, Florida, Georgia, Kentucky, Louisiana, Mississippi, and Tennessee.\(^{13}\) We sent survey packets to the schools \((n = 173)\) in this region identified as affiliated with NCAA Division I, II, and III and NAIA athletics. The school’s athletic affiliation and athletic trainer’s address were found in The 1994–95 National Directory of College Athletics.\(^{14}\) We mailed the packet directly to the head athletic trainer or to the athletic department if the athletic trainer was not identified in the directory.

The survey packets contained a cover letter and ten copies of the survey (Figure). Ten ATCs currently working in collegiate athletic training reviewed drafts of both the survey and cover letter. From their comments, the final drafts used for this study were produced. The cover letter described the purpose of the study and provided instructions for survey completion and return, as well as encouraging photocopying of the surveys for all the athletic trainers in the program. Surveys were to be completed by all athletic trainers, both certified and student, and then returned in the self-addressed, stamped envelope provided.

The survey packets were sent out in the second week of April, 1995. A deadline for return was set for 15 days after receiving the packet. We did not receive all of the returns by the 15-day deadline, but all that were returned were used for data. We received the last packet 6 weeks after the mailing.

Data from completed surveys were entered into an IBM-compatible personal computer in ASCII form. After entering all surveys, the data were analyzed using SPSS-X statistical software (SPSS, Inc, Chicago, IL). We then compared the sets using simple descriptive statistics.\(^{15}\)

**RESULTS**

Of the 173 colleges and universities sent survey packets, 106 responded, for a 61% return rate. Schools with NCAA Division I athletic programs had the highest rate of return (70%, 40 of 57 schools), followed by Division II (64%, 23 of 36), Division III (54%, 7 of 13), and NAIA affiliates (54%, 36 of 67). Three institutions returned letters stating that they did not have an athletic trainer. In all, 599 surveys were returned. One survey did not have the certification status listed and was incomplete. This survey was not included for evaluation, so a total of 598 surveys were analyzed. ATCs accounted for 223 of the completed surveys, and SATs accounted for 375.

Of the 223 ATCs in NATA District IX who completed surveys, 168 (75%) reported they had been immunized against HBV (Table 1). Only 189 of 375 SATs (50%) identified themselves as immunized. Of all persons working in the collegiate athletic training setting, including students and employed staff, approximately 60% claimed to be immunized against HBV.

Fifty-five of 223 ATCs responded that they were not immunized. Sixteen (29% of those not immunized) had been offered immunization and 39 (71%) had never been offered immunization. Of all ATCs in this study, 17% had never been offered immunization. Forty-three (78%) of the unimmunized ATCs stated that they plan to become immunized in the future. Four (7%) did not plan to become immunized and 8 (15%) did not know.

One hundred and eighty-six of 375 SATs responded that they were not immunized. Two hundred and sixty-nine (42% of those not immunized) had been offered immunization and 157 (34%) had never been offered immunization. Of all SATs in this study, 42% had never been offered immunization. One hundred and twenty-one (67%) of the SATs who were not immunized stated that they plan to become immunized in the future. Six (3%) did not plan to become immunized and 56 (30%) did not know.

Of the immunized ATCs, 111 of 168 (66%) were immunized through institutional funding, either through the athletic training budget or a separate institutional account (Table 2). Athletic training budget funds paid for the immunization of 60

### Table 1. Immunization of Athletic Trainers

<table>
<thead>
<tr>
<th>Respondents</th>
<th>Immunized</th>
<th>Not Immunized</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATCs</td>
<td>168 (75%)</td>
<td>55 (25%)</td>
<td>223 (37%)</td>
</tr>
<tr>
<td>SATs</td>
<td>189 (50%)</td>
<td>186 (50%)</td>
<td>375 (63%)</td>
</tr>
<tr>
<td>Totals</td>
<td>357 (60%)</td>
<td>241 (40%)</td>
<td>598 (100%)</td>
</tr>
</tbody>
</table>

### Table 2. Immunization Funding

<table>
<thead>
<tr>
<th>Respondents</th>
<th>Athletic Training</th>
<th>Own Money</th>
<th>Institution Funds</th>
<th>Other Employer</th>
<th>Don’t Know</th>
<th>Other</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATCs</td>
<td>54 (32%)</td>
<td>6 (4%)</td>
<td>57 (34%)</td>
<td>43 (26%)</td>
<td>2 (1%)</td>
<td>6 (4%)</td>
<td>168</td>
</tr>
<tr>
<td>SATs</td>
<td>60 (33%)</td>
<td>42 (23%)</td>
<td>24 (13%)</td>
<td>18 (10%)</td>
<td>20 (11%)</td>
<td>19 (11%)</td>
<td>183*</td>
</tr>
<tr>
<td>Totals</td>
<td>114</td>
<td>48</td>
<td>81</td>
<td>61</td>
<td>22</td>
<td>25</td>
<td>351</td>
</tr>
</tbody>
</table>

* Six SATs failed to answer this question.
DISCUSSION

SATs have a lower rate of HBV immunization than ATCs in NATA District IX, especially in non-Division I-affiliated athletic programs. Unfortunately, it is the SATs who may have a greater need for HBV immunization. SATs may be more likely to contract an infectious dose of HBV in the clinical setting from a lack of experience. Less education and experience may leave an SAT more predisposed to an accident while handling sharp objects or improperly caring for an open wound.

Buxton et al advised that measures for preventing HBV transmission in the athletic training setting, including immunization for all students and staff, “should become standard practice in all athletic training facilities.” The current rate at which SATs are immunized, especially in non-Division I programs, should not be considered acceptable.

Immunization is not the complete answer for preventing HBV transmission to athletic trainers. The prevention plan should include proper use of preventive equipment (gloves, eyeguards, etc), good personal hygiene practices, and consistent disinfectant cleaning of the athletic training facility. Also, immunization is not 100% effective. The normal series of three intramuscular doses of the currently used HBV vaccines has been reported to elicit a protective antibody response in approximately 90% of adults, including a response rate over 95% for those under age 30. Vaccine-induced antibody levels decline steadily over time, and as many as 50% of vaccinated adults who responded adequately initially may have low or undetectable antibody levels by 7 years postvaccination.

Employers not offering immunizations to ATCs may be violating the OSHA ruling on exposure to bloodborne pathogens. However, OSHA’s jurisdiction is not the same in each state. For information concerning OSHA jurisdiction and local health regulations, refer to McMullan.

If the opportunity to become immunized has not been provided by the institution, the head athletic trainer should notify the athletic director and/or institution's director for health and safety. Funding, either from the athletic training budget or from another source within the institution, pays for most of the immunizations of SATs. However, immunization of SATs through institutional funds may not be the only answer. A large number of SATs paid for their own HBV vaccinations. If funds are not available for HBV immunization of SATs through the institution, it may be best that SATs purchase the immunizations themselves. Many pre-professional medical programs (nursing for example) require students to immunize themselves before enrollment. In the same way, candidates for an athletic training program can be required to be immunized before beginning clinical hours in athletic training.

Both ATCs and SATs wear protective barriers with similar frequency when in contact with the blood and bodily fluids of athletes. Of the 183 (33%) SATs, six of 168 (4%) ATCs paid for their own HBV immunization, while 42 of 183 (23%) of the SATs paid for their immunization.

Ninety-one percent (204 of 223) of ATCs reported at least weekly contact with the blood or bodily fluids of athletes (Table 3). Seventy-nine percent (295 of 373) of SATs claimed to have contact at least weekly with blood or bodily fluids of athletes. A total of 84% of the ATCs and SATs in the collegiate athletic training environment came into contact with blood or bodily fluids at least weekly.

Both ATCs and SATs were found to use gloves or other protective barriers most of the time when in contact with blood or bodily fluids (Table 4). Fifty-one percent of ATCs claimed to use protective barriers 100% of the time and 43% used them 75% to 99% of the time. Fifty-five percent of SATs used barriers 100% of the time and 43% used them 75% to 99% of the time. Six percent of ATCs and 10% of SATs used barriers 74% of the time or less.

ATCs in the four different athletic affiliations were immunized similarly at a rate of 67% to 77% (Table 5). The percentages of SATs immunized, when analyzed by athletic affiliation, varied more than did those for the ATCs, with percentages ranging from 64% of the SATs in NCAA Division I athletic programs to 27% in NAIA athletic programs. Only 74% of SATs immunized, when analyzed by athletic affiliation, varied more than did those for the ATCs, with percentages ranging from 64% of the SATs in NCAA Division I athletic programs to 27% in NAIA athletic programs.

We did not evaluate the results from questions No. 6 and No. 6a of the survey regarding immunization policy. These two questions were intended to use the responses of ATCs to determine the immunization policies of the institutions in general. Unfortunately, ATCs from the same program answered these questions differently. As a result, the exact policy for many institutions could not be determined.

We also did not evaluate the results of questions pertaining to demographics. Some athletic trainers did not complete the two questions pertaining to demographics. Since these questions had little bearing on the purpose of the study, they were not included in the analysis.
athletes. The majority of ATCs and SATs appear to consistently take measures to protect themselves from exposure to bloodborne pathogens. However, a number of athletic trainers do not practice acceptable measures of protection. Even one transmission of HBV, HIV, or any other bloodborne pathogen as a result of not using a protective barrier is one too many.

In comparing SATs at NCAA Division I schools with Divisions II and III and NAIA, a substantial difference exists. Of 224 SATs at Division I programs, 143 (64%) were immunized, while only 46 of the remaining 151 (30%) SATs were immunized. A logical explanation for the decline in immunization rates among smaller athletic programs compared with NCAA Division I programs may be available funding. If this reason is true, it would be unfortunate that HBV immunization of SATs is viewed as a luxury instead of a necessity.

According to the results of this study, a dangerous situation exists in many collegiate athletic training programs. A large number of SATs and ATCs have not taken the steps to become immunized against HBV and are exposing themselves to a far greater chance of infection than if they were immunized.

HBV prevention through immunization will, we hope, become more commonplace in the future. A small number of certified athletic trainers indicated in their returns that they currently did not immunize their SATs, but planned to by the fall of 1995.

From the findings in this study, we recommend that
1. all collegiate athletic training programs adopt a policy to have all SATs immunized against HBV;
2. ATCs and SATs who are not immunized take the necessary steps to do so;
3. both ATCs and SATs use protective barriers to bloodborne pathogens with greater frequency;
4. both ATCs and SATs remain continually informed about the prevention of HBV in athletic training and trained in the strict use of universal precautions and infection control;
5. research be undertaken to determine the frequency of HBV infection among ATCs and SATs in collegiate athletic training programs.

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Exposure of Athletic Trainers to Potentially Infectious Bodily Fluids in the High School Setting

David A. Middlemas, MA, ATC; K. Brian Jessee, ATC; Diane K. Mulder, MS, ATC; Robb S. Rehberg, ATC, EMT

Objective: To examine the incidence of exposure to potentially infectious bodily fluids by athletic trainers in the high school setting in the performance of their daily responsibilities. We also looked at the actions of officials in dealing with athletes with bleeding injuries.

Design and Setting: Athletic trainer contact with athletes and incidents of exposure to potentially infectious bodily fluids were recorded at 18 high schools in northern New Jersey during the fall 1994 athletic season. The number of times officials removed an athlete from the game or required a change of uniform, or both, was also counted. The data were analyzed with descriptive statistics.

Subjects: Eighteen athletic trainers and 3537 student-athletes at 18 schools in northern New Jersey.

Measurements: Number of contacts with athletes; number of contacts with potentially infectious bodily fluids; age of athlete; sport of athlete; whether the contact was in a practice or game; if in a game, whether the athlete was removed from the game by the official; and whether or not the athlete was required to clean or change the uniform.

Results: Of the athletic trainer contacts with athletes, 4.10% involved potentially infectious bodily fluids. The incidence of exposure to potentially infectious fluids was 12.9% of the athlete contacts. Athletes in game situations were required to change or clean a uniform in 23.7% of the bleeding incidents, and officials removed an athlete from a contest in 1.7% of the game-related bleeding incidents.

Conclusions: Universal precautions and personal protective equipment should be used in the athletic setting. Further study into the application of rules by officials governing the participation of athletes with blood-stained uniforms is needed.

Key Words: bloodborne pathogens, hepatitis B, HIV

In recent years, increased attention has been drawn to the possibility that health care workers might be exposed to infectious bodily fluids in the course of providing care. Noted in the literature as being particularly important in the sports medicine environment are the following: concerns about exposure to potentially infectious fluids and materials, protection of the athletic trainer while caring for athletes with bleeding injuries, and the disposal of potentially infectious medical waste. The athletic trainer has the potential to come in contact with blood and other bodily fluids while providing first aid and follow-up care for participants.

The number of new cases of human immunodeficiency virus (HIV) each year in the United States has been reported to be in the range of 40,000 to 50,000. Approximately 10,000 health care workers are being infected with the hepatitis B virus (HBV) annually. As more information concerning the transmission of HIV and HBV has become available, most athletic associations and regulating bodies have enacted rules regarding players who are bleeding. These rules cover care of bleeding injuries, changing and cleaning of uniforms, removal from competition, and eligibility to return to play.

Policies concerning the health care provider in athletics have also been enacted. These include the use of personal protective equipment, housekeeping procedures, and procedures for the disposal of waste materials. All procedures for health care workers are based on guidelines determined by the Occupational Safety and Health Administration (OSHA). There were several purposes of this study: to examine the rate at which the athletic trainer in the high school setting is exposed to potentially infectious bodily fluids; to determine the total number of potential exposures in game and practice situations; to record the number of times athletes were removed from competition by an official for a bleeding injury; and to survey the number of times a uniform change or cleaning was required before the athlete was allowed to return to competition.

METHODS

For the purpose of this study, an athlete contact was defined as any time the athletic trainer touched an athlete for the purpose of taping, wound care, assessment, and/or treatment of an injury. Removal of the athlete was defined as any time the contest was stopped by the official as a result of a bleeding injury and the official required the athlete to leave the contest. Required change or cleaning of the uniform was defined as any time a change or cleaning of the uniform was requested or required by the official before an athlete was allowed to return to competition.

Data Collection

Athletic trainers at 18 high schools in northern New Jersey collected data on athletes during the fall athletic season of
Table 1. Total Contacts, Total Exposures, and Exposure Rates by School

<table>
<thead>
<tr>
<th>School</th>
<th>Athletes</th>
<th>Total Contacts</th>
<th>Total Exposures</th>
<th>Exposures per 100 Athletes</th>
<th>Exposures per 100 Contacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>153</td>
<td>289</td>
<td>15</td>
<td>9.80</td>
<td>5.19</td>
</tr>
<tr>
<td>2</td>
<td>321</td>
<td>1289</td>
<td>37</td>
<td>11.53</td>
<td>2.87</td>
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<tr>
<td>3</td>
<td>143</td>
<td>1009</td>
<td>21</td>
<td>14.69</td>
<td>2.08</td>
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<tr>
<td>4</td>
<td>88</td>
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<td>14</td>
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<td>4.39</td>
</tr>
<tr>
<td>5</td>
<td>173</td>
<td>565</td>
<td>25</td>
<td>14.45</td>
<td>4.42</td>
</tr>
<tr>
<td>6</td>
<td>110</td>
<td>99</td>
<td>10</td>
<td>9.09</td>
<td>10.10</td>
</tr>
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<td>7</td>
<td>384</td>
<td>2274</td>
<td>57</td>
<td>14.84</td>
<td>2.51</td>
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<tr>
<td>8</td>
<td>110</td>
<td>541</td>
<td>22</td>
<td>20.00</td>
<td>4.07</td>
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<tr>
<td>9</td>
<td>209</td>
<td>1460</td>
<td>38</td>
<td>18.18</td>
<td>2.60</td>
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<td>10</td>
<td>66</td>
<td>261</td>
<td>13</td>
<td>19.70</td>
<td>4.98</td>
</tr>
<tr>
<td>11</td>
<td>126</td>
<td>875</td>
<td>39</td>
<td>30.95</td>
<td>4.48</td>
</tr>
<tr>
<td>12</td>
<td>140</td>
<td>563</td>
<td>9</td>
<td>6.43</td>
<td>1.60</td>
</tr>
<tr>
<td>13</td>
<td>260</td>
<td>1689</td>
<td>12</td>
<td>4.62</td>
<td>0.71</td>
</tr>
<tr>
<td>14</td>
<td>428</td>
<td>156</td>
<td>23</td>
<td>5.37</td>
<td>14.74</td>
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<tr>
<td>15</td>
<td>262</td>
<td>1332</td>
<td>11</td>
<td>4.20</td>
<td>0.83</td>
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<tr>
<td>16</td>
<td>87</td>
<td>699</td>
<td>12</td>
<td>13.79</td>
<td>1.72</td>
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<tr>
<td>17</td>
<td>207</td>
<td>682</td>
<td>24</td>
<td>11.59</td>
<td>3.52</td>
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<tr>
<td>18</td>
<td>270</td>
<td>649</td>
<td>19</td>
<td>7.04</td>
<td>2.93</td>
</tr>
<tr>
<td></td>
<td>3537</td>
<td>14751</td>
<td>401</td>
<td>12.90</td>
<td>4.10</td>
</tr>
</tbody>
</table>

Table 2. Exposures to Potentially Infectious Fluids, Uniform Changes Required, and Removals By Referee from Games by Sport

<table>
<thead>
<tr>
<th>Sport</th>
<th>Total Exposures</th>
<th>Game Exposures</th>
<th>Practice Exposures</th>
<th>Uniform Changes</th>
<th>Referee Removals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Football, men</td>
<td>315</td>
<td>132</td>
<td>183</td>
<td>32</td>
<td>2</td>
</tr>
<tr>
<td>Volleyball, women</td>
<td>19</td>
<td>11</td>
<td>8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Soccer, men</td>
<td>37</td>
<td>26</td>
<td>11</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>Soccer, women</td>
<td>8</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Field hockey, women</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cross country, men</td>
<td>16</td>
<td>1</td>
<td>15</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cross country, women</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Gymnastics, women</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Tennis, women</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Totals</td>
<td>401</td>
<td>177</td>
<td>224</td>
<td>42</td>
<td>3</td>
</tr>
</tbody>
</table>
fluids at an exposure rate of 12.9 per 100 athletes. It seems appropriate to conclude from the data that the athletic trainer should be prepared for the possibility of an exposure at any time. The more than 460,000 cases of AIDS reported in the United States in the period from June 1991 through June 1995 reinforce the need for athletic trainers to use appropriate precautions when engaged in athletic injury care. In addition, policies, protocols, and Federal guidelines also support the vaccination of athletic trainers and other health care providers against HBV.

CONCLUSIONS

It is important to note that exposure to potentially infectious bodily fluids is not limited to game situations. Although the actual number of total contests and practices was not counted for the original purposes of the study, it is interesting to note that, of the incidents recorded in the athletic programs studied, 44% of the potential exposures occurred in game situations, with the rest occurring in practices. These findings suggest that the athletic trainer has a significant chance of coming in contact with blood or other potentially infectious bodily fluids in both game and practice situations. Study into the rates of exposure in game versus practice situations is needed to determine conclusions about which situation actually provides the higher rate of exposure to potentially infectious bodily fluids.

The athletic trainer should use universal precautions in caring for athletic injuries. The rate of exposure of 4.10 per 100 contacts and 12.90 per 100 athletes includes all athletic-trainer-athlete contacts. These numbers, combined with the ongoing moral and ethical dilemmas surrounding the testing of athletes for HIV and who would have access to the results of the testing, reinforce the need to use personal protective equipment. In this study, the athletic trainers’ contacts for the purpose of taping and preparation for participation were not separated from those for postinjury assessment and care. It would be appropriate and interesting to further examine the nature of these contacts to determine if the rate of exposure to potentially infectious bodily fluids increases when examining the athletic trainer-athlete contacts involving only postinjury assessment and care.

It is worth noting that in only three incidents over the course of this study did officials remove an athlete from a game. The period included an entire fall sports season at the high school level and nine sports. With 177 of the exposures to potentially infectious bodily fluids occurring in game situations, officials removed only 1.7% of the athletes who required attention from the athletic trainer for bleeding or potentially infectious bodily fluids. From these results, the question arises as to whether all of the athletes who should be removed from competition because they have potentially infectious fluids on their uniforms are, in fact, being removed from the games by the officials for the purpose of cleaning or changing of uniforms. Further study into the officials’ understanding of the rules regarding removal of bleeding athletes from games, the nature of officials’ interpretation of the rules, and other factors affecting the decisions of officials regarding whether it is appropriate for an athlete to stay in a game with a bleeding injury would provide additional information as to whether officials’ decisions are appropriate and in line with policies established by athletic regulating bodies.

Further study is needed in the area of actual exposure of athletic trainers to potentially infectious bodily fluids. This study covered only the fall athletic season. It would be appropriate to expand the study over an entire year. Additional research on wrestling, basketball, lacrosse, hockey, baseball, softball, and track would provide information as to whether the exposure patterns revealed in this study occur on a consistent basis in all sports.

REFERENCES

Predictors of Success on the NATABOC Certification Examination

Gary L. Harrelson, EdD, ATC; James B. Gallaspy, MEd, ATC; Harold V. Knight, EdD; Deidre Leaver-Dunn, MEd, ATC

**Objective:** To determine the degree to which a selected number of variables could predict success on the first attempt at the National Athletic Trainers’ Association Board of Certification Examination.

**Design and Setting:** Data were obtained from the student records of subjects who were enrolled in the same undergraduate athletic training education program for a minimum of two years, maintained a minimum GPA of 2.5 on a 4.0 scale, and had taken the National Athletic Trainers’ Association Board of Certification Examination. A telephone survey of the subjects was used to supplement these records.

**Subjects:** Fifty-two subjects (38 male, 14 female) who had been enrolled for a mean of seven semesters (±2.57) participated in this study. Subjects maintained a mean overall GPA of 3.27 (±0.39), with an athletic training mean GPA of 3.34 (±0.43) and an academic minor mean GPA of 2.91 (±0.46). The mean ACT composite score was 18 (±4.02).

**Measurements:** Subjects sat for the National Athletic Trainers’ Association Board of Certification Examination. Examination passing status, rather than subjects’ scores on individual sections, was used in the analysis.

Data collected by the National Athletic Trainers’ Association Board of Certification, Inc (NATABOC) show that, in 1995, 58% of the candidates from an athletic training education program (ATEP) successfully completed all three sections of the NATABOC Certification on their initial attempt. These data also demonstrate a failure rate of 21% to 41% on the three sections for first-time ATEP students. Statistics for ATEP-trained candidates retaking portions of the examination also show failure rates ranging from 22 to 51% for all three sections.

Research using independent variables to predict success on health care licensing/certification examinations is scarce. Most of the investigations in this area were conducted with students in nursing, medicine, and physical therapy programs. Only Draper investigated predictors of student success on the certification examination for athletic trainers. This research focused on learning style as it relates to success on the examination. In addition, this study also addressed GPA and clinical experience, expressed as contact hours, as predictors of examination success. If it were possible to predict from a group of selected variables which candidates taking the NATABOC Certification Examination would pass or fail particular sections, then steps could be taken to address those areas where a significant relationship exists. By making ATEP directors and student athletic trainers aware of significant relationships between certain variables, a candidate’s chance of passing the Certification Examination on the initial attempt might be enhanced. The purpose of this study was to investigate ATEP students’ success on the NATABOC Certification Examination and its component sections and the degree to which this success was related to selected academic, demographic, and social variables.

**METHODS**

**Subjects**

Fifty-two athletic training students (38 male, 14 female) who were enrolled in an undergraduate ATEP from 1978 to 1992...
and who had taken the NATABOC Certification Examination participated in this study. All subjects had been enrolled in the University of Southern Mississippi for a minimum of four semesters and had maintained a minimum GPA of 2.5.

We reviewed each subject's student records to determine overall GPA, athletic training GPA, academic minor, academic minor GPA, fraternity or sorority affiliation, ACT composite score, teaching versus nonteaching degree track (18 versus 34 students), and number of semesters of university enrollment. As needed, we supplemented these records through a telephone survey with each subject.

Survey Instrument

Ten certified athletic trainers involved in the education component of the ATEP at the University of Southern Mississippi reviewed the survey to determine face validity. We determined the number of attempts for successful completion of each section of the NATABOC Certification Examination from the ATEP director's records and supplemented these data with a telephone survey.

NATABOC Certification Examination

Content validity of the NATABOC Certification Examination is ensured through the Role Delineation Study.\textsuperscript{11} Reliability of the examination sections has been reported as 0.84 for the written (W), 0.80 for the written simulation (WS), and 0.88–0.91 for the oral/practical (OP) sections.\textsuperscript{12} Reliability for the W and WS sections was determined by using the Kuder-Richardson internal consistency formula, and the OP section reliability was determined by inter-rater reliability.\textsuperscript{12}

Statistical Analysis

We used the statistical package SPSS for Windows (v. 6.0, SPSS Inc, Chicago, IL) for data analysis. Multiple linear regression (MLR) identified any of the independent variables that could predict success on the NATABOC Certification Examination. Multiple discriminant analysis (MDA) allowed us to determine if a composite set of variables could predict success on the NATABOC Certification Examination. The alpha level ($p < .05$) was established a priori for all analyses.

RESULTS

This sample was primarily male, enrolled in a nonteaching track, with no fraternity or sorority affiliation, and a preference for a physical education minor (Table 1). Table 2 summarizes the descriptive data for the independent continuous variables of overall GPA, athletic training GPA, academic minor GPA, ACT composite score, and number of semesters at the university.

<table>
<thead>
<tr>
<th>Table 1. Descriptive Data Representing the Categorical Independent Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variables</td>
</tr>
<tr>
<td>Academic minor</td>
</tr>
<tr>
<td>Biology-General Science</td>
</tr>
<tr>
<td>Social Studies</td>
</tr>
<tr>
<td>Physical Education</td>
</tr>
<tr>
<td>Physical Education w/ Exercise Science</td>
</tr>
<tr>
<td>General Science</td>
</tr>
<tr>
<td>Mathematics</td>
</tr>
<tr>
<td>Premedical</td>
</tr>
<tr>
<td>None</td>
</tr>
<tr>
<td>Sex</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>Fraternity or sorority affiliation</td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td>Teaching</td>
</tr>
<tr>
<td>Nonteaching</td>
</tr>
</tbody>
</table>

* The WS was initiated in 1987 and 16 of the subjects did not take this part of the examination.
The descriptive data representing the criterion variables and the number of attempts to pass the entire NATABOC Certification Examination and each of its three sections are contained in Table 3. The greatest success occurred on the OP section, with 64% of the subjects successfully completing this section on the first attempt. The WS was the most difficult, with 42% of the subjects being successful in their initial attempt.

Data analysis using forward MLR (Table 4) indicated a significant relationship between the independent variables of overall GPA, athletic training GPA, academic minor GPA, ACT composite score, sex, fraternity or sorority affiliation, ACT composite score, teaching versus non-teaching degree track, and the number of semesters at university enrollment and the criterion variable of number of attempts before successful completion of the entire examination. A significant relationship was also found between these variables and the number of attempts before successful completion of the W and WS sections (df = 5, 49; F = 3.36; \( p = .01; R^2 = 0.26 \)). However, the data indicated that the relationship with respect to the OP component was much weaker. As might be expected, no significant independent relationship was observed for any of the independent variables.

No single independent variable predicted success on the entire examination or its sections. However, MLR indicated significant interrelationships between the criterion variables of number of attempts and the independent variables of overall GPA, athletic training GPA, academic minor GPA, sex, fraternity or sorority affiliation, ACT composite score, teaching or non-teaching track, and number of semesters at the university.

Therefore, we used MDA to determine if a composite set of independent variables could predict success on this test. The first analysis determined the efficiency of the composite set of predictor variables in predicting the attempt on which the entire NATABOC Certification Examination was passed by the subjects (Table 5). The Wilks’ lambda of 0.62 indicates that 62% of the original variance was not explained by the classification power of the predictor variables. Table 5 also shows the result of applying function 1 to the analysis of the data. The canonical correlation of 0.65 indicates that 42.25% of the variance was explained by the variables used in predicting the attempt on which the subjects were successful.

Table 6 contains data on the standardized canonical discriminant function. This represents the weights for each independent variable used in predicting attempts on which the subjects passed the entire examination. These weights, in standard score form, are equivalent to beta weights in multiple regression in that they represent the value that would be multiplied by the standard score for each of the predictor variables. Also, these values represent a composite variable consisting of the weighted value of all predictors, which would change if any of the variables were not included in the set. In addition, the negative values for athletic training GPA and number of semesters at the university are arbitrary; they would become positive if the other variables were made negative. The variables in Table 6 indicate that, of the total number of predictor variables originally considered, only the five indicated were used in a composite set predicting the criterion variable.

In an attempt to increase predictive power, we used the composite set of variables to determine the degree to which they could predict the success on attempts one and two in passing each section of the examination (Table 7). Inspection of these data shows that the highest canonical correlation between the composite set and the criterion was found for the WS (0.73), followed by the W (0.45) and the OP (0.42). As may be expected, the corresponding Wilks’ lambda values show the same pattern.

Table 8 contains standard canonical discriminant weights for the set of predictor variables in predicting the attempt on which the subjects passed the sections of the NATABOC Certification Examination. These data indicate that the overall GPA had the highest weight for the W and OP sections of the examination. However, for the WS, the highest weight was observed in the academic minor GPA, followed by the athletic training GPA. Again, these weights represent the composite variable consisting of the weighted value for each variable in the set. Therefore, these weights would be applied to the standardized

### Table 4. Composite Set of Independent Variables and Criterion Variable of Number of Attempts Before Successful Completion: Multiple Correlation *

<table>
<thead>
<tr>
<th>Criterion Variable**</th>
<th>df</th>
<th>F</th>
<th>p</th>
<th>R²</th>
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</thead>
<tbody>
<tr>
<td>Entire examination</td>
<td>5</td>
<td>3.36</td>
<td>.01</td>
<td>.26</td>
</tr>
<tr>
<td>Written section</td>
<td>2</td>
<td>3.60</td>
<td>.03</td>
<td>.12</td>
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<tr>
<td>Written simulation section</td>
<td>1</td>
<td>6.62</td>
<td>.01</td>
<td>.11</td>
</tr>
<tr>
<td>Oral/practical section</td>
<td>2</td>
<td>2.90</td>
<td>.06</td>
<td>.10</td>
</tr>
</tbody>
</table>

* Composite set of independent variables includes overall academic GPA, athletic training GPA, academic minor GPA, ACT composite score, and number of semesters enrolled at the university.

** Criterion variables include number of attempts before successful completion of the entire examination and the three sections of written, written simulation, and oral/practical.

### Table 5. Discriminant Power in Predicting Attempts Necessary To Pass The Total NATABOC Certification Examination

<table>
<thead>
<tr>
<th>Function</th>
<th>Eigenvalue</th>
<th>Variance Explained</th>
<th>Canonical Correlation</th>
<th>After Function</th>
<th>Wilks’ Lambda</th>
<th>Chi-Square</th>
<th>df</th>
<th>p</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>.6066</td>
<td>100.00</td>
<td>.6496</td>
<td>0</td>
<td>.622</td>
<td>14.46</td>
<td>5</td>
<td>.012</td>
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</table>
Table 7. Discriminant Statistics in Predicting Attempts Necessary to Pass Each Section of the NATABOC Certification Examination

<table>
<thead>
<tr>
<th>Section</th>
<th>Function</th>
<th>Eigenvalue</th>
<th>Canonical Correlation</th>
<th>After Function</th>
<th>Wilks’ Lambda</th>
<th>Chi-Square</th>
<th>df</th>
<th>p</th>
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</thead>
<tbody>
<tr>
<td>W</td>
<td>1</td>
<td>.25</td>
<td>.45</td>
<td>0</td>
<td>.80</td>
<td>7.92</td>
<td>5</td>
<td>.16</td>
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<tr>
<td>OP</td>
<td></td>
<td>.22</td>
<td>.42</td>
<td>.83</td>
<td>8.75</td>
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<tr>
<td>WS</td>
<td>1.15</td>
<td>.73</td>
<td></td>
<td>.46</td>
<td>14.62</td>
<td>5</td>
<td>.07</td>
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</tr>
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Table 8. Standardized Canonical Discriminant Function for Each Predictor Variable and Each Section of the NATABOC Certification Examination

<table>
<thead>
<tr>
<th>Predictor Variable</th>
<th>Written</th>
<th>O/P</th>
<th>WS</th>
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</thead>
<tbody>
<tr>
<td>Overall GPA</td>
<td>1.39</td>
<td>.47</td>
<td>-.41</td>
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<tr>
<td>Athletic training GPA</td>
<td>-.92</td>
<td>.27</td>
<td>.85</td>
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<tr>
<td>Academic training minor</td>
<td>.11</td>
<td>.20</td>
<td>1.11</td>
</tr>
<tr>
<td>ACT composite score</td>
<td>.26</td>
<td>.05</td>
<td>-.64</td>
</tr>
<tr>
<td>Semesters at the university</td>
<td>-.08</td>
<td>-.34</td>
<td>.73</td>
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</tbody>
</table>

Table 9. Results of the Composite Set of Predictor Variables in Identifying Successful Completion of the NATABOC Examination

<table>
<thead>
<tr>
<th>Examination</th>
<th>Actual Attempts</th>
<th>First Attempt</th>
<th>Second Attempt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entire Examination</td>
<td>1st</td>
<td>76.2</td>
<td>23.8</td>
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<tr>
<td></td>
<td>2nd</td>
<td>21.4</td>
<td>78.6</td>
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<tr>
<td>W</td>
<td>1st</td>
<td>97.0</td>
<td>3.0</td>
</tr>
<tr>
<td></td>
<td>2nd</td>
<td>57.1</td>
<td>42.9</td>
</tr>
<tr>
<td>OP</td>
<td>1st</td>
<td>95.0</td>
<td>5.0</td>
</tr>
<tr>
<td></td>
<td>2nd</td>
<td>80.0</td>
<td>20.0</td>
</tr>
<tr>
<td>WS</td>
<td>1st</td>
<td>95.5</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td>2nd</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 9 show that prediction of first-attempt success was more accurate than for the second attempt. This trend was indicated by the high classification of the first attempt for the W section, followed by the WS and OP sections, and then the entire examination. The ability to predict success after the first attempt decreased greatly for the criterion variables. Accurate prediction of success on the second attempt was greatest for the WS section, followed by the entire examination.

DISCUSSION

Research in nursing and physical therapy3-5,9 has demonstrated that one or more independent variables could be used as predictors of success on health care licensing/certification examinations. Our results support some of those same variables as predictors of ATEP student success on the NATABOC Certification Examination. Investigators in other allied health professions have used either correlations3-5,9 or stepwise MLR9 in their data analyses. These studies reported a relationship between the independent variables and the criterion variable(s), although the independent effects of these variables were not analyzed. In many cases, as in our study, variables selected in MLR may not demonstrate a significant independent effect. For this reason, we used MDA to determine the independent variables that, through their interrelationship, would form a composite set of variables that could predict success on the NATABOC Certification Examination.

Previously, Draper10 reported no relationship between GPA and score on the WS and OP components of the NATABOC Certification Examination. Our results, however, demonstrated a significant relationship between GPA and initial success on these sections. Our findings do support Draper’s10 report that there is a relationship between GPA and success on the W section of the examination.

Our investigation demonstrated that none of the variables could independently be used to predict ATEP students’ success on the NATABOC Certification Examination or its component sections. This may be because there is no relationship between success on the examination or its sections, or both, and these variables. However, a plausible reason for the failure to demonstrate a relationship between the independent and criterion variables is that we used the subjects’ number of attempts, rather than NATABOC Examination test scores, as the criterion variable. Other studies3-4,9,10 (personal communication, P. Grace, September 29, 1993) examining predictor variables for success on health care licensing/certification examinations used the subjects’ actual test scores as their criterion variable.

Although no one variable could independently predict success, a composite set of variables correctly classified a large percentage of the students on their first attempt at the NATABOC Certification Examination. In rank order, these variables included overall academic GPA, athletic training GPA, academic minor GPA, ACT composite score, and the number of semesters of university enrollment. Of the five variables in the composite set, three are GPA variables. Therefore, we might extrapolate that GPA is a very important consideration in predicting first-attempt success on the NATABOC Certification Examination. The ability to predict success after the first attempt decreased greatly for the criterion variables.

These data reflect initial success rates on the NATABOC Certification Examination and its components that are similar
to those reported by the NATABOC for undergraduate ATEP first-time and retake candidates. A review of student records and telephone survey results demonstrated that 40% of the subjects passed the entire NATABOC Certification Examination on their initial attempt, while 27% had not passed the examination at the time of data collection. With respect to the components of the test, the OP appears to be the easiest for these subjects, with 77% passing on their initial attempt. Twenty-seven percent of the subjects had not passed the W section and 17% had not passed the WS.

Limitations of this investigation include changes that occurred in the ATEP over the time period of data collection. The subjects were exposed to different instructors as well as a trend toward more psychomotor skills testing and instruction. A second limitation is the changes that occurred in the NATABOC Certification Examination. These would include changes in the test questions; however, we assumed that the NATABOC Certification Examination is reliable and valid. The WS was also added during this time frame, but the only effect this addition should have on data analysis is a decrease in the number of subjects who took this section of the examination.

Our results support the premise that success on the total NATABOC Certification Examination and each of its sections may be predicted by the variables we used. However, these data strongly indicate that, in this sample, success in passing each of the sections of the NATABOC Certification Examination could be more accurately predicted than could overall examination success. In addition, those successful in passing each section of the examination on the first attempt could be predicted at a higher rate as compared with success on the second attempt. These results indicate the value in specifying test sections as the unit of classification rather than a composite total of the examination.

CONCLUSIONS

Our study provided data that may be used in classifying subjects relative to their successful attempt in passing the overall NATABOC Certification Examination and each of its three component sections. No one independent variable was able to predict success on the NATABOC examination, but rather a composite set of variables had the best predictive power. Five predictor variables were selected by the discriminant analysis technique from a total of nine original variables. In rank order, the selected variables were overall academic GPA, athletic training GPA, academic minor GPA, ACT composite score, and the number of semesters of university enrollment.

Academic variables are the strongest predictors of first-time success on the overall NATABOC Certification Examination and its component sections. Thus, ATEP directors need to stress to students that the higher their GPAs in the areas identified in this study, the greater the probability of successfully completing the NATABOC examination on the first attempt. Additional research is needed to further investigate variables that may be linked to success on the NATABOC Certification Examination. For future research, we suggest using actual NATABOC Certification Examination scores for criterion variables and including several undergraduate ATEPs in order to apply the results to a larger population.

REFERENCES

6. 6-7.
Student and Supervisor Perceptions of the Quality of Supervision in Athletic Training Education

Mark B. Andersen, PhD; Gerald A. Larson, EdD, ATC; Jeffrey J. Luebe, BS

Objective: To assess the perceptions of the quality of athletic training supervision via the internship route to certification and the NATA-approved/CAAHEP programs.

Design and Setting: A questionnaire was mailed to head athletic trainers or NATA/CAAHEP program directors and athletic training students in 40 programs nationwide (stratified random sample).

Subjects: Head athletic trainers (20), NATA-approved or CAAHEP-accredited program directors (20), and athletic training students in those educational programs (149).

Measurements: The Athletic Training Supervisory Skills Inventory (ATSSI) was adapted from the Supervisory Evaluation Form (SEF) and athletic training literature. The ATSSI was reviewed by 30 certified athletic trainers, and their feedback was incorporated into the final version of the questionnaire. The ATSSI contains 46 questions that cover six major domains of athletic training supervisor behavior.

Results: Overall, there were no differences in how internship route supervisors and NATA/CAAHEP program directors rated their own supervisory skills. Also, there were few differences in how students in those two types of athletic training education programs rated their supervisors.

Conclusions: This exploratory study’s limitations included a one-time assessment approach and a small sample of supervisors. Future studies in supervision should take a longitudinal approach and include a larger sample size.

Key Words: assessment, internships, NATA/CAAHEP programs

In recent years, professionals in the field of athletic training have expended a considerable amount of effort in examining the field itself. For example, Weidner and Vincent1 evaluated the professional preparation of athletic trainers. Draper2 proposed a model for evaluating student athletic trainers’ clinical experiences. Other self-examination studies have included evaluation of athletic training education programs,3 the roles and responsibilities of athletic trainers in clinical settings,4 the roles of NATA and Commission on Accreditation of Allied Health Education Programs (CAAHEP) curriculum directors as educators,5 and clinical teaching roles for athletic trainers.6

One specific area that has not been addressed in the athletic training literature is an evaluation of the skills of athletic training supervisors in internship route programs and NATA/CAAHEP-approved route programs. (Both internship and NATA-approved programs are being phased out and will be replaced with CAAHEP-accredited programs by 2004, but one would expect similar responses from both.) One of the most important aspects of the student athletic trainer’s education is working with athletes under supervision. The students we supervise will become athletic trainers, and an assessment of the quality of that supervision might help future supervisors deliver better clinical experiences to students.

Although the athletic training literature has not specifically examined student and supervisor views of the quality of supervision, other fields related to sports medicine (and medicine in general) have extensive literatures on supervision models, theories, and evaluations. For example, clinical and counseling psychology have entire journals dedicated to supervisory processes (eg, The Clinical Supervisor, Counselor Education and Supervision). Recently, in the sport psychology literature, Andersen, Van Raalte, and Brewer7 published a survey of supervisors and students in training for sport psychology service delivery. They found that students rated their supervisors’ skills more favorably than supervisors rated themselves and that supervisors rated themselves slightly better than students did. In most studies where students rated their supervisors’ skills, the students have been masters- or doctoral-level students. Thus, the average age of students in past supervision research has been well over 21 years. In athletic training education programs, however, many of the students are undergraduates. There may be differences in how younger and older students rate their supervisors and supervision experiences.

The purpose of this study was to assess the skills of supervisors in both internship programs and NATA/CAAHEP-approved programs from the viewpoints of the supervisors themselves and their students. We wished to examine both internship programs and NATA/CAAHEP programs, but no specific hypotheses were formulated for any differences between the two. It was, however, hypothesized that the supervisors would rate their skills more favorably than their students would rate them, following a trend found in other clinical settings.8,9 We also hypothesized that older, more mature...
students would be more critical of their supervisors than younger students.

**METHODS**

**Participants**

Participants were 20 NATA/CAAHEP program directors and 20 head athletic trainers of internship programs, along with their students (stratified by geographic regions in the United States and then randomly selected). Each program director and head athletic trainer-supervisor was asked to contact 10 of his or her students. Exactly how many students would be contacted was unknown because the sizes of individual athletic training education programs could not be determined.

**Inventory**

The Athletic Training Supervisory Skills Inventory (ATSSI) was developed from the Supervisory Evaluation Form (SEF). The ATSSI was modified from the SEF to better assess athletic training supervisors. The ATSSI was sent to 30 experts in the field (athletic trainers with substantial backgrounds in scholarly inquiry and histories of delivering supervisory services) for their feedback on the appropriateness of the items for assessing athletic training supervisory skills. Their feedback (18 responded) was incorporated into the final version of the ATSSI (Figure). The ATSSI contains 46 items that cover six major domains of athletic training supervisor behaviors: (1) providing information and technical support, (2) fulfilling supervisory responsibilities, (3) facilitating interpersonal communication, (4) fostering student autonomy, (5) competencies in athletic training domains, and (6) providing a professional model. A few items from the original SEF were deleted because they lacked relevance to athletic training supervision (eg, “returned lesson plans within reasonable time”), and several items were modified slightly to address athletic training supervision specifically (eg, “conveys understanding of clinical supervisor’s role to student” became “conveys understanding of the athletic training supervisor’s role to the students”). The subjects rated each item on a five-point scale, where 1 = very poor, 2 = poor, 3 = fair, 4 = good, and 5 = very good. NA (not applicable) was available as a choice if the item was in no way applicable to the supervisory services. We could not assume that the original reliability and validity of the SEF would hold for the ATSSI. We could not run a factor analysis on the data gathered because we lacked the minimum 5:1 participant-to-variable ratio (some experts say a 10:1 ratio is necessary for a valid factor analysis). As a check for internal consistency, we calculated Cronbach’s alphas. All the subscales had alphas between 0.72 and 0.81, and these are all in the acceptable range.

**Procedures**

After randomly choosing athletic training programs, we sent inventories to head athletic trainers and program directors (internship programs and NATA/CAAHEP-certified programs, respectively). Each head athletic trainer/supervisor and program director received an inventory for self-rating and ten similar inventories for his or her students (n = 440). Follow-up letters were sent to each head athletic trainer/supervisor and program director 4 weeks after the initial mailing.

**RESULTS**

The return rate for supervisors was 62.5% (n = 25). For student athletic trainers, 149 surveys were returned. An exact percentage for return rate for students could not be determined because the number of forms distributed by the supervisors to their students was unknown. If it is assumed that all of the inventories were distributed, then the return rate would be 37%.

**Description of Supervisors**

The average age of all athletic training supervisors was 39.5 years (SD = 5.0). Approximately three-fourths of the supervisors were male (76%). Nearly half of the supervisors graduated after 1980. Terminal bachelor’s degrees were held by 16%; 64% had master’s degrees, and 20% had doctoral degrees. About half of the supervisors had received their NATA certification by the year 1979. The athletic training supervisors had supervised students for an average of 14.2 years (SD = 5.6).

**Description of Students**

The average age of student athletic trainers was 21.9 years (SD = 3.0). Fifty-eight percent of the students were female. Eighty-two percent of the students planned to graduate before the year 1996. Seventy-nine percent planned to take their NATA Board of Certification entry-level examination before 1996. Only 5% of the students did not expect to fulfill their clinical hours requirements for certification before graduation.

**ATSSI**

No significant differences were found between supervisors of NATA/CAAHEP-approved programs and internship programs on the six composite scores (eg, providing information, fostering student autonomy) and the “overall rating” item (Figure). Similar findings were true for student athletic trainers’ ratings of their supervisors. Only the overall rating item (item 46) was significantly different for supervisors and students. Supervisors gave themselves a slightly lower overall rating than their students did.

For students in internship programs versus NATA/CAAHEP programs, three items were significantly different from each other. Item 14 (“conveys opinions regarding students’ specific athletic training weaknesses”), item 31 (“encourages students to become increasingly more independent and autonomous professionals”), and item 41 (“discusses with the students the NATA Code of Ethics”) were all rated higher by students in...
The Athletic Training Supervisory Skills Inventory*

Providing Information and Technical Support
1. Conveys practicum/clinical requirements to the students.
2. Conveys understanding of the athletic training supervisor’s role to the students.
3. Provides information to supplement the students’ theoretical knowledge.
4. Communicates knowledge effectively.
5. Suggests appropriate outside resources and reading material.
6. Demonstrates sufficient athletic training expertise with the presenting problems of athletes.
7. Provides direct suggestions for evaluation and/or treatment when needed or requested.
8. Demonstrates athletic training skills, techniques, and procedures when needed or requested.
10. Provides guidance for maintaining records and report writing tasks.

Fulfilling Supervisory Responsibilities
11. Remains up-to-date regarding students’ ongoing practicum/clinical experience.
12. Provides adequate amount of direct supervision.
13. Conveys opinions regarding students’ specific athletic training strengths.
14. Conveys opinions regarding students’ specific athletic training weaknesses.
15. Suggests ways for students to improve areas of weakness.
16. Appropriately confronts students for not fulfilling practicum/clinical requirements.
17. Provides opportunities for sufficient number of supervisory conferences.
18. Provides comprehensive supervisory evaluations periodically.

Facilitating Interpersonal Communication
20. Allows the students sufficient opportunity to interact during the supervisory conferences.
21. Listens attentively to students.
22. Demonstrates empathy and respect toward students.
23. Communicates at a level consistent with the students’ professional development.
24. Maintains emotional stability during supervisory encounters.
25. Exhibits an appropriate sense of humor.
26. Encourages student feedback concerning the supervisory process.

Fostering Student Autonomy
27. Remains receptive to student ideas concerning assessment and treatment strategies.
28. Shows flexibility in permitting student to explore a variety of treatment procedures.
29. Motivates the students to develop listening skills.
30. Encourages the students’ self appraisals of their athletic training skills.
31. Encourages students to become increasingly more independent and autonomous professionals.

Competencies in Athletic Training Domains
32. Helps students in planning and implementing comprehensive athletic injury/illness prevention programs.
33. Helps students recognize and evaluate injuries and illnesses commonly sustained by athletes.
34. Models appropriate referrals to physicians for diagnosis and medical treatment.
35. Demonstrates appropriate first aid and emergency care for acute athletic injuries/illnesses.
36. Helps students plan and implement comprehensive rehabilitation/reconditioning programs for illnesses/injuries sustained by athletes.
37. Provides a good model for the organization and administration of an athletic training program.
38. Instructs the student in financial, personnel, and public relations management.
39. Demonstrates good counseling skills when interacting with athletes, coaches, and parents.

Providing Professional Model
40. Maintains appropriate ethical behavior with athletes.
41. Discusses with the students the NATA Code of Ethics.
42. Demonstrates interest and enthusiasm regarding the profession.
43. Provides an appropriate model of speech and language.
44. Maintains an appropriate professional appearance.
45. Provides an appropriate professional model overall.
46. Overall rating of supervisory effectiveness.

* Respondents were asked to rate their supervisor using 1 = very poor, 2 = poor, 3 = fair, 4 = good, 5 = very good, and NA = not applicable to you or your supervisor.
NATA/CAAHEP-approved programs (all $t$ values $> 2.0$, $p < .05$).

Individual item analysis for all supervisors versus all students revealed that students rated their supervisors better on item 2 ("conveys understanding of the athletic training supervisor’s role to the students") than supervisors rated themselves ($t(170) = 2.51$, $p < .01$). Students also rated their supervisors on item 3 ("provides information to supplement the students’ theoretical knowledge") better although this result was not statistically significant ($t(170) = 1.92$, $p < .06$). Finally, along with the "overall rating" (item 46), students also rated item 43 ("provides an appropriate model of speech and language") better than their supervisors did.

The analysis of results of student ratings of supervisors by age of student revealed that older students (ie, 22 years and older) rated their supervisors lower on the composite score "Providing Information and Technical Support" than their younger counterparts did ($t(147) = 2.75$, $p < .01$). For "Fulfilling Supervisory Responsibilities," older students rated their supervisors marginally lower than younger students did ($t(147) = 1.92$, $p < .06$). Finally, "Competencies in Athletic Training Domains" was rated lower by older students ($t(147) = 2.49$, $p < .02$).

For student ratings on individual items, older students rated items 2, 4, 6, 8, 9, 10, 12, 17, 21, 29, 33, 36, 37, and 39 lower than younger students did (see Figure, $p < .05$ for all $t$ values). No other items were significantly different when students were compared by age.

**DISCUSSION**

The fact that no differences were found between internship programs and NATA/CAAHEP-approved programs and between supervisors and students was not too surprising given the large ceiling effect on the items of the ATSSI (most responses being 4 and 5 on a 5-point scale). As can be seen from the composite scores in the Table, supervisors and students as a whole generally rated supervisor’s skills in the good to very good range. It was a bit surprising, however, to find that supervisors were more critical of themselves than their students were on some items. There was also ample evidence from the composite scores and the individual items that older students do not rate their supervisors as positively as younger students. Such findings did not occur in other similar supervision studies.7,9 These results may be connected to the age of the sample. Of the total student sample, 57% ($n = 85$) were 21 years or younger. Younger students may be more likely to have unrealistic or idealistic opinions of their superiors.

When performing multiple $t$ tests, the problem of alpha slippage leads to a high likelihood of some of the significant findings being spurious (eg, if performing 20 $t$ tests at $p < .05$, the probability that one of the tests will be significant purely by chance is quite high). This study, however, was exploratory in nature, and the results are suggestive rather than definitive of where differences in perceptions of supervisors might be found in the future.

Most students believed that they receive adequate supervision. The results of the ATSSI also indicate that supervisors were satisfied with the quality of supervision they provide. Further, supervisors’ perceptions of themselves did not differ substantially from the perceptions of their students. These apparently positive results should receive cautious interpretation in light of the differences found between older and younger students.

The assessment of supervision is a new area of inquiry in athletic training and deserves further attention. This exploratory study does have some weaknesses other than alpha slippage. First, it was a “snapshot” approach. Supervision and supervisory relationships are dynamic and undoubtedly change over time. Future research might take a longitudinal approach and follow supervisors and students over a year or two, assessing skills and perceptions several times in the course of the study. Second, a larger sample size, including perhaps all athletic training education programs, might provide more generalizable results.

Finally, athletic training supervisors might use the ATSSI routinely as a tool to monitor the quality of the supervision they provide and to assess their students’ perceptions of the training received. Supervision in athletic training appears healthy. Future research may provide a better picture of the state of supervision and help pinpoint areas where supervisors could improve to better serve their trainees. Raising the quality and extent of supervision experiences can only help to improve the services that athletic trainers provide to their clients.

**Means and Standard Deviations for the Six Composite Scores and the Overall Rating Item on the ATSSI for Supervisors and Students**

<table>
<thead>
<tr>
<th>ATSSI Scores</th>
<th>Supervisors</th>
<th></th>
<th>Students</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Providing information and technical support</td>
<td>4.2</td>
<td>.65</td>
<td>4.3</td>
<td>.59</td>
</tr>
<tr>
<td>Fulfilling supervisory responsibilities</td>
<td>3.9</td>
<td>.77</td>
<td>3.9</td>
<td>.80</td>
</tr>
<tr>
<td>Facilitating interpersonal communication</td>
<td>4.2</td>
<td>.69</td>
<td>4.2</td>
<td>.76</td>
</tr>
<tr>
<td>Fostering student autonomy</td>
<td>4.1</td>
<td>.68</td>
<td>4.1</td>
<td>.72</td>
</tr>
<tr>
<td>Competencies in athletic training domains</td>
<td>4.2</td>
<td>.67</td>
<td>4.2</td>
<td>.61</td>
</tr>
<tr>
<td>Providing professional model</td>
<td>4.2</td>
<td>.79</td>
<td>4.5</td>
<td>.63</td>
</tr>
<tr>
<td>Overall rating</td>
<td>4.0</td>
<td>.80</td>
<td>4.4</td>
<td>.76*</td>
</tr>
</tbody>
</table>

*p < .02.

**REFERENCES**


Social Support in the Athletic Training Room: Athletes’ Expectations of Staff and Student Athletic Trainers

Scott Barefield, MSEd, ATC/L; Sarah McCallister, EdD

Objective: Social support has been identified repeatedly in the literature as being beneficial to individuals suffering from injury or illness. Because of the frequent interaction between athletic trainers and student athletes, the athletic trainer is in a unique position to provide a variety of social support to the athlete. The purpose of the study was (1) to identify the degree to which athletes actually receive each of eight types of social support; (2) to identify the types of social support athletes need or expect to receive from staff and student athletic trainers; and (3) to compare the athletes’ satisfaction with the quality of the support received from athletic training staff and students.

Design and Setting: A questionnaire was used to collect data for this study. It was administered at a Division I university.

Subjects: Eighty-five student-athletes at a Division I university.

Athletic trainers are quite often an injured athlete’s first and most frequent point of contact with the health care system. They see the athlete on almost a daily basis from the time the athlete is first injured until he or she returns to competition—a period that can include physicians’ appointments, medical testing, surgery, and rehabilitation. Furthermore, because of the sheer number of athletes for whom the athletic trainer is responsible, student athletic trainers are often involved in the injury and rehabilitation process. As a result of the consistency and frequency of contact between the athlete and athletic trainer, the rapport established between the two individuals can have far-reaching effects. This places the athletic trainer (either certified or student) in a position to significantly affect the athlete’s psychological recovery from injury, in addition to physical recovery. Social support has repeatedly been found to be one tool for enhancing a patient’s psychological recovery.

Social support has been defined as “an exchange of resources between at least two individuals perceived by the provider or the recipient to be intended to enhance the well-being of the recipient” and “information from others that one is loved and cared for, esteemed and valued, and part of a network of communication and mutual obligations.” A variety of names and definitions have been used to identify social support, an idea that has been prevalent in research for quite some time. Using early definitions of social support, Pines, Aronson, and Kafry identified six specific components of the process, which were expanded to the current eight categories by Richman, Rosenfeld, and Hardy. Their definitions for the eight categories of social support were used in this study and are as follows:

1. Listening Support: the perception that an other is listening without giving advice or being judgmental;
2. Emotional Support: the perception that an other is providing comfort and caring and indicating that she or he is on the support recipient’s side;
3. Emotional Challenge: the perception that an other is challenging the support recipient to evaluate his or her attitudes, values, and feelings;
4. Reality Confirmation: the perception that an other is confirming the support recipient’s perspective of the world;
5. Task Appreciation: the perception that an other is acknowledging the support recipient’s efforts and is expressing appreciation for the work she or he does;
6. Task Challenge: the perception that an other is challenging the support recipient’s way of thinking about a task or an activity in order to stretch, motivate, and lead the support recipient to greater creativity, excitement, and involvement;
7. Tangible Assistance: the perception that an other is providing the support recipient with financial assistance, products, and/or gifts;
8. Personal Assistance: the perception that an other is providing services or help, such as running an errand or driving the support recipient somewhere.

Measurements: The survey consisted of 24 questions that used a five-point Likert rating scale.

Results: There was no significant difference in the amount of social support received by athletes from staff and student athletic trainers, in athletes’ expectations of staff and student athletic trainers with regard to provision of social support, or in the athletes’ level of satisfaction with staff and student athletic trainers’ provision of social support.

Conclusions: Examined collectively, the findings indicate that athletes do not differentiate between staff and student athletic trainers with regard to the provision of social support. However, finding that athletes do not differentiate between staff and student athletic trainers in this area is significant in itself and has implications for athletic training education programs.

Key Words: sport psychology, psychology of injury...
Within the health care context, social support has been studied in a wide range of areas. Patients recovering from stroke, heart attack, and cancer, as well as patients with psychiatric illnesses and patients with spinal cord injuries, have all been the focus of studies investigating the nature of social support and its effects on individuals and groups. A summary of the findings of these studies leads to the following conclusions: (1) There is a need for social support among individuals suffering from health problems. (2) The presence of adequate social support is positively related to improved recovery and decreased stress. (3) A lack of adequate social support is linked to poor recovery and poor stress management.

Providing social support is one way in which an athletic trainer can enhance an athlete’s psychological recovery. However, providing social support, while simple at times, can also become quite complex. For example, Sarason, Sarason, and Pierce suggested that there may be some types of support that are more beneficial in certain situations and that the individual recipient benefits only to the extent that the support provided is accurately matched with the type of stress he or she is experiencing. Therefore, knowledge of the types of social support to provide for an athlete, or rather, which types of support an athlete needs or desires, can be quite valuable to the athletic trainer. Rosenfeld, Richman, and Hardy studied the composition of athletes’ social support networks and the sources from which athletes receive social support. However, they did not specifically address athletic trainers in their study. Furthermore, there is no information in the social support literature regarding which types of social support athletes need, or expect to receive, from athletic trainers.

The current social support literature contains no evidence to suggest that professionals in any field are held to a higher standard of providing social support than students in that field. That is, there have been no attempts to compare professionals’ provision of social support with that of students. However, given the close proximity to athletes in which student athletic trainers work, athletic training is one profession in which these comparisons are very worthy of study.

Richman, Rosenfeld, and Hardy stated that task appreciation and task challenge can be provided only by “individuals who understand the demands, complexities, and technicalities of [an athlete’s] vocation.” Although student athletic trainers have begun to develop this understanding, we assumed that certified staff members, through their education and experience, would be more qualified to provide these types of support. We expected that athletes would share this view and would, therefore, report receiving and expecting to receive more task appreciation and task challenge from staff members than from students.

We also expected that athletes would associate listening, emotional support, and emotional challenge with professional staff members. These types of social support tend to consist of more involved communication with the athlete and, to some extent, may involve an emotional investment in the athletic trainer-athlete relationship. Although student athletic trainers can certainly provide these types of support, we believed that the athletes would view these efforts to be more within the job description of the certified staff member. Therefore, we hypothesized that athletes would report receiving and expecting to receive more of these types of support from staff members than from students.

Finally, we expected to find that similarities in age and shared life experiences (eg, classes and college social life) that exist between student-athletes and student athletic trainers would lead athletes to report receiving and expecting to receive higher levels of reality confirmation and personal assistance from student athletic trainers than from staff members.

In summary, we conducted this study (1) to identify the degree to which athletes actually receive each of the eight types of social support; (2) to identify the types of social support athletes need or expect to receive from staff and student athletic trainers; and (3) to compare the athletes’ satisfaction with the quality of the support received from athletic training staff and students.

METHODS

The participants were 85 intercollegiate athletes (age range, 18 to 25 years) from a midwestern Division I university, representing the football, softball, baseball, women’s volleyball, men’s and women’s tennis, and women’s track and field teams. With the permission of the athletic director and approval of the Human Subjects Committee at the university, coaches for each of the 16 athletic teams were contacted in writing to request assistance with the study. With follow-up phone calls, we arranged to visit a team meeting or practice to administer the questionnaire. Coaches from the eight teams listed above agreed to have their athletes participate. One coach was not willing to have his team participate. The remaining coaches either could not be reached or could not arrange their schedules to accommodate the questionnaire.

Upon arrival at the meeting or practice site, we distributed the questionnaires and reviewed the instructions. To ensure that the athletes had had more than just casual contact with the athletic training staff within a reasonable period of time prior to the study, the athletes were asked whether they had been treated for an injury or illness during the current school year. Those responding affirmatively were asked to continue. Athletes who had not received treatment within the past school year were instructed to return their questionnaires without completing them.

We had constructed the questionnaire based upon ideas and definitions contained in the Social Support Survey. This instrument was developed by Rosenfeld, Richman, and Hardy, from whom we obtained permission for its use. They conducted extensive studies to determine the validity and reliability of this instrument and reported their findings in the literature. To determine validity, the authors tested the measurement of each of the eight types of social support and found acceptable levels of content, construct, and concurrent validity for all eight types. Regarding reliability, the authors felt that the results of the test-retest were encouraging but cautioned that “in light of low test-retest reliabilities found with many other social support measuring instruments given over extended periods of time, it may be that perceptions of social
LISTENING SUPPORT: People who listen to you without giving advice or being judgmental.

1. In general, to what degree did members of the athletic training staff provide you with listening support?

<table>
<thead>
<tr>
<th></th>
<th>Certified Staff Members</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>very little support provided</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>

2. In general, to what extent did you expect or hope to receive listening support from members of the athletic training staff?

<table>
<thead>
<tr>
<th></th>
<th>Certified Staff Members</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>very little expectation</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>

3. In general, how satisfied are you with the overall quality of listening support you received from members of the athletic training staff?

<table>
<thead>
<tr>
<th></th>
<th>Certified Staff Members</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>very dissatisfied</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
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</table>

Our questionnaire was composed of one page for each of the eight categories of social support. Each page began by defining the type of social support, followed by three questions designed to assess (1) the degree to which the athletic training staff and students provided the indicated type of support; (2) the extent to which the athlete expected or hoped to receive that type of support from the athletic training staff and students, and (3) the athlete’s satisfaction with the quality of the support received from athletic training staff and students. Athletes were asked to focus only on their interactions with the athletic training staff and students when answering the questions. A copy of the first page of the questionnaire is reproduced in the Figure. Each subsequent page was identical in form to the first page, with the only changes being those necessary to identify and define each category of social support. The questionnaire was reviewed by a jury of experts in the fields of athletic training, sport psychology, sport sociology, and physical education and was found to have logical validity.

Athletes responded to each question by circling a number on a five-point Likert scale (1 = low rating, 5 = high rating). For each question, one scale addressed certified staff members and one scale addressed student athletic trainers. Distinguishing between certified staff members and athletic training students was deemed important for a number of reasons. First, it allowed for more specific answers from athletes and eliminated confusion as to whom the questions referred. Second, it allowed for independent evaluation of the quantity and quality of social support provided by staff and student athletic trainers. Third, it allowed staff and students to become more aware of the types of social support they are providing and of which types athletes feel they would benefit from were they to receive more.

STATISTICAL ANALYSIS

The Table contains the means and standard deviations of the athletes’ responses to the questionnaire (based on a five-point Likert scale). Using $t$ tests for independent samples ($\alpha = 0.05$), each category of social support was examined for differences in the amount of social support expected and received by athletes from staff and student athletic trainers. Differences in athletes’ satisfaction with social support received were also examined.

RESULTS

Student athletic trainers scored slightly lower than certified staff members on each question. However, there were no significant differences found in the amount of social support athletes received or expected from staff and student athletic trainers. There were also no significant differences in the athletes’ satisfaction with the social support received from staff and student athletic trainers.
Table 1. Values for Social Support Received and Expected and Level of Satisfaction

<table>
<thead>
<tr>
<th></th>
<th>Received</th>
<th></th>
<th>Expected</th>
<th></th>
<th>Satisfaction</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
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<tr>
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<tr>
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<td>3.69</td>
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<td>1.01</td>
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<tr>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
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<td>3.51</td>
<td>1.23</td>
<td>3.40</td>
<td>1.29</td>
<td>3.74</td>
<td>1.11</td>
</tr>
<tr>
<td>Students</td>
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<td>1.17</td>
<td>3.20</td>
<td>1.29</td>
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<td>1.06</td>
</tr>
<tr>
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<td></td>
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<tr>
<td>Certified staff</td>
<td>3.07</td>
<td>1.75</td>
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<td>3.52</td>
<td>1.14</td>
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<td>2.81</td>
<td>1.37</td>
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<tr>
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<tr>
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<td><strong>Task challenge</strong></td>
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<td>Certified staff</td>
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<td>3.82</td>
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<td>3.27</td>
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<td>1.59</td>
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<tr>
<td>Students</td>
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<tr>
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</tr>
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<td>2.80</td>
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<td>1.48</td>
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<tr>
<td>Students</td>
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<td>1.50</td>
<td>2.56</td>
<td>1.42</td>
<td>3.44</td>
<td>1.38</td>
</tr>
</tbody>
</table>

Athletes reported receiving mostly listening support and task appreciation from both staff and student athletic trainers, while tangible assistance and personal assistance were received the least often. Athletes also reported expecting more listening support and task appreciation from both staff and student athletic trainers, while expecting the least amounts of tangible assistance and personal assistance. Satisfaction with social support received by the athletes was highest for listening support and task appreciation from both staff and student athletic trainers. All satisfaction values fell above 3.0 on the five-point Likert scale.

Student athletic trainers provided athletes with slightly lower levels of social support than staff athletic trainers in six of the eight categories. However, there were no significant differences found in the amount of social support athletes received from staff and student athletic trainers.

Athletes reported receiving similar amounts of social support from both staff and student athletic trainers in the areas of listening support, emotional support, emotional challenge, task appreciation, and task challenge. Athletes also reported receiving similar amounts of tangible assistance and personal assistance from staff and student athletic trainers; however, these two types of social support were reported with less overall frequency.

**DISCUSSION**

Because this study was conducted at only one university, the amount of social support provided to the athletes and their level of satisfaction with that support are, perhaps, more specific to the athletic training staff involved in this study and less generalizable to the athletic trainer population. However, the most important and applicable findings from this study relate to the athletes' expectations, particularly when we consider that those expectations often arise from the athletes' needs.

Interestingly, the level of the athletes' expectations across the different categories of social support varied depending upon how applicable that type of social support is to injury rehabilitation. Injured athletes particularly need athletic trainers to take the time to listen to them. They also need to know that the exercises and work they accomplish as part of their rehabilitation are appreciated (task appreciation). This is not to say that the athletic trainer should watch and praise passively. We have all experienced the value of task challenge in a rehabilitation setting. As in their sports, most athletes need and want to be pushed to succeed in their rehabilitation. Certainly the need for emotional support during an injury period is high for athletes, as is the need to know that others understand what they are going through (reality confirmation).

Athletes feel less of a need to be challenged emotionally by athletic trainers. This is not surprising because there is probably no good time to be confronted about one's values and attitudes. However, many of us have experienced times when an athlete does not have the proper attitude toward rehabilitation or toward the athletic training staff or students. Although the athlete may not feel the "need" to be challenged about his or her attitude and may not appreciate such a confrontation, it becomes clear that it is necessary. If the athlete responds appropriately to this type of emotional challenge, the end result is usually enhancement of the rehabilitation process.

Finally, the areas of tangible assistance (eg, money or gifts) and personal assistance (eg, running an errand) are not particularly applicable to an athletic training setting and it is generally unacceptable for athletic trainers to provide these
types of support to athletes. Athletes appear to recognize this and, thus, have much lower expectations of staff and student athletic trainers in these areas.

It is important to note that the differences in age and professional credentials of staff and student athletic trainers do not have an impact on the types of social support the athletes expect to receive. Those differences also do not affect the sources from which athletes wish to receive that support. Athletes expect (and need) to receive social support from student athletic trainers just as much as they do from certified staff. Student athletic trainers need to be educated about the importance of their role in helping to provide social support to injured athletes. The following is a list of strategies that athletic trainers and educators may employ to help educate student athletic trainers about social support and to help encourage them to provide that support to athletes.

1. Students are already taught to observe staff members working with athletes for the purpose of learning psychomotor techniques (e.g., evaluation, treatment, rehabilitation techniques, etc). Certified athletic trainers should demonstrate the provision of social support to athletes through their own verbal and nonverbal communication. Students should be encouraged to make note of the psychological aspects of the athletic trainer-athlete relationship and to incorporate them into their own interactions with athletes.
2. Offer inservices, classes, and lectures on the psychological aspects of injury, including the importance of social support in the rehabilitation process. Include role playing to practice providing social support to athletes.
3. Although sometimes difficult, it is important to make every effort to maximize travel experiences for students. There are few better ways for student athletic trainers and athletes to get to know each other than by being “on the road” together. This shared experience provides an excellent opportunity for the student athletic trainers to become “members of the team” and establish themselves as sources of social support for the athletes.
4. Emphasize the importance of confidentiality to student athletic trainers. Have them, in turn, assure athletes that not only are injuries and treatments confidential, but so too are conversations.
5. Encourage lower-level student athletic trainers to establish a rapport with athletes. Lower-level student athletic trainers may not have the technical knowledge to discuss a specific injury with an athlete, but they can play a valuable role in listening to and being supportive of the athlete. Encourage lower-level students to play this role when needed. This benefits athletes and helps student athletic trainers feel useful as well.
6. Assign mid- to upper-level student athletic trainers to follow athletes through their daily rehabilitation protocols. This provides athletes with a source of task appreciation and challenge, in addition to listening and emotional support, and establishes consistency in the athlete’s treatment. It can also help the athlete become more comfortable with the athletic training room environment, enhance enjoyment of the rehabilitation process, and increase the motivation to work harder. Finally, it provides the student athletic trainer with an excellent learning experience, in addition to the opportunity to build a strong rapport with the athletes.

The findings of this study clearly have implications for clinical supervisors and athletic training program directors. These individuals must realize the importance of educating athletic training students in the psychological aspects of sport and injury rehabilitation. Just as students learn the medical knowledge and psychomotor skills necessary to become athletic trainers, they must also be exposed to the basic psychological aspects of working with athletes (e.g., social support). As with other material in the curriculum, educating students in the psychological aspects of athletic training can be accomplished through a combination of coursework, seminars, and clinical experiences. Clinical supervisors and program directors are encouraged to consider the results of this study in developing this facet of their programs.

Athletic trainers have many athletes to care for and often not enough time to do so. When the athletic training room gets crowded, it is sometimes easier to give out exercises or use a modality and move on to the next athlete. But the athletes’ needs go beyond physical care. They need to know that there are people in their corner who understand the frustration they are experiencing, the physical pain their injuries are causing, and the emptiness they are feeling from not being able to do what they love so much. It is unfair to the athlete for the athletic trainer to assume that someone else is providing them with the needed support or that the athlete “just understands” that he or she is cared for. Staff and student athletic trainers, as much as anyone, are in a position to provide the variety of social support that athletes need. Both groups must be aware of the importance of social support to athletes and its value in enhancing not only injury rehabilitation but also the overall athletic experience. The extra time needed to provide social support to athletes is minimal compared with the potential results. Through a team effort by both staff and student athletic trainers, this valuable resource can be provided to every athlete.

ACKNOWLEDGMENTS

We express our appreciation to Sally A. Perkins, ATC/L, Program Director of Athletic Training, Department of Physical Education, Southern Illinois University at Carbondale, for her time and contribution to this work. Her insight and suggestions regarding educational strategies for athletic training programs proved most valuable.

REFERENCES

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Diabetes and Exercise: The Role of the Athletic Trainer

Carolyn C. Jimenez, MS, ATC

Objective: To identify the role that exercise plays in the management of diabetes mellitus and to provide the reader with guidelines for preventing and treating exercise-related complications.

Data Sources: MEDLINE was searched from 1985 to 1996 using the key words “diabetes,” “exercise,” “Type I diabetes,” and “athlete.”

Data Synthesis: Diabetes mellitus is a chronic metabolic disorder characterized by an abnormally elevated blood glucose level. It is a disease that has long-term ramifications for the body’s organ systems. The primary goal of diabetes management is to normalize the blood glucose level. Exercise, along with dietary modifications and insulin, is an important component of the management scheme. While exercise is not consistently associated with improvements in long-term blood glucose control, it does lead to other benefits that may reduce the severity and number of diabetes-related complications.

Conclusions/Recommendations: The athletic trainer can help athletes with diabetes to compete safely by understanding their unique physiologic responses to exercise, as well as the risks and benefits of exercise.

Key Words: diabetes mellitus, blood glucose control, Type I diabetes

Whether an individual is diabetic or not, physical exercise is an important component of a healthy lifestyle. There are many benefits of regular exercise: decreased body fat, increased lean body mass, a better-functioning cardiovascular system, and an improved sense of psychological well-being. These exercise-related benefits are especially important for people with diabetes, who are at greater risk for coronary artery disease, arteriosclerosis, cerebral vascular diseases, renal diseases, ocular diseases, and other health problems. Therefore, along with dietary modifications and oral diabetes medications or insulin therapy, regular exercise is an important component of diabetes management.

While there are several types of diabetes, the focus of this article will be Type 1 diabetes mellitus, previously known as insulin-dependent diabetes mellitus and previously identified as Type I. Type 1 diabetes is one of the most common chronic childhood diseases. The prevalence of Type 1 diabetes among children, adolescents, and young adults means that this is the form most certified athletic trainers will encounter. It is important that the athletic trainer understand the role of exercise in the management of diabetes, including the diabetic’s physiologic response to exercise and how it differs from the nondiabetic’s, and the risks and benefits of exercise. In this article, I will discuss these issues and how the athletic trainer can work with the diabetic to make physical exercise a safe, valuable, and enjoyable part of life.

DIABETES MELLITUS DEFINITION

Diabetes mellitus is a chronic metabolic disorder in which the body either does not produce adequate amounts of insulin or does not use it properly. Insulin, a hormone created in the pancreas, is necessary for carbohydrate metabolism. Insulin allows glucose to enter the cell, where it is converted to energy. In addition, insulin plays important roles in protein synthesis and fat storage.

Diabetes is characterized by an abnormally high blood glucose level and the inability to properly metabolize and store ingested dietary “fuels.” Chronically elevated levels of blood glucose eventually damage the body’s systems. As a result, diabetes is a disease with long-term negative effects on the body’s renal, neurologic, ocular, cardiovascular, and musculoskeletal systems.

TYPE 1 DIABETES MELLITUS

Type 1 diabetes affects approximately 10% of the diabetic population. It is an autoimmune disorder in which the insulin-secreting beta cells of the pancreas are destroyed over time. The immune response can be triggered by hereditary factors or environmental conditions, such as a virus. When approximately 80% of the beta cells are destroyed, the individual no longer produces sufficient insulin to facilitate the uptake of ingested fuels. Subsequently, the individual develops the signs and symptoms associated with diabetes, which may include fatigue, visual changes, excessive hunger, extreme thirst, frequent urination, and weight loss. In addition, the Type 1 diabetic is at risk for developing ketoacidosis. Ketoacidosis is caused by the buildup of ketones, acid by-products that poison the blood. It is commonly referred to as diabetic ketoacidosis (DKA) and occurs almost exclusively in the Type 1 diabetic.

IMPACT OF DIABETES

Diabetes is a disease associated with many acute and chronic complications. The acute complications include DKA and hypoglycemia (low blood sugar). Chronic complications affect the eyes, nervous system (especially the peripheral and autonomic nerves), kidneys, and cardiovascular system. It is
important for athletic trainers to be aware that young Type 1 diabetics who have had the disease for a number of years may present with various degrees of these chronic complications.

MANAGEMENT OF TYPE 1 DIABETES

Effective management of Type 1 diabetes is composed of three elements: insulin, dietary modifications, and exercise. The primary goal of diabetes management is to maintain blood glucose levels as close to normal (80–120 mg/dL) as possible.8,9 The importance of a consistent, near-normal blood glucose level has recently been brought to light by the Diabetes Control and Complications Trial.10 This study evaluated the effects of intensive blood glucose management on the prevention and progression of diabetes-related complications. Following more than 1400 Type 1 diabetics for an average of 6.5 years, the trial demonstrated that maintaining near-normal blood glucose levels reduces the risk of developing chronic complications and slows the progress of these conditions. Specifically, the risk of developing retinopathy was reduced by 76%, and the progression of existing retinopathy was slowed by 54%. In the Diabetes Control and Complications Trial, the risk of developing nephropathy was reduced by 34%, and disease progression was slowed by 43%. Similarly, the risk of developing neuropathy was reduced by 69%, and progression was slowed by 57%.10

THE ROLE OF EXERCISE IN THE MANAGEMENT OF TYPE 1 DIABETES

Exercise is an important component of diabetes management. Various authors1,2,11 have reported that regular exercise has improved the cardiovascular system, decreased some of the risk factors leading to cardiovascular disease, promoted fat loss, increased muscle mass, increased glucose uptake by cells, improved insulin sensitivity, and enhanced the psychological well-being of the diabetic. In other research,2,11 regular exercise was noted to improve cardiovascular fitness and work capacity, while decreasing resting and exercise blood pressures, as well as peripheral vascular resistance. Finally, exercise has been shown to decrease the risk of cardiovascular disease and improve total cholesterol and high-density lipoprotein levels.2,12 These benefits are especially important since a Type 1 diabetic is two to four times more likely to develop heart disease and five times more likely to have a stroke than a nondiabetic.2

Exercise also increases total caloric expenditure, promotes fat loss, and increases lean body mass.2,11 Excessive amounts of fat are associated with insulin resistance, a phenomenon in which the body may have an adequate amount of insulin available but cannot use it.3,7 A loss of body fat has been shown to decrease insulin resistance in diabetics.2 Along with decreasing body fat, exercise can increase muscle mass. Increases in muscle mass are important because muscles are a major disposal site for excess blood glucose.13

Finally, exercise can lower blood glucose levels by increasing insulin’s binding activity to insulin receptors, enhancing the cell membrane permeability to glucose and increasing peripheral glucose uptake.1,5,7 Increases in the rate of glucose uptake are due in part to an increase in expression of a cellular glucose transporter (GLUT 4), which assists in the transport of glucose during exercise.13 It should be noted, however, that although blood glucose levels decrease with exercise, most studies have demonstrated that exercise alone has not improved long-term blood glucose control in Type 1 diabetics.1,12,14,15

Long-term blood glucose control is measured through a glycosylated hemoglobin test (Hgb Alc), which reflects the average blood glucose control over the past 3 or 4 months.5 Landry and Allen16 demonstrated that, despite exercise-induced improvements, such as an increase in insulin sensitivity, long-term blood glucose control did not improve. A possible explanation may be the necessity for concurrent dietary and insulin adjustments.2,11,15 Schneider et al15 reported an improvement in blood glucose control in Type 1 diabetics who were enrolled in an exercise program. However, they noted that these individuals were highly motivated to maintain appropriate diets, adjusted insulin doses in anticipation of exercise, and demonstrated above-average monitoring of their blood glucose levels.

Based on all these observations, the American Diabetes Association currently recommends that Type 1 diabetics should exercise to improve their cardiovascular fitness, to derive the benefits in insulin sensitivity and glucose uptake, and to enhance their psychological well-being.3

PHYSIOLOGIC RESPONSE TO EXERCISE

The athletic trainer should have an understanding of the Type 1 diabetic’s physiologic response to exercise. Exercise requires rapid mobilization and utilization of fuels, particularly glucose and free fatty acids,5 which are accomplished through the release of hormones such as epinephrine, norepinephrine, insulin, and glucagon.1,7 In the nondiabetic, the end result is a coordinated and balanced response, so that fuel supply is adequate to meet demand.

In the nondiabetic, the onset of exercise brings about a complex neural and hormonal response. The primary goal of this response is to maintain the supply of metabolic fuels for the muscles. Exercise results in an increase in epinephrine and glucagon levels and a decrease in insulin levels.5,7 Each of these hormones plays an important role in providing adequate fuel for working muscles. The release of epinephrine stimulates the release of free fatty acids from lipocytes and signals the liver to produce glucose. Similarly, a decrease in insulin stimulates the release of free fatty acids and increases hepatic glucose production. Hormonal increases in glucagon further increase hepatic glucose output.1,5,7

In contrast to the well-coordinated response described above, the exercise response for the Type 1 diabetic is complicated by the fact that exogenously administered insulin cannot match the precise control of natural endogenous insulin during activity.16 During exercise, Type 1 diabetics may experience problems with both excessive and inadequate amounts of insulin. If the diabetic athlete begins exercise with an excessive amount of insulin in the blood, which can occur if an insulin injection is taken shortly before exercise, hypo-
glycemia will result. This happens for two reasons. First, insulin and exercise facilitate cellular glucose uptake. Working together, they have an additive effect that rapidly lowers blood glucose. Second, insulin suppresses glucose production in the liver. Thus, excess levels of insulin both inhibit glucose production and increase glucose uptake, with the end result of hypoglycemia in the exercising diabetic.

RISKS OF EXERCISE FOR TYPE 1 DIABETICS

In addition to the benefits of regular exercise, the Type 1 diabetic and the athletic trainer should be aware of the potential risks. These include the previously mentioned hypoglycemia, as well as, occasionally, hyperglycemia (high blood sugar) leading to DKA.

Hypoglycemia is the most frequently encountered risk. Maynard noted that the factors that affect blood glucose levels during exercise include the time and content of the last meal; time, dosage, and type of diabetic medications; and type of activity being performed. If all factors are considered equal, then the duration and intensity of the exercise affect blood glucose levels the most.

Hypoglycemia is a problem for Type 1 diabetics because their ability to recover from it is limited. Recovery is mediated via the release of epinephrine, norepinephrine, and glucagon. Schneider et al. compared recovery rates after an exercise bout involving hypoglycemic Type 1 diabetics and involving controls in whom hypoglycemia was induced. Increases in glucagon, epinephrine, and norepinephrine were lower in the Type 1 diabetic group. Therefore, the ability to recover endogenously from a hypoglycemic event is clearly impaired in Type 1 diabetics and may require the special management strategies that are described later.

Another problem Type 1 diabetics may encounter is an increase in blood glucose levels during exercise. If blood glucose control is poor or blood glucose levels are excessively high prior to activity, which may occur when the diabetic is sick or forgets an insulin dose, exercise can cause a further rise in the blood glucose level. Superimposing exercise may lead to the production of ketones, causing DKA. This occurs because, when insulin is not available to facilitate glucose uptake, the body assumes that blood glucose levels are low. It responds by releasing hormones that cause a further rise in the blood glucose level. Also, if the body cannot use glucose as a fuel, it will begin to metabolize fats. Ketones are by-products of fat metabolism. Excessive levels of ketones in the blood lead to DKA, a potentially life-threatening condition.

GUIDELINES FOR SAFE EXERCISE

Epidemiologic evidence suggests that Type 1 diabetics who engage in a lifetime of regular physical activity may live longer and suffer fewer and less severe diabetes-related complications. As part of the routine medical clearance procedure, the athletic trainer will want to ensure that the Type 1 diabetic athlete has had a thorough medical examination conducted by a physician. The examination should establish that the athlete is in good metabolic control, as measured by the Hgb A1C test, and does not have any existing medical conditions that may be exacerbated by exercise.

Several authors recommend that all exercising diabetics should:
1. wear identification indicating that they are diabetic;
2. avoid exercising at the peak of insulin action;
3. adjust carbohydrate intake or insulin dosage before exercise;
4. check blood sugar before, after, and, if possible, during exercise;
5. prevent dehydration by consuming adequate fluids before, during, and after exercise;
6. have access to a fast-acting carbohydrate during exercise in the event of hypoglycemia;
7. have blood glucose testing equipment and supplies available.

The athletic trainer should be ready and able to handle exercise-related emergencies. As stated earlier, the most frequently encountered exercise risk is hypoglycemia. Although each athlete responds differently, hypoglycemia is defined as a blood glucose level less than 70 mg/dL. The signs and symptoms of a hypoglycemic reaction include shakiness, sweating, a rapid heartbeat, trouble concentrating, headache, dizziness, mood changes, and tingling in the face, tongue, and lips. Most cases of hypoglycemia can be reversed by giving the athlete 10 to 15 g of a fast-acting carbohydrate source, such as half a can of nondiet soda, 118 ml (4 oz) of orange juice, four packets of table sugar, or five to seven Life Savers. Foods that contain high levels of fat, such as chocolate, should not be used for treating a hypoglycemic reaction because the fat interferes with the absorption of the sugar. After eating, the athlete should wait 15 minutes and check the blood sugar level. If the blood glucose level remains below 70 mg/dL, another 10 to 15 g of carbohydrates are given. Repeat blood testing and treating until the blood glucose level is normalized.

In cases of severe hypoglycemia, where the athlete is unconscious or unable to swallow, glucagon must be administered. While diabetics are instructed to teach friends and relatives how to mix, draw up, and inject glucagon, the role of the athletic trainer in this circumstance is less clear. To clarify responsibility, the athletic trainer should meet with the athlete, the parents, the physician, and appropriate school officials to discuss how to handle a severe hypoglycemic reaction. Specifically, the athletic trainer needs to know whether, and under what circumstances, a glucagon injection should be administered and the time line for activating emergency medical services. The agreed-upon policy should then be put in writing. If the athletic trainer is to administer the injection, he or she must be trained to do so. This training can be easily provided by the athlete’s physician or appointee.

Although there is some variation, a glucagon injection kit typically contains a syringe that is prefilled with a diluting solution and a vial of glucagon powder. Once the solution and powder are thoroughly mixed, they are injected into the upper arm, thigh, or buttock. The athlete should be placed on his or
Recommended Food Intake Based on Type of Exercise and Blood Glucose Level*

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Blood Glucose Level</th>
<th>Food Exchanges to Add†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short-duration, low- to moderate-intensity</td>
<td>under 80 mg/dL</td>
<td>2 fruit</td>
</tr>
<tr>
<td>exercise</td>
<td>over 80 mg/dL</td>
<td>1 fruit</td>
</tr>
<tr>
<td>walking (1/2 mile) or leisurely cycling (less</td>
<td>80–180 mg/dL</td>
<td>1/2 meat and 2 bread</td>
</tr>
<tr>
<td>than 30 minutes)</td>
<td>180–300 mg/dL</td>
<td>1 fruit or 1 bread</td>
</tr>
<tr>
<td>Moderate-intensity</td>
<td>over 300 mg/dL</td>
<td>no extra food</td>
</tr>
<tr>
<td>exercise</td>
<td>80–180 mg/dL</td>
<td>DO NOT EXERCISE</td>
</tr>
<tr>
<td>tennis, swimming, jogging, golfing, or</td>
<td>180–300 mg/dL</td>
<td>1 meat, 2 bread, 1 fruit, and 1 milk</td>
</tr>
<tr>
<td>leisurely cycling (1 hour)</td>
<td>over 300 mg/dL</td>
<td>1 meat and 2 bread</td>
</tr>
<tr>
<td>Strenuous exercise</td>
<td>80–180 mg/dL</td>
<td>1 fruit or 1 bread</td>
</tr>
<tr>
<td>football, hockey, racquetball, basketball,</td>
<td>180–300 mg/dL</td>
<td>DO NOT EXERCISE</td>
</tr>
<tr>
<td>strenuous cycling or swimming, or shoveling</td>
<td>over 300 mg/dL</td>
<td></td>
</tr>
</tbody>
</table>

* Adapted with permission from Lundstrom and Rossini.21
† 1 fruit = 118 ml (4 oz) orange juice. 1 meat = 15 ml (1T) peanut butter. 1 bread = 14 g (1/2 oz) bagel. 1 milk = 237 ml (8 oz) 2% or skim milk.

her side because the glucagon may cause vomiting. Given available glycogen stores in the liver, an individual will typically respond within 15 minutes. When the athlete is able to chew and swallow, a fast-acting source of carbohydrate should be provided, followed by a longer-acting source of carbohydrate, such as cheese and crackers.5

If the diabetic’s pre-exercise blood glucose is excessively high, signs and symptoms may include headache, blurry vision, sleepiness, and increased thirst and urination. In this situation, the athlete should conduct a blood glucose test. If the reading is 250 mg/dL or higher, then the athlete should check the urine for ketones. Ketones suggest a loss of metabolic control, in which case exercise should be delayed until the ketone test is negative and until the athlete’s physician is contacted for further instructions. In order to prevent dehydration as a result of the high blood glucose level, the athlete should drink plenty of water.

STRAATEGIES TO PREVENT HYPOGLYCEMIA AND HYPERGLYCEMIA DURING EXERCISE

The diabetic athlete and the athletic trainer should know how to prevent both hypoglycemia and conditions that may lead to DKA. Two strategies to prevent hypoglycemia include decreasing the amount of insulin injected before exercise and supplementing carbohydrates before and during exercise. The diabetic should discuss specific insulin adjustments with the physician, particularly when the exercise bout is longer than 45 minutes. The Table provides general guidelines for carbohydrate supplementation prior to different types of exercise and when such exercise should be delayed.21 In addition to supplementing carbohydrates before exercise, it is generally recommended that 10 to 15 g of carbohydrates be ingested during activity for every 30 minutes of exercise.5

Occasionally exercise will cause blood glucose levels to rise, particularly when the pre-exercise blood glucose level is at or above 250 mg/dL. If ketones are present, exercise should be delayed. However, Maynard2 believes that, if the pre-exercise blood glucose is 250 mg/dL without ketones in the urine, insulin levels are adequate for exercise to cause a decrease in blood glucose levels. As noted in the Table, when the pre-exercise blood glucose reading is over 300 mg/dL, regardless of the ketone status, exercise should be delayed until blood glucose levels are less than 250 mg/dL.2,5,21

CONCLUSIONS

As athletic trainers, we must recognize that we are key players on the diabetic’s management team. We are likely to have more contact with the diabetic athlete than the athlete’s physician does. As such, we can help the athlete learn how to appropriately monitor and regulate blood glucose levels before and during exercise, allowing physical activity to become an integral and enjoyable component of life, which may significantly reduce the risk of many of the serious complications of this disease.

ACKNOWLEDGMENTS

I thank Dr. Peter Nowell, Kristin Nowell, Sandy Godek, Joe Godek, and Marsha Grant for their assistance and support on this project.

REFERENCES

Risk of Upper Respiratory Tract Infection in Athletes: An Epidemiologic and Immunologic Perspective

David C. Nieman, DrPH, FACSM

Objective: The chronic and acute immune responses to both heavy and moderate exercise are reviewed, with guidelines provided for the prevention and management of upper respiratory tract infection (URTI) in athletes.

Data Sources: Epidemiologic and experimental exercise immunology research data were used. The MEDLINE database was searched for the years 1970 to 1997 with the terms "exercise," "immune," "infection," "lymphocyte," and "neutrophil."

Data Synthesis: A descriptive review with summary figures and one table.

Conclusions/Recommendations: The epidemiologic data suggest that endurance athletes are at increased risk for URTI during periods of heavy training and the 1- to 2-week period after marathon-type race events. Several researchers have reported a diminished neutrophil function in athletes during periods of intense and heavy training. Following each bout of prolonged heavy endurance exercise, several components of the immune system appear to demonstrate suppressed function for several hours. This has led to the concept of the "open window," described as the 3- to 12-hour time period after prolonged endurance exercise when host defense is decreased and the risk of URTI is elevated. There is sufficient evidence for sports medicine professionals to encourage athletes to practice various hygienic measures to lower their risk of URTI and to avoid heavy exertion during systemic illness.

Key Words: immune system, exertion, lymphocyte, neutrophil, common cold

Among elite athletes and their coaches, a common perception is that heavy exertion lowers resistance and is a predisposing factor to upper respiratory tract infections (URTI). Many elite athletes, including Sebastian Coe, Uta Pippig, Liz McColgan, Michelle Akers-Stahl, Alberto Salazar, and Steve Spence, have reported significant bouts with infections that have interfered with their ability to compete and train.

On the other hand, there is also a common belief among many individuals that regular exercise confers resistance against infection. For example, a 1989 Runner’s World subscriber survey revealed that 61% of 700 runners reported fewer colds since beginning to run, while only 4% felt they had experienced more colds (Runner’s World, April 1990:77). A survey of 750 masters athletes (ranging in age from 40 to 81 years) showed that 76% perceived themselves as less vulnerable to viral illnesses than their sedentary peers. Among 170 nonelite marathon runners (personal best time, average of 3 hours, 25 minutes) who had been training for and participating in marathons for an average of 12 years, 90% reported that they definitely or mostly agreed with the statement that they “rarely get sick” (D.C.N., unpublished data, 1993).

The National Center for Health Statistics reports that acute respiratory conditions (primarily the common cold and influenza) have an annual incidence rate of 90 per 100 persons, imposing substantial morbidity and economic burden upon families. The common cold is probably the most frequently occurring illness in humans worldwide. More than 200 different viruses cause colds, and rhinoviruses and coronaviruses are the culprits 25 to 60% of the time. Rhinoviruses often attack during the fall and spring seasons, while the coronavirus is common during the winter. The average adult has two or three respiratory infections each year, with young children suffering six to seven infections.

Understanding the relationship between exercise and infection has potential implications for public health. Illness may cause the athlete to perform at a subpar level or miss an event altogether. The relationship between exercise and URTI may be modeled in the form of a “J” curve (Figure). This model suggests that although when one engages in moderate exercise training the risk of URTI may decrease below that of a sedentary individual, risk may rise above average during periods of excessive amounts of high-intensity exercise.

Upper Respiratory Tract Infection

Heavy Exertion and URTI: Epidemiologic Evidence

Several epidemiologic reports suggest that athletes engaging in marathon-type events and/or very heavy training are at increased risk of URTI (Table). Nieman et al. researched the incidence of URTI in a group of 2,311 marathon runners who varied widely in running ability and training habits. Runners retrospectively self-reported demographic, training, and URTI episode and symptom data for the 2-month period (January, February) before and the 1-week period immediately after the 1987 Los Angeles Marathon. During the week following the race, 12.9% of the marathoners reported a URTI, compared with only 2.2% of control runners who did not participate (odds ratio, 5.9). Forty percent of the runners reported at least one URTI episode during the 2-month winter period before the Marathon.

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Controlling for various confounders, it was determined that runners training more than 96 km/wk doubled their odds for sickness compared with those training less than 32 km/wk.

Other epidemiologic data support these findings. Linde\textsuperscript{7} studied URTI in a group of 44 elite orienteers and 44 nonathletes of the same age, sex, and occupational distribution during a 1-year period. The orienteers experienced significantly more URTI episodes during the year in comparison with the control group (2.5 versus 1.7 episodes, respectively).

Peters and Bateman\textsuperscript{8} studied the incidence of URTI in 150 randomly selected runners who took part in a 56-km Cape Town race and compared them with matched controls who did not run. Symptoms of URTI occurred in 33.3\% of runners, compared with 15.3\% of controls during the 2-week period after the race, and were most common in those who achieved the faster race times.

Two subsequent studies from Peters et al\textsuperscript{9,10} have confirmed this initial finding. In one study, 28.7\% of the 108 subjects who completed the 56-km Milo Korkie Ultramarathon in Pretoria, South Africa, reported nonallergy-derived URTI symptoms during the 2-week period afterward, as compared with 12.9\% of controls.\textsuperscript{10} In another study, 68\% of runners reported the development of URTI symptoms within 2 weeks after the 90-km Comrades Ultramarathon.\textsuperscript{9} Using a double-blind placebo research design, it was determined that only 33\% of runners taking a 600-mg vitamin C supplement daily for 3 weeks before the race developed URTI symptoms. The authors suggested that because heavy exertion enhances the production of free oxygen radicals, vitamin C, which has antioxidant properties, may be required in increased quantities.

URTI risk following a race may depend on the distance, with an increased incidence conspicuous only after marathon or ultramarathon events. For example, Nieman et al\textsuperscript{11} were unable to establish any increased prevalence of URTI in 273 recreational runners during the week after 5-km, 10-km, and 21.1-km events as compared with the week before. URTI incidence was also measured during the 2 winter months before the three races. Twenty-five percent of those running 25 or more km/wk (average of 42 km/wk) reported at least one URTI episode, as did 34\% of those training fewer than 25 km/wk (average of 12 km/wk) \( (p = .09) \). These findings suggest that, in recreational running, an average weekly distance of 42 km versus 12 km is associated with either no change in, or even a slight reduction of, URTI incidence and that racing 5 to 21.1 km is not related to an increased risk of sickness during the ensuing week.

Together, these epidemiologic studies imply that heavy acute or chronic exercise may be associated with an increased

### Table: Epidemiologic and clinical research on the relationship between exercise and URTI

<table>
<thead>
<tr>
<th>Investigators</th>
<th>Subjects</th>
<th>Method of Determining URTI</th>
<th>Major Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peters and Bateman\textsuperscript{8} (1983)</td>
<td>150 South African marathon runners vs 124 controls who lived with them</td>
<td>2-wk recall of URTI incidence and duration after 56-km race</td>
<td>URTI incidence twice as high in runners (33.3%) vs controls (15.3%) after 56-km race</td>
</tr>
<tr>
<td>Linde\textsuperscript{7} (1987)</td>
<td>44 Danish elite orienteers vs 44 matched nonathletes</td>
<td>URTI symptoms self-recorded in daily log for 1 year</td>
<td>Orienteers had 2.5 URTIs vs controls' 1.7 URTIs during year</td>
</tr>
<tr>
<td>Nieman, Johanssen, &amp; Lee\textsuperscript{11} (1989)</td>
<td>273 California runners training for race</td>
<td>2-mo recall of URTI incidence; 1-wk recall after March 5-, 10-, and 21-km races</td>
<td>Training 42 vs. 12 km/wk associated with fewer URTIs; no effect of race participation on URTI incidence</td>
</tr>
<tr>
<td>Peters\textsuperscript{10} (1990)</td>
<td>108 South African marathon runners vs 108 controls who lived with them</td>
<td>2-wk recall of URTI incidence and duration after 56-km race</td>
<td>URTI incidence: 28.7% in runners vs 12.9% in controls after 56-km race</td>
</tr>
<tr>
<td>Nieman et al\textsuperscript{6} (1990)</td>
<td>2,311 Los Angeles marathon runners</td>
<td>2-mo recall of URTI incidence during training for marathon; 1-wk recall after March race</td>
<td>Runners training ( \geq 97 ) vs ( &lt; 32 ) km/wk at higher URTI risk; odds ratio 5.9 for participants vs nonparticipants 1 wk after 42.2-km race</td>
</tr>
<tr>
<td>Nieman et al\textsuperscript{13} (1990)</td>
<td>36 mildly obese, inactive California women</td>
<td>Daily logs using self-reported, precoded URTI symptoms</td>
<td>Increase in running distance positively related to increased URTI risk</td>
</tr>
<tr>
<td>Heath et al\textsuperscript{12} (1991)</td>
<td>530 South Carolina runners</td>
<td>1-y daily log using self-reported, precoded symptoms</td>
<td>URTI incidence: 68% in runners vs 45% in controls after 56-km race, 33% in runners using vitamin C vs 53% of controls</td>
</tr>
<tr>
<td>Peters et al\textsuperscript{6} (1993)</td>
<td>84 South African marathon runners vs 73 nonrunner controls</td>
<td>2-wk recall of URTI incidence and duration after 90-km race</td>
<td>Incidence of URTI: 8% in athletes; with inactives randomized to 12-wk walking vs controls, 21% in walkers, 50% in sedentary controls</td>
</tr>
<tr>
<td>Nieman et al\textsuperscript{14} (1993)</td>
<td>42 elderly North Carolina women (30 inactive, 12 athletes)</td>
<td>Daily logs using self-reported, precoded URTI symptoms</td>
<td></td>
</tr>
</tbody>
</table>
risk of URTI. The risk appears to be especially high during the 1- or 2-week period after marathon-type races. Among runners varying widely in training habits, the risk for URTI is slightly elevated for the longest distance runners, but only when confounding factors (eg, training and demographic variables) are controlled.

Moderate Exertion and URTI

What about the common belief that moderate physical activity is beneficial in decreasing URTI risk? At present, there are no published epidemiologic reports that have retrospectively or prospectively compared the incidence of URTI in large groups of moderately active and sedentary individuals.

Two randomized experimental trials using small numbers of subjects have provided important preliminary data in support of the viewpoint that moderate physical activity may reduce URTI symptomatology. (Table). In one randomized, controlled study of 36 women (mean age, 35 years), exercise subjects walked briskly for 45 minutes, 5 days a week, and experienced one-half the number of days with URTI symptoms during the 15-week period compared with that of the sedentary control group (5.1 ± 1.2 vs 10.8 ± 2.3 days, p = .039). In a second study, the incidence of the common cold in a population of elderly women during a 12-week period was found to be lowest in highly conditioned, lean subjects who exercised moderately each day for about 1.5 hours (8%). Subjects who walked 40 minutes, 5 times per week, had an incidence of 21%, compared with 50% for the sedentary control group (χ² = 6.36, p = .042). These data suggest that elderly women not engaging in cardiorespiratory exercise are more likely than those who do exercise regularly to experience a URTI during the fall season.

EFFECTS OF EXERCISE ON THE IMMUNE SYSTEM

If heavy and fatiguing exertion leads to an increased risk of URTI, it follows that various measures of immune function should be negatively affected. Conversely, if moderate exercise decreases URTI risk, there should be some aspect of immune function that is chronically or at least transiently improved.

Resting Immunity in Endurance Athletes Versus Nonathletes

In this section, data currently available on cross-sectional comparisons of human endurance athletes and nonathletes for natural killer cell activity (NKCA), neutrophil function (phagocytosis and oxidative burst), and lymphocyte proliferative response (T-cell function) will be reviewed.

Natural Killer Cell Activity

Natural killer (NK) cells are large granular lymphocytes that can mediate non-major histocompatibility complex (MHC)-restricted cytolytic reactions against a variety of neoplastic and virus- or bacteria-infected cells. NK cells also exhibit key non-cytolytic functions and can inhibit microbial colonization and growth of certain viruses, bacteria, fungi, and parasites.

Most cross-sectional studies support the finding of enhanced NKCA in athletes when compared with nonathletes, in both younger and older groups. NKCA data comparing 22 experienced marathon runners and 18 sedentary controls indicated higher NKCA in the marathon runners (373 ± 38 versus 237 ± 41 total lytic units, p = .02). Tvede et al also observed a higher NKCA in elite cyclists during the summer months (intensive training period) when compared with the winter (light training period).

However, several prospective studies with subjects exercising moderately for 8 to 15 weeks reported no significant elevation in NKCA relative to sedentary controls. Together, data from these studies imply that endurance exercise may have to be intensive and prolonged (ie, at athletic levels) before NKCA is chronically elevated.

Neutrophil Function

Neutrophils are an important component of the innate immune system, aiding in the phagocytosis and killing (ie, through an oxidative burst) of many bacterial and viral pathogens and the release of immunomodulatory cytokines. The neutrophil function cross-sectional data appear to contrast with those for NKCA. No researcher has reported an elevation in neutrophil function (ie, both phagocytic and oxidative burst activity) among endurance athletes when compared with nonathletes. Instead, during periods of high-intensity training, neutrophil function has been reported to be suppressed in athletes. This is especially apparent in studies by Hack et al and Baj et al demonstrating that neutrophil function in athletes was similar to controls during periods of light training workloads but significantly suppressed during the summer months of intensive training. Pyne et al reported that elite swimmers undertaking intensive training have significantly lower neutrophil oxidative activity at rest than do age- and sex-matched sedentary individuals and that function is further suppressed during periods of strenuous training before national-level competition.

Neutrophils are considered the body’s best phagocytes. Suppression of neutrophil function during periods of heavy training is probably a significant factor explaining the increased URTI risk among athletes. Muns has reported that neutrophils in the upper airway passages of athletes have a decreased phagocytic capacity when compared with those of nonathletes and that, following heavy exertion, a further suppression is experienced for 1 to 3 days afterward. Repeated cycles of heavy exertion may thus put athletes at increased risk of URTI.

Lymphocyte Proliferative Response

T and B cells are a part of the adaptive immune system, taking several days to divide and secrete various chemicals in response to foreign antigens. Determination of the proliferative response of human lymphocytes upon stimulation with various mitogens (eg, phytohemagglutinin or concanavalin A) in vitro
is a well-established test to evaluate the functional capacity of T and B lymphocytes. Mitogen stimulation of lymphocytes in vitro using optimal and suboptimal doses is believed to mimic events that occur after antigen stimulation of lymphocytes in vivo. Data on the lymphocyte proliferative response to athletic endeavor are less clear than for NK cells and neutrophils but generally support no significant difference between athletes and nonathletes.14,16,17,19,20,30–32

Among highly conditioned elderly women in a state of rest, phytohemagglutinin-induced lymphocyte proliferative response was reported to be 56% higher than among sedentary controls.14 Data from Japan also support enhanced T-cell function among trained elderly men versus untrained controls.32 These data are interesting because T-cell function tends to diminish with age. However, moderate exercise training for 12 weeks failed to alter T-cell function in elderly women, indicating that higher levels of vigorous exercise may be necessary over greater time periods before an effect on T-cell function can be measured in the elderly population.14

Salivary Immunoglobulin A (IgA)

The secretory immune system of the mucosal tissues of the upper respiratory tract is considered the first barrier to colonization by pathogens, with IgA the major effector of host defense.36 Secretory IgA inhibits the attachment and replication of pathogens, preventing their entry into the body. While several studies have shown that salivary IgA concentration decreases after a single bout of intense endurance exercise, further research is needed to determine the overall chronic effect.36–38 Tomasi et al39 reported that resting salivary IgA levels were lower in elite cross-country skiers than in age-matched controls, but this was not confirmed by a follow-up study of elite cyclists.37

Together these data support the concept that the immune system responds differentially to the chronic stress of intensive exercise, with NKCA tending to be enhanced, while neutrophil function is suppressed. The decrease in neutrophil function may be of more importance when considering host protection against foreign pathogens. T and B cells seem to be largely unaffected by athletic endeavor, although the research data at present are mixed. Further study is needed with larger groups of athletes to allow a more definitive comparison.

THE ACUTE IMMUNE RESPONSE TO AEROBIC EXERCISE

As reviewed earlier, epidemiologic studies suggest that marathon and ultramarathon race events are associated with a significant increase in risk of URTI during the 1- to 2-week recovery period. In light of the mixed results regarding the effect of chronic, intensive training on resting immune function, several authors have posited that prolonged cardiorespiratory endurance exercise (defined in the present article as longer than 2 hours) leads to transient but significant perturbations in immunity and host defense, providing a physiologic rationale for the epidemiologic data.1,36,40

For example, NKCA41–48 mitogen-induced lymphocyte proliferation,45,49–54 upper airway neutrophil phagocytosis and blood neutrophil oxidative burst,29,35,36 and salivary IgA concentration36–39,57 have all been reported to be suppressed for at least several hours during recovery from prolonged, intense endurance exercise. During this “window of decreased host protection,” viruses and bacteria may gain a foothold, increasing the risk of subclinical and clinical infection. This may be especially apparent when the athlete goes through repeated cycles of heavy exertion.

Natural Killer Cell Activity

NKCA is decreased 45 to 62% for at least 6 hours after 2.5 to 3 hours of high-intensity running.41,42 The drop in NKCA has been related to a loss of natural killer cells from the blood compartment, which probably reduces host protection against viruses and bacteria for a short time period.43

Lymphocyte Proliferative Response

The mitogen-induced lymphocyte proliferative response (T-cell function) after 2.5 hours of running at high intensity is suppressed for several hours relative to control levels.49,50,52 Additionally, after 2.5 hours of running at high intensity, serum cortisol concentrations are significantly elevated above control levels for several hours.43 There is evidence that elevation of serum cortisol and plasma epinephrine both inhibit mitogen-induced lymphocyte proliferation.51–53 Various monocyte functions are inhibited in the presence of cortisol, and since monocytes are important as accessory cells in many T and B lymphocyte responses, cortisol-induced inhibition of monocyte function indirectly contributes to the decrement in ability of T-cells to proliferate in response to concanavalin.58

Taken together, these data suggest that the immune system is suppressed and stressed following prolonged endurance exercise, decreasing host protection against viruses and bacteria. More research, however, is needed to link these immune changes to the increased risk of URTI suggested by epidemiologic data. In a small study of elite squash and hockey athletes, Mackinnon et al59 have demonstrated that low salivary IgA concentrations precede URTI. However, exercise training-induced changes in T-cell or neutrophil function have not been related to URTI.27,59,60

MANAGEMENT OF THE ATHLETE DURING INFECTION

Endurance athletes are often uncertain of whether they should exercise or rest during an infectious episode. There are few data available in humans to provide definitive answers. Most clinical authorities in this area recommend that if the athlete has symptoms of a common cold with no systemic involvement, then regular training may be safely resumed a few days after the resolution of symptoms.61–64 Mild exercise during sickness with a common cold does not appear to be contraindicated, but there is insufficient evidence at present to say one way or the other. However, if there are symptoms or
signs of systemic involvement (fever, extreme tiredness, muscle aches, swollen lymph glands, etc.), then 2 to 4 weeks should probably be allowed before resumption of intensive training.1,61–64

These recommendations are speculative, however, and are primarily based on animal studies and some case reports among humans who died following bouts of vigorous exercise during an acute viral illness.1 Depending on the pathogen (with some more affected by exercise than others), animal studies generally support the finding that one or two periods of exhaustive exercise following inoculation of the animal leads to a more frequent appearance of infection and a higher fatality rate.63 It is well established that various measures of physical performance capability are reduced during an infectious episode.63,65–69 Although causes are debated, muscle protein catabolism, circulatory deregulation, and mitochondrial abnormalities have been reported.68,70,71 Several case histories have been published demonstrating that sudden and unexplained deterioration in athletic performance can in some individuals be traced to either recent URTI or subclinical viral infections that run a protracted course.61–64 In some athletes, a viral infection may lead to a severely debilitating state known as "post-viral fatigue syndrome."70,71 The symptoms can persist for several months and include lethargy, atypical depression, excessive sleep, night sweats, easy fatiguability (made worse by exercise), and myalgia.

For athletes who may be undergoing heavy exercise stress in preparation for competition, several precautions may help to reduce their risk of URTI.1

1. Eat a well-balanced diet to keep vitamin and mineral pools in the body at optimal levels.72 Although there is insufficient evidence to recommend nutrient supplements, ultramarathon runners may benefit by taking vitamin C supplements before ultramarathon races.

2. Keep other life stresses to a minimum. Mental stress in and of itself has been linked to an increased risk of URTI.73

3. Avoid overtraining (ie, training beyond what the body can recover and adjust to) and chronic fatigue.6,12,19,20,27,59

4. Avoid rapid weight loss (eg, more than 1% of body weight per week, which has also been linked to negative immune changes, especially T-cell suppression).74

5. Avoid putting hands to the eyes and nose (a primary route of introducing viruses into the body).75 Before important race events, avoid sick people and large crowds when possible.

6. For athletes competing during the winter months, flu shots are recommended.1

7. Obtain adequate sleep on a regular schedule. Sleep disruption has been linked to suppressed immunity.76

8. Use carbohydrate beverages before, during, and after marathon-type race events or unusually heavy training bouts. These may lower the impact of stress hormones on the immune system. 77,78

REFERENCES


The Role of Nonsteroidal Anti-Inflammatory Drugs in the Treatment of Acute Soft Tissue Injuries

Jay Hertel, MEd, ATC

Objective: Nonsteroidal anti-inflammatory drugs (NSAIDs) are frequently used to hasten the return of injured athletes to competition after injury. Evidence demonstrates that while NSAIDs may speed recovery after acute soft tissue injuries, long-term healing may be compromised. This review aims to assess the effects of NSAIDs on inflammation and healing associated with acute soft tissue injury.

Data Sources: CINAHL (1982 to 1997), SPORT Discus (1977 to 1997), and MEDLINE (1993 to 1997) were searched using the keywords “NSAIDs,” “musculoskeletal,” “acute,” “sprain,” and “strain.”

Data Synthesis: NSAIDs exhibit anti-inflammatory effects via prostaglandin inhibition, neutrophil migration suppression, and oxygen free-radical inhibition. Retardation of inflammatory processes after acute injury may limit the area of secondary tissue damage but may also retard healing. Animal models have demonstrated short-term benefits with NSAIDs after acute injury, along with long-term adverse effects on tissue structure and function. NSAIDs have exhibited few benefits in the treatment of delayed-onset muscle soreness. Clinical trials of NSAIDs in the treatment of acute soft tissue injuries have shown conflicting results and have been highly criticized.

Conclusions/Recommendations: Based on the research literature, the short-term benefits of NSAIDs in the treatment of acute soft tissue injuries must be weighed against the potential long-term adverse effects on tissue healing, structure, and function.

Key Words: NSAID, acute injury, delayed-onset muscle soreness, inflammation

NSAIDs are most commonly administered orally and are broken down in the gastrointestinal system. The drug circulates and is metabolized by either the kidneys or the liver, depending on the individual properties of the NSAID. NSAIDs may also be delivered via topical gels, phonophoresis, iontophoresis, or intramuscular injection, although the efficacy of these routes of administration is not as well studied as the oral route of administration. This article will concentrate on the properties of orally administered NSAIDs.

CLASSIFICATION OF NSAIDS

Three classification systems are used to describe NSAIDs. The first system distinguishes between prescription and OTC NSAIDs. Prescription NSAIDs must be prescribed by a health care provider licensed by the individual state and are more potent and, thus, also potentially more harmful than OTC NSAIDs. Dosages of prescription NSAIDs are much higher than those available OTC. NSAIDs are one of the most commonly prescribed classes of pharmaceuticals. In the past few years, many more OTC NSAIDs have become available in the United States (Table 1). Athletic trainers must be extremely cautious in the recommendation of OTC NSAIDs to athletes and must be aware of the drugs’ characteristics.

OTC NSAIDs are available in doses that primarily yield analgesic and antipyretic effects, but not anti-inflammatory effects. The dosage to achieve anti-inflammatory effects generally is twice that needed to achieve analgesic effects. Clinically, it is very difficult to distinguish between the anti-inflammatory and analgesic effects of NSAIDs.

Another means of classifying NSAIDs is by chemical structure (Table 2). If the desired effects from a given NSAID are not obtained after 2 weeks of consistent drug therapy, a trial with an NSAID from a different chemical classification is recommended.

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Table 1. Over-the-Counter NSAIDs and Their Common Trade Names Available in the United States*

<table>
<thead>
<tr>
<th>Active Drug</th>
<th>Common OTC Trade Names</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetylsalicylic acid</td>
<td>Aspirin, Ascriptin, Bufferin, Excedrin</td>
</tr>
<tr>
<td>Ibuprofen</td>
<td>Motrin, Advil, Nuprin</td>
</tr>
<tr>
<td>Ketoprofen</td>
<td>Orudis KT, Actron</td>
</tr>
<tr>
<td>Magnesium salicylate</td>
<td>Doan’s Analgesic</td>
</tr>
<tr>
<td>Naproxen sodium</td>
<td>Aleve</td>
</tr>
</tbody>
</table>

* Summarized from the Physicians’ Desk Reference for Nonprescription Drugs.51

NSAIDs are also commonly classified by half-life (Table 3), the time necessary to eliminate half of the ingested amount of drug from the body.4 The half-lives of NSAIDs vary from less than an hour to more than 24 hours. Peak plasma concentrations and peak clinical effects are seen after 3 to 5 half-lives when the patient is consistently taking the medication.4,7,9,10 Drugs with short half-lives normally are taken three to six times per day to achieve anti-inflammatory effects. Peak plasma concentrations and peak clinical effects can be seen sooner with short half-life NSAIDs. In contrast, drugs with longer half-lives are taken only once or twice per day and are slower in eliciting the desired clinical effects. However, patients who are prescribed drugs with longer half-lives tend to be more compliant in taking their medication.10 It is interesting to note that all but one of the OTC NSAIDs (naproxen sodium) are in the short half-life category.

Acetaminophen is a drug that is not an NSAID but deserves special mention. Acetaminophen (commonly marketed as Tylenol) renders analgesic and antipyretic effects but not anti-inflammatory or anticoagulant effects. It appears to operate independently of the cyclooxygenase pathway by which NSAIDs work. Acetaminophen is commonly administered for its analgesic effects after acute injury.5

THE INFLAMMATORY PROCESS

After acute injury, inflammation is the body’s method of limiting the amount of tissue damage and protecting against further insult. Injury to soft tissue results in a nonspecific physiologic response that activates a series of proinflammatory events. Immediate vasoconstriction limits local hemorrhage and is followed by subsequent vasodilation and an increase in vascular permeability near the site of injury.11 Platelets quickly adhere to one another at the site of capillary damage to provide a mechanical plug to prevent further bleeding. The clotting cascade is simultaneously activated and results in the formation of fibrin and fibronectin, which form cross-links with collagen to reinforce the temporary plug and stop hemorrhage.11 The zone of primary injury is defined by the extent of the initial hematoma.10

Bradykinin, serotonin, and histamine are pain-producing chemical mediators that are released quickly after trauma and aid in the attraction of leukocytes to the site of injury. Table 4 summarizes the role of the different leukocytes in the inflammatory process.

Arachidonic acid is a phospholipid that is a component of all cell membranes. Injury causing disruption of a cell membrane allows an increase in intracellular Ca++, leading to the activation of phospholipase A2, which cleaves arachidonic acid from the cell membrane. Arachidonic acid is then metabolized by either the cyclooxygenase or lipoxygenase pathways. Prostaglandins, thromboxanes, and prostacyclin are produced via the cyclooxygenase pathway, while leukotrienes are produced

Table 2. Chemical Classifications of Common NSAIDs and Their Common Trade Names*

<table>
<thead>
<tr>
<th>Carboxylic Acids</th>
<th>Enolic Acids</th>
<th>Nonacids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Propionic Acids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carprofen (Rimadyl)</td>
<td></td>
<td>Oxicams</td>
</tr>
<tr>
<td>Fenoprofen (Nalfon)</td>
<td></td>
<td>Piroxicam (Feldene)</td>
</tr>
<tr>
<td>Flurbiprofen (Ansaid)</td>
<td></td>
<td>Pyrazolones</td>
</tr>
<tr>
<td>Ibuprofen (Advil, Motrin)</td>
<td></td>
<td>Oxyphenylbutazone</td>
</tr>
<tr>
<td>Ketoprofen (Orudis)</td>
<td></td>
<td>Phenylbutazone (Azolid, Butazolidin)</td>
</tr>
<tr>
<td>Naproxen (Aleve, Naprosyn)</td>
<td></td>
<td>Pyrolopyrroles</td>
</tr>
<tr>
<td>Naproxen sodium (Anaprox)</td>
<td></td>
<td>Ketorolac (Toradol)</td>
</tr>
<tr>
<td>Oxaprosin (Daypro)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fenamates</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meclofenamate sodium (Meclomen)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mefenamic acid (Ponstel)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acetic Acids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diclofenac sodium (Voltaren)</td>
<td></td>
<td>Nabumetone (Relafen)</td>
</tr>
<tr>
<td>Etdolac (Lodine)</td>
<td></td>
<td></td>
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<tr>
<td>Indomethacin (Indocin)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sulindac (Clinoril)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tolmetin (Tolectin)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salicylates</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acetylsalicylic acid (Aspirin)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diflunisal (Dolobid)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salsalate (Salflex, Disalcid)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnesium salicylate (Doan’s Analgesic)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Choline magnesium trisalicylate (Trilisate)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Summarized from various sources.4,5,7,9,23,52-54
via the lipoxygenase pathway. The Figure illustrates the arachidonic acid cascade.

Prostaglandins, especially PGE₂, play an integral role in the inflammatory process and may be produced by all cells in the human body except erythrocytes. They signal a plethora of proinflammatory events including induction of vasodilation, increased vascular permeability, increased local blood flow, and increased body temperature via actions on the hypothalamus. Prostaglandins also serve to increase the sensation of pain by decreasing the sensitivity of nociceptors and potentiating the effects of bradykinin and histamine. PGE₂ expression may increase 10- to 80-fold during acute inflammation. Additionally, PGE₂ attracts leukocytes to the site of inflammation.

Prostacyclin and thromboxane are chemically unstable, yet extremely potent, compounds that have antagonistic actions during inflammation. Prostacyclin, also known as PGI₂, inhibits platelet aggregation on blood vessel walls, while thromboxane A₂ induces rapid platelet aggregation and vasoconstriction. This antagonist relationship serves to control the amount of local bleeding that occurs after injury.

Leukotrienes are derived from arachidonic acid via the lipoxygenase pathway. Leukotriene B₄ (LKB₄) is an extremely potent chemoattractant for leukocytes and causes an increase in vascular permeability. LKB₄ can also stimulate granulocyte aggregation to the site of injury. Other leukotrienes are not as potent as LKB₄, but they do play an inflammatory role in slow-reacting anaphylaxis (for example, during asthma attacks).

Neutrophils are the first leukocytes attracted to the site of inflammation by many of the previously discussed mediators. Neutrophil activation results in a respiratory burst, which is characterized by the generation of high concentrations of oxygen free radicals and reactive oxygen species such as hydrogen peroxide (H₂O₂), superoxide anions (O₂⁻), and hydroxyl radicals (HO·). These are extremely reactive and chemically unstable compounds that attack cell membranes and break down cell walls via the production of lysosomal enzymes such as collagenase. Lysis of cell membranes further potentiates the inflammatory process by liberating additional amounts of arachidonic acid from cell membranes.

More cell damage can occur from the edema and tissue hypoxia that are the result of the acute vascular inflammatory response. This subsequent tissue damage is often referred to as the "secondary zone of injury," in contrast to the initial damage caused by the actual mechanism of injury.

There are also other components of the inflammatory process, such as the complement system and a complex interaction of cellular messengers known as cytokines. The complement system provides a nonspecific reaction to injured tissue and infectious particles by assembling a membrane attack complex and attracting leukocytes to the site of injury. Several cytokines that are also known as interleukins have been identified as active components in chronic inflammatory conditions such as rheumatoid arthritis and osteoarthritis, but their exact role in the inflammatory process associated with acute soft tissue injury is not fully understood.
Macrophages will migrate to the area of inflammation within 24 hours of initial trauma and begin to phagocytize necrotic debris. At this point, the inflammatory process becomes a healing process as the body begins to clear away damaged tissues and lay the foundation for new tissues. Rampant phagocytosis normally lasts for several days after injury but varies depending on the severity of the injury. As phagocytosis is nearing completion, fibroblasts and granulocytes are drawn to the site of injury by growth factors, and new collagen is produced in an effort to replace the injured tissues. This is referred to as the proliferation phase of healing. A new network of capillaries is established within a few days of trauma to ensure that the scar tissue is well vascularized.

The tensile strength at the site of injury is at its weakest between day 2 and day 5 after injury. Tensile strength is normally increasing by day 7 after injury and, as new tissue is constructed, the original scar tissue is being dissolved. The scar eventually decreases in size, and tissue remodeling occurs according to the specific demands placed on the healing tissues. Complete scar maturation may take up to 1 year.

**Effects of NSAIDs on Prostaglandin Synthesis**

The primary mechanism of action of NSAIDs has been identified as inhibition of prostaglandin synthesis by blocking the cyclooxygenase pathway of the arachidonic acid cascade. By blocking the cyclooxygenase pathway, the production of prostaglandins, thromboxane, and prostacyclin are thus thwarted by NSAIDs. However, the inflammatory process is not stopped entirely by NSAIDs because the arachidonic acid cascade is able to continue via the lipoxygenase pathway. LKB4, an extremely potent inflammatory mediator, and other leukotrienes are still produced in the presence of NSAIDs.

Two isoenzymes of cyclooxygenase have been identified and are referred to as cox-1 and cox-2. NSAIDs act indiscriminately on both cox-1 and cox-2. Cox-1 functions as a physiologic “housekeeper” and induces prostaglandin synthesis for normal healthy body functions, such as producing cytoprotective mucus in the digestive tract. Prostaglandins are required for normal physiologic processes to occur in the gastrointestinal tract, kidneys, liver, and other organs. When cox-1 is inhibited by NSAIDs, prostaglandin synthesis does not occur in the gastrointestinal tract, kidneys, and other organs, and, thus, the normal physiologic functions carried out by prostaglandins cannot occur. Inhibition of cox-1 causes many of the visceral side effects associated with NSAIDs.

Cox-2 is present in most tissues in small amounts, but levels are enhanced considerably at sites of inflammation. Cox-2 is involved in prostaglandin synthesis associated with the inflammatory process. NSAIDs blocking cox-2 thus inhibit prostaglandin synthesis associated with inflammation. Hence, the ultimate anti-inflammatory drug would theoretically inhibit prostaglandin synthesis mediated by cox-2 while having no effect on cox-1.

**Nonprostaglandin Effects of NSAIDs**

While NSAIDs are known to slow inflammation by blocking the cyclooxygenase pathway of the arachidonic acid cascade, NSAIDs also have anti-inflammatory effects unrelated to arachidonic acid. NSAIDs are known to inhibit neutrophil aggregation and migration to sites of inflammation. Other alterations of neutrophil function are also affected, including the slowing of lysosomal enzyme release, decreased oxidative phosphorylation, and decreased production of substances that are chemotactic for other leukocytes. Oxygen free-radical production by neutrophils and phagocytes is also decreased in the presence of NSAIDs.

Anion transport across cell membranes has been shown to be diminished, while Ca++ transport into cells is facilitated by NSAIDs. NSAIDs have also been shown to have anticoagulant effects by acting on platelets. NSAIDs may also inhibit T-cell activity and the release of histamine by mast cells.

**Effects of NSAIDs on Muscle and Ligament Injury Models**

Researchers utilizing animal models to study the histologic effects of NSAIDs on muscle and ligament injury have shown that NSAIDs yield short-term improvements in muscle healing and function, but either no long-term benefits or potentially deleterious long-term effects on muscle structure and function.

Mishra et al induced muscle strain to the anterior tibialis muscle of rabbits, treated one group with flurbiprofen and another group with a placebo, and then assessed muscle function and histology at 3, 7, and 28 days after injury. The treatment group was able to generate greater peak torque and exhibited greater maximum tetanic tension than the placebo group at days 3 and 7 postinjury. However, at 28 days, those treated with flurbiprofen were able to produce less torque and demonstrated less maximum tetanic tension than those treated with the placebo. In addition, the treatment group had significantly less structural protein loss at the site of injury at 3 and 7 days postinjury and fewer circulating lymphocytes than the placebo group at 7 days.

In a study examining the effects of piroxicam on the healing and function of anterior tibialis muscle strains in rabbits, the piroxicam-treated group was able to generate more contractile force than the placebo group on the day after injury. No significant differences were found in maximum tetanic contraction between the groups through 1 week postinjury. However, the piroxicam-treated group subjectively appeared to have delayed inflammation and healing compared with the placebo group throughout the first week after injury.

The effects of immobilization and piroxicam with immobilization after stretch-induced muscle injury to the anterior tibialis muscle of rats were compared at 0, 2, 4, and 11 days after injury. The piroxicam-treated group exhibited greater maximum tetanic tension than the immobilization group at days 2 and 11. The piroxicam-treated group also had less macrophage invasion at day 2. In addition, the immobilization
group had more subjective signs of healing than the piroxicam group at day 11.3 Thomas et al25 studied the effects of indomethacin on the healing of Achilles tendon ruptures in rabbits and found no differences in tensile strength or histologic examination up to 6 weeks after the injury. The results of this study demonstrating no effect of indomethacin on soft tissue healing are in contrast to studies that have shown indomethacin to retard the healing of fractures.26,27

Almekinders et al19 examined the in vitro effects of indomethacin on DNA synthesis, protein synthesis, and PGE₂, LKB₄, and interleukin-6 levels in human tendon fibroblasts exposed to bouts of repetitive motion over the course of 108 hours. PGE₂ levels were found to be significantly decreased in the presence of indomethacin, while no changes in LKB₄ levels were observed. DNA synthesis was inhibited by indomethacin, while protein synthesis was enhanced. Interleukin-6 levels were elevated in the absence of indomethacin. These results suggest that indomethacin may have confounding actions on tissue healing by decreasing DNA synthesis, yet stimulating protein synthesis.

The effects of piroxicam on the healing of ligament injuries were investigated after the severing of the medial collateral ligaments of rats.28 Those treated with piroxicam for the first 6 days after injury demonstrated greater tensile tension of the ligament at 14 days postinjury than those treated with a placebo. However, no significant differences in tensile tension were noted at 21 days postinjury. Doubling or halving the dose of piroxicam given to the rats did not alter the findings. Administration of piroxicam after ligament injury did not yield detrimental effects on healing within 21 days of injury.28

The results of these studies seem to demonstrate that NSAIDs are effective in reducing acute inflammation, but they may compromise the long-term healing of the injured tissue. Generalizing the results of animal studies to humans must be done cautiously. Animals’ metabolism of NSAIDs may be different from that of humans, and it is difficult to estimate dose sizes comparable in animals and humans. While animal studies allow for excellent control of drug compliance, it is not possible to assess the effects of NSAIDs in conjunction with a structured rehabilitation program on the healing of acute soft tissue injuries.

Effects of NSAIDs on Delayed-Onset Muscle Soreness

The effects of NSAIDs on human muscle inflammation have been studied using the induction of delayed-onset muscle soreness (DOMS) after repetitive eccentric contractions as a model of muscle injury in humans. Bouts of eccentric exercise generate small amounts of muscle fiber damage and result in significant pain in the days after eccentric exercise.

Several authors have found no beneficial results when NSAIDs were administered before and after bouts of lower extremity eccentric exercise.29–31 Flurbiprofen (150 mg/day) was not found to decrease subjective scores of pain or tissue damage markers on histologic examination of muscle when administered 6 hours before and for 72 hours after 30 minutes of eccentric cycling.31 Administration of diclofenac (150 mg/day) 6 hours before and for 72 hours after 45 minutes of downhill running was not found to decrease soreness or tenderness and resulted in no alterations of blood chemistry when compared with a placebo.30 In a follow-up study, subjects ingesting ibuprofen (2400 mg/day) before and after 45 minutes of downhill running had increased pain on palpation and elevated levels of serum creatine kinase and serum urea compared with those ingesting a placebo, suggesting that the ibuprofen may have contributed to further muscle damage.29

Grossman et al32 found that subjects taking ibuprofen (2400 mg/day) before and after eccentric exercise of the elbow flexors had no differences in concentric or eccentric muscle strength, pain, or range of motion at 48 and 96 hours postexercise compared with a group taking a placebo.

In contrast, Hasson et al33 found that those taking ibuprofen prophylactically (400 mg before exercise and 1200 mg/day after) had less pain and strength loss 24 hours after inducement of DOMS. Subjects who took ibuprofen either prophylactically or after the exercise (1200 mg/day) session had less pain and strength loss 48 hours after exercise than those taking a placebo.

The results show a consensus of studies demonstrating that NSAIDs do not adequately reduce the effects of DOMS after eccentric exercise. While DOMS models induce pain and some degree of myofibular disruption, prostaglandins do not appear to play as integral a role as they do in the inflammatory process accompanying actual muscle strains.31

Clinical Trials of NSAIDs in Sports Medicine

Clinical studies of the efficacy of NSAIDs on acute soft tissue injuries in the sports medicine setting have been highly criticized in previous literature reviews.22,34–36 Many studies have lacked quality research design methods such as not being conducted in a double-blind manner or not using a placebo control. Often two or more NSAIDs have been compared for efficacy, but no placebo was included in the study, so there was no way to verify that any of the NSAIDs yielded beneficial effects. In addition, the interval between injury and initial administration of the drug has often been poorly controlled. To truly identify the effects NSAIDs have on acute injuries, drug therapy should begin within 24 hours of injury.34

Clyman22 has criticized previous studies for employing poorly defined subjective measurements rather than objective variables as indicators of healing. Other common problems with clinical trials have included several different types of injuries (eg, sprains, strains, contusions, tendinitis) in the same trial and poor control over the severity of injuries included in trials. Researchers have also tended to track injured subjects only for a short period of time, such as a few weeks, after injury and to not gather data regarding reinjury rates or long-term functional capacity and performance. The adverse effects of NSAIDs have also not been regularly examined. Furthermore, many researchers have failed to control for adjunct treatments including rehabilitation, immobilization, or weightbearing status.35 Given these criticisms, readers must interpret the data from these studies cautiously.
A review of the ten placebo-controlled, scientifically sound trials investigating the effects of NSAIDs on acute soft tissue injuries since 1980 revealed that six found beneficial effects, three did not yield beneficial results, and one had conflicting results. Most benefits were seen in the first few weeks after injury, and no long-term benefits were seen. These findings may be attributable to the generally quick healing of strains and sprains regardless of different types of therapy.

Santilli et al investigated the effects of piroxicam (20 mg/day), OTC ibuprofen (900 mg/day), and a placebo on soft tissue injuries in 30 professional athletes. Patients in all three groups improved significantly throughout the trial, although the piroxicam group demonstrated less pain and functional disability than the OTC ibuprofen and placebo groups.

McLetchie et al examined 133 athletes suffering mild or moderate ankle sprains who were treated with either 600 mg ibuprofen four times daily, 1200 mg ibuprofen twice daily, or a placebo for 7 days. Those treated with either dosing schedule of ibuprofen had greater active range of motion 3 days postinjury, but no differences in motion were noted at 7 days. The ibuprofen groups did exhibit less joint tenderness and more functional capacity than the placebo group at 7 days.

Hutson investigated the effects of two different daily doses of ibuprofen (1800 mg/day and 2400 mg/day) and a placebo on the recovery of 46 individuals who suffered ligamentous knee injuries. While significant improvements were seen in the level of joint effusion and pain in all three groups on days 7 and 14, those treated with ibuprofen returned to weightbearing sooner and had greater range of motion on days 7 and 14. The ibuprofen groups had a greater functional capacity than the placebo group at day 7 but not at day 14.

Lereim and Gabor examined the effects of piroxicam (40 mg/day for 2 days, then 20 mg/day for 5 days) versus a placebo in 74 individuals suffering from a variety of lower extremity soft tissue injuries. At 3 days postinjury, the piroxicam group had significantly less pain at rest, with movement, and with weightbearing and less tenderness and functional limitation, as well as greater muscle strength, than the placebo group. However, at 7 days the only differences between groups were seen in strength and tenderness. On average, the piroxicam groups had complete relief from symptoms 2.7 days sooner than the placebo group.

Bahamonde and Saavedra studied the effects of diclofenac (150 mg/day), piroxicam (20 mg/day), and a placebo for 7 days on 93 subjects who sustained ankle sprains. After 2 days of treatment, diclofenac reduced pain at rest and while weightbearing to a greater degree than piroxicam or a placebo, but no differences were seen in edema. There were no differences in any of the dependent variables among the three groups after the medications were discontinued.

Giani et al utilized telethermography in addition to clinical examination to investigate the effects of a 7-day administration of diclofenac sodium (150 mg/day), suprofen (600 mg/day, an NSAID not available in the US), and a placebo on the outcome of 45 patients suffering acute musculoskeletal injuries. Diclofenac sodium was found to be superior to suprofen and placebo with regard to the physician’s clinical evaluations, the patients’ subjective evaluations, and the telethermographic evaluation.

Jenner performed a meta-analysis on the effects of nabumetone (2 g/day) with a placebo and with aspirin (2700 mg/day), ibuprofen (1600 mg/day), and naproxen (1000 mg/day) on 986 patients suffering from soft tissue and skin injuries. Drug therapy lasted for 7 days, and no significant differences were found between the placebo and nabumetone in regard to patient recovery. Nabumetone was found superior to aspirin in limiting pain and swelling, but inferior to naproxen in regard to pain. Nabumetone also yielded fewer gastrointestinal side effects than aspirin.

Dupont et al compared the effects of ibuprofen (2400 mg/day) and a placebo on 61 athletes suffering acutely sprained ankles over the course of 8 days. An aggressive functional rehabilitation program was performed by all subjects. Subjects were evaluated for pain, tenderness, edema, and functional capacity at baseline and 4, 8, and 28 days after injury. No significant differences were found between groups, and the authors emphasized that the successful outcomes of the subjects may be linked to the aggressive rehabilitation program.

Fredberg et al examined the effects of ibuprofen (2400 mg/day) and a placebo on 68 individuals who suffered acute ankle sprains. Subjects had their ankles immobilized in casts for 4 days after the initial examination and were then evaluated for changes in pain and ankle circumference on the fourth day of treatment. No significant differences were found between the ibuprofen and placebo groups for pain or joint circumference.

Slatyer et al examined the effects of piroxicam (40 mg/day for 2 days, then 20 mg/day for 5 days) and a placebo on recovery from ankle sprain in 364 Australian military recruits. Subjects in both groups underwent a standard course of physical therapy and were evaluated at 3, 7, and 14 days and 1, 3, and 6 months after injury. The piroxicam group experienced less pain, was able to return to military training sooner, and had increased exercise endurance upon return to training over the placebo group. However, the piroxicam group also demonstrated a higher prevalence of positive anterior drawer signs and reduced ankle ranges of motion than the placebo group. These data suggest that, while piroxicam may help an injured individual return to activity sooner, adequate healing of injured tissues may not take place if an NSAID is administered in the days after acute injury. The authors reported a 25% recurrence rate within 6 months of initial injury, but they failed to identify any differences in recurrence between treatment groups.

These studies yielded conflicting results pertaining to the role of NSAIDs in the treatment of acute soft tissue injuries. These inconsistencies may be due to a number of factors, including the differences in drug choice and dosage and severity of injuries investigated. Given the disparity in these findings, it is difficult to either unequivocally advocate or condemn the use of NSAIDs in the treatment of acute soft tissue injuries. Those prescribing NSAIDs must be aware of the potential benefits and risks of these drugs as they relate to soft tissue healing.
The retarded healing of injured soft tissues after the administration of NSAIDs may be due to limiting development of the secondary zone of injury. If neutrophil and phagocyte migration are limited after injury, fibroblast and granulocyte activity may also be diminished in the days after injury. This may result in impaired scar tissue formation, thus leading to a subsequent decreased tensile strength of the mature scar tissue.

It is difficult to separate the anti-inflammatory and analgesic effects of NSAIDs in the treatment of acute injuries.8 Analgesia may allow increased range of motion earlier in the rehabilitation process and thus hasten the recovery process, regardless of the anti-inflammatory effects. Further research is needed to examine the effects of analgesics without anti-inflammatory effects, such as acetaminophen, in the treatment of acute athletic injuries.

Previous authors34–36 have expressed a need for better-controlled clinical studies to explore the efficacy of NSAIDs in the treatment of acute injuries. Future studies must use randomized, double-blind, placebo-controlled designs and also must limit the interval from injury to onset of drug therapy to less than 24 hours. In addition, rehabilitation and other adjunct therapies must also be controlled for and treated as independent variables. Including a control group consisting of injured subjects who receive neither NSAIDs nor a placebo will help to eliminate any placebo effects from the study. Dependent variables must include objective measurements of functional status and rates of reinjury in addition to the subjective assessments of pain and tenderness.

**Adverse Systemic Effects of NSAIDs**

As mentioned previously, aspirin was the original NSAID, but it was found to cause numerous adverse systemic effects in addition to its target analgesic, antipyretic, and anti-inflammatory effects. The other members of the NSAID class, while producing fewer adverse effects than aspirin, are also not free of side effects.

The most common side effects associated with NSAIDs are gastrointestinal ailments such as dyspepsia, nausea, gastrointestinal bleeding, and ulcers.12,34,47 These effects stem primarily from the inhibition of prostaglandins in the gastric mucosa. Prostaglandins normally decrease gastric acid secretion and increase bicarbonate and mucus secretion; however, in the presence of prostaglandin-inhibiting drugs, these protective mechanisms cannot occur.7 Gastrointestinal symptoms are most often related to chronic NSAID use but may also be seen with short-term use.7

Gastrointestinal effects may be reduced by the concurrent prescription of a cytoprotective medication, such as an H2 blocker or misoprostol.9 Etodolac, a member of the pyranocarbacylic acid class, does not inhibit prostaglandin synthesis in the gastric mucosa; therefore, ingestion of etodolac is associated with fewer serious gastrointestinal effects than other NSAIDs.7 In addition, ingestion of NSAIDs with food appears to decrease gastrointestinal distress.48

Some NSAIDs, especially aspirin and the salicylates, are known to impair normal coagulation by inhibiting platelet aggregation. This effect is potentially harmful during periods of acute inflammation because it may lead to a greater area of initial hematoma after injury. The adverse effects on clotting mechanisms associated with NSAIDs are of particular importance in individuals who have a coagulopathy or a closed head injury.48 Aspirin permanently inhibits cyclooxygenase for the length of an erythrocyte’s life and can thus impair clotting for up to a week after injury.49 Non-traumatic compartment syndrome has been reported following ingestion of aspirin 2 days after a muscle strain injury.50 NSAIDs should be avoided when an individual is taking anticoagulant medications, such as coumadin and warfarin.5,10 NSAIDs are sometimes prescribed specifically for their anticoagulant effects in the treatment of conditions such as deep vein thrombosis.12

A less common side effect involves renal dysfunction after the ingestion of NSAIDs.23 This effect is most often seen in the elderly and those with previous kidney damage and thus is less likely to occur in the athletic population.12 Prostaglandins are involved in the regulation of normal renal homeostasis; therefore, normal renal function can be inhibited by NSAIDs. Calabrese and Rooney47 caution against the use of NSAIDs by individuals who are dehydrated because of the possibility of causing renal damage.

Aspirin sensitivity is an allergic reaction resulting in urticaria, angioedema, and asthma. Those with aspirin sensitivity should avoid all NSAIDs.9,47

Other side effects occasionally associated with NSAID use include hepatic damage and central nervous system dysfunction. Liver damage typically occurs only in individuals who have suffered previous liver damage.12 The most common central nervous system effects include headache, tinnitus, and drowsiness.12

Limitation of side effects is best achieved via careful monitoring by the prescribing physician and other health care providers of patients prescribed NSAIDs. It should also be noted that many of the adverse effects are associated with chronic NSAID use. Prescription and OTC NSAID use by athletes must be closely monitored by all health care providers.

**CONCLUSIONS**

NSAIDs are commonly used in the treatment of acute soft tissue injuries in athletes, yet their efficacy is not substantiated in the scientific literature. While NSAIDs are often prescribed for their anti-inflammatory, analgesic, and antipyretic effects after acute injury, there is little evidence to support the claim that NSAIDs hasten the return of injured athletes to competition. In addition, separating the anti-inflammatory effects from the analgesic effects is not easy. Recent evidence from studies using animal models suggests that the short-term benefits of NSAIDs may be outweighed by long-term compromise of the structure and function of the injured tissue.

Because of the numerous adverse effects associated with NSAIDs, athletic trainers must be aware of the potential benefits and liabilities of NSAID use by injured athletes. Further research must address the effectiveness of NSAIDs in clinical trials involving injured athletes. Current research...
demonstrates that NSAIDs may be beneficial in hastening the return to competition by injured athletes but also that NSAIDs should be only one part of the total treatment plan. NSAIDs do not take the place of therapeutic modalities and exercise and must be considered as an adjunct to rehabilitation rather than the most direct route to recovery.

ACKNOWLEDGMENTS

I thank Craig Denegar, PhD, ATC, PT, Associate Professor of Kinesiology and Orthopedics at the Pennsylvania State University, for his initial review of this manuscript.

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Exercise-Induced Vasodepressor Syncope in a Collegiate Wrestler: A Case Study

Jim Hand, MS, ATC

**Objective:** To present the case of an 18-year-old collegiate wrestler diagnosed with vasodepressor syncope.

**Background:** Vasodepressor syncope and the pathophysiologic mechanisms responsible are not fully understood. It is postulated that a sudden, rapid reduction in venous return to the heart allows for quite forceful ventricular contractions. Hypotension, bradycardia, and possible cerebral hypoxia may result, which could cause loss of consciousness.

**Differential Diagnosis:** Cardiovascular, neurologic, metabolic, and psychogenic causes.

**Treatment:** Pharmacologic therapy of fludrocortisone acetate and potassium chloride was effective. The athlete returned to full activity without restrictions and remained symptom free throughout the remainder of the season.

**Uniqueness:** Vasodepressor syncope is usually associated with full syncope. However, this 18-year-old wrestler never fully lost consciousness. His symptoms occurred primarily with exercise.

**Conclusions:** The athletic trainer should consider exercise-induced vasodepressor syncope as a possible etiology for those athletes who present with presyncopal episodes.

**Key Words:** presyncope, tilt-table test, cardiovascular system, cerebral hypoxia

The occurrence of syncope or presyncope among conditioned athletes can be an indicator of a serious or life-threatening condition. Therefore, a definitive diagnosis must be established. One possible cause of these symptoms is exercise-induced vasodepressor syncope. This condition affects the vagal reflex, lowering the blood pressure and heart rate, and it can lead to cerebral hypoxia. Symptoms of syncope or presyncope can include lightheadedness, fatigue, nausea, disorientation, warmth, heart palpitations, diaphoresis, paresthesias, pallor, loss of consciousness, convulsions, or seizures. Exercise-induced vasodepressor syncope can be controlled with pharmacologic therapy, and completely asymptomatic return to sport is typical.

**REPORT OF CASE**

An 18-year-old white male, a first-year NCAA Division I wrestler, presented with presyncopeal episodes. His symptoms included blurred vision, vertigo, nausea, diaphoresis, and paresthesias of the fingertips and occasionally the mouth and cheeks. These episodes had occurred once a year since he was six years old. At age seven, he experienced his second episode and was examined by his family physician. The physician did not find anything clinically wrong at the time, and, since these symptoms occurred so rarely and were isolated, no further testing was done. Although these episodes continued at the rate of about once a year, they were not reported to his physician. The athlete reported that he had never had more than two episodes in any given year and certainly never two in the same month. There was no family history of syncope or congenital heart conditions. Although his history revealed no known causes of his presyncope, this athlete was in the process of losing weight during the week of the onset of these presyncopal episodes, 3 months into the season. He had lost 7 pounds in 4 days and was considered slightly dehydrated.

When this case was first reported to the coach and the certified athletic trainer, the athlete had had three episodes in 3 days. Physical examination revealed pallor, hyperventilation, diaphoresis, and a stuporous expression. The athlete’s subjective complaints were anxiety, blurred vision, vertigo, paresthesias of the fingertips and the mouth, and headache. These symptoms lasted approximately 10 to 15 minutes and diminished gradually when the athlete was placed in the supine position with his feet elevated. Vital signs were normal; blood pressure was 134/74; resting heart rate was 56 beats per minute (bpm); eyes were equally reactive to light; and temperature was 37.3°C (99.1°F). There were no prodromal symptoms to these episodes. A thorough history revealed that the only reported abnormality or change in normal routine was that the athlete had decreased his diet and fluid intake by about 60%. The athlete was withheld from all practices and conditioning sessions. He was instructed to immediately cease all weight reduction practices and to drink plenty of fluids, and he was referred to the team physician.

The team physician conducted a thorough physical examination that demonstrated no explanation for the athlete’s presyncope. However, a slight systolic heart murmur was discovered. The physician ordered blood tests, computed tomography (CT) of the head, and an echocardiogram and confirmed the prior decision to withhold the athlete from cardiovascular exercise and fasting practices. The blood tests were taken with the athlete in a fasting state and measured Na, K, Cl, CO₂, glucose, T₄ (thyroxine), and the anion gap (the difference between the concentrations of serum cations (⁺) and anions (⁻); all were within normal limits.

A CT of the head was ordered to rule out any neurologic disorder or genetic abnormality of the brain. Pre- and post-contrast CT imaging of the brain demonstrated no evidence of mass lesions or mass effect and no evidence of intracranial bleeding. The ventricular system of the brain was of normal
size and configuration. There was good gray-white matter differentiation, and the overall study was within normal limits.

An echocardiogram was ordered to rule out mitral valve prolapse. M-Mode and two-dimensional echocardiograms were performed with Doppler and color flow imaging. There was no pericardial effusion and no evidence of mitral valve prolapse. Left ventricular systolic function was normal, and only mild tricuspid regurgitation was evident. Overall, this test was unremarkable and the heart appeared normal morphologically.

Based upon the outcome of these tests, the physician allowed the athlete to wrestle and lift weights but recommended avoiding intense cardiovascular activity that could lead to exhaustion. During the time the athlete was permitted to work out, the presyncopal symptoms persisted, occurring only during exercise or within 30 minutes after exercise. The team physician was notified after each episode. Episodes occurred with each successive practice.

In the continuing search for a diagnosis, a glucose tolerance test was performed. A glucose tolerance test measures the amount of insulin in the bloodstream, a hepatic function based on the liver's ability to absorb and store large quantities of glucose. The results of a 3-hour glucose tolerance test were within normal limits. The physician had actually requested a 5-hour glucose tolerance test, so the test was repeated. The procedure was done with the athlete in the fasting state and was found to be slightly abnormal. His fasting glucose level was 94 mg/dL; 1-hour level was 119 mg/dL; 2-hour level was 56 mg/dL; 3-hour level was 61 mg/dL; and 4- and 5-hour levels were 90 and 96 mg/dL, respectively. The normal range for these levels is between 70 and 105 mg/dL. Despite these slightly abnormal levels of serum glucose, the physician did not find these results significant enough to be causative of the athlete's presyncopal episodes.

The next diagnostic test was an ambulatory electrocardiograph (ECG), otherwise known as Holter monitoring. The athlete was instructed to keep a diary of his symptoms and activities so that the physician could correlate them with the ECG. Twenty-three hours and 11 minutes were recorded as low heart rates and a relative bradycardia, and (2) the reproduction of the clinical symptoms associated with syncope and presyncope. With these criteria met, the diagnosis of vasodepressor syncope was established.

Pharmacologic therapy of Florinef (Bristol-Myers Squibb Co, Princeton, NJ) fluadrocortisone acetate, 0.1 mg daily) was prescribed. Florinef is a corticosteroid that enhances sodium retention and acts as a mediator to the electrolyte balance. It also causes a rise in blood pressure due to its effects on the electrolytes. After 2 weeks of this pharmacologic therapy, a follow-up HUTT test was performed to determine the effectiveness of Florinef in controlling the athlete's vasodepressor syncope.

First, a drug-free HUTT test was administered with the same parameters and guidelines as previously described. No hypotension or presyncope symptoms were produced after 20 minutes at a 70-degree tilt. The test was repeated with the infusion of incremental doses of isoproterenol at a rate of 2 µg/min. The athlete's heart rate went from 56 bpm to 117 bpm with the start of the infusion of isoproterenol, which was given with the athlete in the supine position. The table was again tilted to a 70-degree angle. This triggered the vagal reflex 4 minutes into the test. His blood pressure dropped to 72/33 and his heart rate dropped to 70 bpm, both significantly lower than his baseline rates for the second test with blood pressure of 110/62 and heart rate of 117 bpm.

In order to reproduce the athlete's symptoms, it was necessary to administer isoproterenol, in contrast to the original drug-free HUTT test that produced symptoms. Because this improvement occurred with the use of Florinef, pharmacologic therapy remained the treatment of choice. The physician changed the athlete's prescription to Florinef 0.1 mg two times a day and added K-Dur 20 (Key Pharmaceuticals, Kenilworth, NJ) potassium chloride, 20 mEq) two times a day. Potassium is the major cation of intracellular fluid and is essential for maintenance of acid-base balance, isotonicity, and electrolytic characteristics of the cell. Potassium is also essential to the transmission of nerve impulses and the contraction of cardiac muscles.

The HUTT was administered again, with the same parameters and guidelines as before, this time 4 weeks after the last,
to test the effectiveness of Florinef and K-Dur on the athlete’s presyncope. As with the second tilt test, the third HUTT at 70 degrees for 20 minutes produced no presyncopal symptoms or hypotension. The tilt was repeated with the infusion of incremental doses of isoproterenol at a rate of 2 μg/min. No syncopal or presyncopal symptoms arose for the full 20-minute duration of the test. The third test was considered negative, and the pharmacologic therapy selected in this case was proved to be effective in relieving the symptoms of presyncope.

Based on the results of the third tilt-table test, the athlete was allowed to return to full activity with no restrictions. The athlete did not experience any further syncopal or presyncopal symptoms following his return to wrestling. The cardiologist suggested that the athlete continue his pharmacologic therapy for the duration of his collegiate career, indicating that there is a very good chance this athlete will become asymptomatic in a few years, or at least not experience any more episodes when his wrestling career is over. Despite the good prognosis in either situation, the athlete will need to continue the pharmacologic therapy for 4 years.

**DISCUSSION**

Vasodepressor syncope and the pathophysiologic mechanisms responsible for vasovagal mediated hypotension and bradycardia are not completely understood. In those individuals with vasovagal syncope, it is postulated that a sudden rapid reduction in venous return to the heart allows for quite forceful ventricular contractions. Hypotension, bradycardia, and possible cerebral vasoconstriction may result, which could cause cerebral hypoxia and loss of consciousness. The most current theory on the cause of the hypotension and bradycardia that lead to syncope takes the above explanation a step further. Several authors theorize that a rapid decrease in venous return to the heart may also result in quite vigorous ventricular contractions that activate mechanoreceptors (c-fibers), which are sparse in the right ventricle but are particularly numerous in the inferoposterior wall of the left ventricle, causing an increase in afferent neural output. It is believed that this sudden surge in neural input to the brainstem produces a reflex bradycardia and peripheral vasodilation, resulting in cerebral hypoxia. Kosinski and Grubb found that all of their 21 patients could control their syncope (31) or presyncope (28) with pharmacologic therapy. Pharmacologic means used to control vasodepressor syncope may include one or more of the following: beta-blocker, verapamil, disopyramide, scopolamine, fludrocortisone, theophylline, alpha agonist, alpha adrenergic agent, fluoxetine hydrochloride, and metoprolol. The appropriate therapy depends on patient age, sex, diet, activity, and symptoms and the physician’s preference. The symptoms of patients with exercise-induced vasodepressor syncope are lightheadedness, fatigue, nausea, disorientation, warmth, heart palpitations, diaphoresis, and pallor (observed). These reported symptoms last from 10 to 15 minutes. There have also been rare cases of convulsions and seizures with neurally mediated syncope. Prodromal symptoms may include nausea, warmth, diaphoresis, lightheadedness, palpitations, and constriction of visual fields. These symptoms can occur up to 30 seconds before an actual syncopal episode. Most reported cases included a complete syncopal episode at some time. However in the current case, only presyncope occurred, except during the tests used to diagnose and produce the athlete’s symptoms. This deviation from the standard may have been a factor in delaying his diagnosis since early childhood. Presyncope should be dealt with and treated with the same intensity as actual syncopal episodes.

The diagnosis of this athlete’s exercise-induced vasodepressor syncope was based on clinical history and the results of the HUTT test. This test has proved to be a safe and effective way to identify those with vasodepressor syncope. The HUTT test has an overall reproducibility of at least 90% and a false-positive rate of between 0 and 10%. Many different test parameters are used with the HUTT, but the parameters administered in the current case are the most popular. Thorough diagnostic testing, such as that used in this case, should be performed to rule out all other possible etiologies. Perhaps the most important condition to rule out is hypertrophic cardiomyopathy (enlarged heart), a proved risk factor for sudden death syndrome. Other causes of syncope and presyncope that should be considered are carotid sinus syndrome, dehydration, hyperventilation, and psychiatric disorders.

Therapeutic choices for controlling vasodepressor syncope are numerous and include both nonpharmacologic and pharmacologic treatments. Educating patients with regard to their disorder is of paramount importance. Frequently patients can identify, and therefore avoid, specific circumstances that trigger their episodes. Nonpharmacologic therapy includes the counseling as mentioned above, the use of biofeedback, psychological counseling, and pacing, with dual-chamber pacing being the most popular. Kosinski and Grubb found that all of their 21 patients could be controlled with medications. Scott et al found that 83% of 59 patients could control their syncope (31) or presyncope (28) with pharmacologic therapy. Pharmacologic means used to control vasodepressor syncope may include the administration of up to 5 μg/min of isoproterenol intravenously. If the test is negative, pharmacologic therapy is considered successful. If the test is positive, an alternative therapy is warranted. Extensive research found the HUTT test to be a valuable tool in testing the effectiveness of pharmacologic therapy and its treatment of vasodepressor syncope. In the current case, fludrocortisone and potassium chloride were used successfully. This wrestler was instructed by the physician to use the medications daily for his 4 years of collegiate wrestling. At the end of this athlete’s career, he, in consultation with his physician, may elect to stop taking his medication to see if he
has become asymptomatic from his exercise-induced vasodepressor syncope. Further testing at that time would be warranted.

CONCLUSIONS

Presyncope symptoms should be considered very serious. There are many causes of presyncope and syncope, and all patients should have thorough diagnostic tests administered to rule out possible life-threatening etiologies. Exercise-induced vasodepressor syncope is one cause of such symptoms, and it can be controlled with various pharmacologic and nonpharmacologic therapies. The HUTT test has been proved to be a reliable diagnostic tool, as well as a way to assess the effectiveness of pharmacologic therapy. With the proper diagnosis and treatment of exercise-induced vasodepressor syncope, the athlete may return to unrestricted sport activities.

REFERENCES

20th 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 (eg, 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, 1998. 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 two copies of each entry must be received at the following address by March 1, 1998:

NATA Student Writing Contest
Deloss Brubaker, EdD, ATC
Life College
1269 Barclay Circle
Marietta, GA 30060

Journal of Athletic Training CEU Quiz Has Moved to the NATA News

Beginning with the March 1997 issue (Volume 32, No. 1), the CEU quizzes for the Journal of Athletic Training moved to the NATA News. Please follow this schedule:

<table>
<thead>
<tr>
<th>Articles in this issue of Journal of Athletic Training</th>
<th>Quiz in this issue of NATA News</th>
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<tbody>
<tr>
<td>March (Vol. 32, No. 1)</td>
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Details about the new procedures for the CEU quiz can be found on pages 35 to 37 of the April 1997 issue of the NATA News.

The CEU Quiz is also posted on NATA’s Fax-On-Demand Service. To access Fax-On-Demand, just dial toll-free 1-888-ASK-NATA or 214-353-6130 from a touch-tone phone. Follow the automated instructions and ask for Document #112.
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 coauthor. 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 subdisciplines 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.
2. 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.
3. 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.
4. 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).
5. Double space and begin typing the text of the abstract flush left in a single paragraph with no indentions. Do not justify the right margin. Do not include tables.
6. The abstract must not exceed 400 words.

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 coauthor.
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. Provide all information requested on the information form on the next page. Please note that the institution (including the city and state) where the clinical case occurred should be cited, not the current address of the author(s), if different.
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 their 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 (eg, 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 sponsors the Free Communication Sessions at the NATA Annual Meeting & Clinical Symposia. 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, your preferred review category, and a short description of why you would make a good abstract evaluator to:

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

Responses preferred by December 1, 1997

Older studies of humans seem to suggest a correlation between free fatty acid (FFA) turnover and oxidation on the one hand and plasma FFA concentration on the other hand during submaximal exercise. However, recent studies, in which higher concentrations of plasma FFA have been reached during prolonged submaximal exercise, have revealed a leveling off in net uptake in spite of increasing plasma FFA concentrations. Furthermore, this relationship between FFA concentration and FFA uptake and oxidation is altered by endurance training. These recent findings in humans support the notion from other cell types that transmembrane fatty acid transport is not only by simple diffusion, but is facilitated by carrier-mediated. During prolonged submaximal knee-extension exercise it has been demonstrated that the total oxidation of fatty acids was approximately 60% higher in trained subjects than in nontrained subjects. The training-induced adaptations responsible for this increased utilization of plasma fatty acids by the muscle could be located at several steps from the mobilization of fatty acids to skeletal muscle metabolism in the mitochondria. In this paper regulation at the transport steps and also at various metabolic steps is discussed.

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The maximum force a muscle can produce depends on its cross-sectional area (CSA). However, the exact interpretation of this relationship has been a matter of controversy. Recently, the controversy has centered on whether the measurements are best correlated using regression analysis or ratio standards. Applying regression analysis to this problem implies that all the experimental error is in the measurement of force. Thus, confusion may arise by failure to take account of errors in the measurement of CSA. Using a statistical model, we show how regression analysis can be misleading as error is introduced into the measurement of CSA as well as that of force. Because neither the errors in force nor CSA can be quantified in the experimental situation, we conclude that ratio standards are less likely to mislead although the accuracy of the result depends on the degree of correlation between force and CSA in the muscle measured.

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Heating with continuous wattage ultrasound combined with mobilization procedures is often used to treat ligament "tightness," but the effects of heat on ligament extensibility have not previously been studied in vivo. To address this problem, 25 young adults underwent knee joint displacement tests on a Genucom arthrometer before and after continuous wattage ultrasound (1 MHz, 1.5 W/cm² x 8 min). Preultrasound intrarater reliability (ICC; n = 11) was 0.87 to 0.98 for varus/valgus and recurvatum tests and 0.70 to 0.73 for anterior-posterior drawer tests. Results: continuous wattage ultrasound was associated with small increases in mean varus/valgus excursion at 0° and 20° of knee flexion (p = .04) and in recurvatum excursion (p = .04) but not in anterior-posterior drawer excursion. The magnitude of the changes was 1.3° or less and represented relative changes of 6.1% to 9.8%. Conclusion: continuous wattage ultrasound at common clinical intensities made some knee ligaments slightly more extensible in normal subjects although the magnitude of the effect was not deemed clinically significant.

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The purpose of this study was to determine the effects of preoperative, intraoperative, and postoperative intervention on the incidence of loss of motion following ACL reconstruction. A retrospective review of patients undergoing ACL reconstruction between 1990 and 1991 was conducted to identify those with LOM. Factors potentially related to loss of motion were recorded. The results were compared to the findings of a similar group of patients who underwent ACL reconstruction between 1987 and 1989. From 1990 to 1991, less concomitant ligament surgery was performed, the incidence of loss of extension was significantly reduced, and the incidence of loss of flexion was significantly increased. It appears the risk for loss of extension can be minimized by delaying surgery following acute injury, performing less concomitant ligament surgery, paying meticulous attention to notchplasty and anatomic placement of the graft, and placing early emphasis on restoration of full extension following surgery.
**Current Literature**

Clint Thompson, MS, ATC

**ANKLE**


**ASTHMA**


**BASEBALL**


**CREATINE**


expression of herpes simplex virus infections with
oral lithium carbonate: a possible antiviral activ­
ity.


KNEE


LOW BACK


**NSAIDs**


**Book Reviews**

**Alcohol and Sport**  
Robert D. Stainback  
Human Kinetics, Champaign, IL  
1997  
232 pages  
ISBN: 0-87322-531-7  
Price: $30.00  

Robert Stainback, clinical and sport psychologist, has taken the number one drug of choice among Americans—alcohol—and investigated its role in the wide world of sports. Alcohol and Sport is a one-of-a-kind publication: never before has an author isolated a specific, yet so commonly used and abused, drug of athletes, sports professionals, and sports fans and collated the relevant research into a comprehensive text. Most texts of this nature look at the entire array of drug use among athletes, including therapeutic medications and ergogenic and ergolytic aids. Stainback, however, takes the reader on a journey that follows alcohol use in the broad context of sports, encompassing the effects of alcohol on human and sports performance, prevention strategies, intervention, and treatment programs.

Chapter 1 introduces terms, definitions, and theories associated with alcohol use and abuse and addiction, along with basic epidemiology related to the use of alcohol among various subpopulations. In chapter 2, the use of alcohol among high school, college, and professional athletes is addressed. This chapter is extremely brief, but to the author's defense, epidemiologic studies on the use of alcohol in athletes, sports professionals, and sports fans are few. In addition, the impact of advertisements on the use of alcohol in sports is discussed. With alcohol distributors and related companies playing major roles in the sponsorship of many sports events, it is unfortunate that more energy was not devoted to this section to better relate the role the media and advertising play in the use of alcohol among this population.

Chapter 3, “Alcohol, Human Function, and Sport Performance,” and chapter 4, “Alcohol Abuse and Dependence Among Athletes and Sports Professionals,” are the cornerstones of the text. These are the chapters that would certainly catch the eye of educators and clinicians in athletic training who scan the table of contents. Chapter 3 emphasizes the biomedical effects of alcohol in sports (using a pharmacologic description), the behavioral effects (using easy-to-read charts and graphs), and the ergogenic and ergolytic effects as they relate to sport performance (using psychomotor and metabolic physiologic functions). Chapter 4 highlights current theories and issues associated with alcohol use, abuse, and dependence among athletes. Stainback provides case studies, with diagnostic analyses, that focus on confidentiality, diagnosing coexisting problems, the validity of self-report measures, and alcohol misuse, abuse, and dependence.

Chapters 5, 6, and 7 concentrate on prevention programs, intervention strategies, and treatment programs. While the information presented here is similar to that found in other publications, the author attempts to relate prevention, intervention, and treatment to the sports environment and mentions specific alcohol-related problems that may affect the athlete. The text ends with a summary chapter and questions for discussion.

As previously mentioned, Alcohol and Sport provides a holistic account of alcohol and sports. It is easy to read and user friendly, yet challenging. Using the basic components of prevention, intervention, and treatment as a foundation, the author ties these in with the unique environment of sports participation and competition.

This book would complement the professional libraries of athletic trainers and other sports professionals. Reasonably priced at $30.00, it could serve as a supplementary text for upper-level undergraduate and introductory graduate courses that deal with athletes and drugs.

**Management of Bloodborne Infections in Sport: A Practical Guideline for Sports Health Care Providers and Coaches**  
Terry Zeigler  
Human Kinetics, Champaign, IL  
1997  
90 pages  
ISBN: 0–88011-682-X  
Price: $18.00  

I found Management of Bloodborne Infections in Sport: A Practical Guideline for Sports Health Care Providers and Coaches to be an excellent resource regarding bloodborne infections in sports for athletic trainers, coaches, team physicians, athletic health care personnel, student health physicians, and athletes. This information is also important to the lay public and any physician caring for an athletic team. It would be appropriate (either as a primary source or a supplement) for introductory courses in advanced athletic training and sports medicine, as well as immunology in medical school, and it would be recommended reading for fellows in primary care sports medicine.

In my opinion, this text is significantly better than similar available materials. It provides in one quick reference comprehensive information concerning OSHA, NCAA, NATA, CDC guidelines, and the joint position statement of the AMSSM and the AASM. The illustrations are helpful, and the text flows smoothly and easily.

This information is pertinent in today's sports medicine society. The impact of HIV and bloodborne pathogens in the athletic setting will most definitely increase over the course of the next few years. This is an area of expanding medical knowledge, and practical guidelines are necessary along with institutional recommendations so that the paranoia surrounding bloodborne pathogens, particularly HIV, can be lessened.

I would recommend this text highly, and in my opinion, it should be on the shelf of every team physician who takes care of athletes in intercollegiate, high school, or professional sports. In addi-
New Horizons in Pediatric Exercise Science
Editors: Cameron Blimkie and Oded Bar-Or
Human Kinetics, Champaign, IL
1995
249 pages
ISBN: 0-87322-528-7
Price: $39.00

As high schools and secondary schools realize the benefits of having a certified athletic trainer on staff, the number of athletic trainers serving younger populations of athletes will continue to grow. The education of the certified athletic trainer includes understanding the development process of the adolescent athlete and giving greater consideration to the needs of these young athletes. New Horizons in Pediatric Exercise Science, edited by Blimkie and Bar-Or, offers the reader insight into the current research investigating the physiology of adolescent development as it relates to physical activity.

Topics represent a synthesis of works from subject matter experts in the areas of pediatric sports medicine and exercise physiology. They provide results from current research findings and explain contemporary theories of physical activity and its physiologic implications on the skeletally immature athlete. The text is separated into five areas, including exercise and its effects on the endocrine system, bone, congenital heart disease, nutritional considerations for children and adolescents, and international perspectives on activity, growth, and cardiovascular disease.

Part I is prefaced by a lengthy introduction to the endocrine system. The first three chapters include critical detail on the endocrine system response to activity involving laboratory test subjects, with accompanying figures and graphs. Part II includes details specific to the dynamic nature of the skeletal system through development. Specific considerations for the treatment of athletic injuries in the skeletally immature make this section the most interesting to the athletic training student. Part III is a close second as far as generating interest in the athletic trainer. This section investigates the benefits of cardiac rehabilitation on congenital heart disease patients and correlates specific theories with those benefits.

The subject matter and current concepts are what make this text so unique. Each chapter reports investigative research that supports the theories discussed and is accompanied by well-labeled complex figures. Most chapters have a well-developed summary to allow the reader follow-up on the significance of the information within the chapter.

The material discussed in this text is advanced in the area of pediatric exercise and related research. This text would be appropriate as a supplement in a course designed for advanced concepts in pediatrics and physiology. It could be used by both undergraduate students with knowledge of advanced human physiology and its current research and by graduate students. The applicability to both levels of athletic training students is possible due to the variety of educational programs that currently exist in athletic training. Although the information is technical, the contents of this text would supplement much of the practical information found in texts specific to sports medicine and adolescent athletes.

Michael Steinagel, MED, ATC
College of Mount St. Joseph
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Sports Medicine in General Practice
Randell K. Wexler, MD
Mount Carmel Health, Columbus, OH
1995
129 pages
ISBN: 0-9646891-0-3
Price: $22.95

This book is short, sweet, and to the point. In its succinctness, it accomplishes the task of putting some very important and useful information in a handy reference manual. In short, it provides us with a "minimalist" approach to sports medicine. While I might change the order of the table of contents a bit for bias and personal reasons, I find that it contains most of the useful information that an individual beginning to care for athletes might like to have handy. The book itself, I think, is a good entry-level reference text for the individual who needs to be introduced to a subject area or reminded of what he or she might have forgotten. This is not a text to be placed on a shelf and ignored, but rather used on a daily basis.

The outline format lends a certain degree of usefulness to the book. Because it was written by a single author, continuity is not an issue except within the confines of the outline format. I would never consider this to be a book on which a health care provider should base all clinical knowledge, but it can be and should be used as a nice, neat introduction to sports medicine. The vagueness inherent in various clinical situations is not within the scope of this book.

One thing that I find somewhat discouraging about the book deals with the lack of labeling of the illustrations. A reader unfamiliar with anatomy will not be aided much by the text’s illustrations. Most of my criticisms of the volume would probably change it from what the author intended it to be—a quick, useful field reference—into a much more comprehensive text on the subject. This book will certainly get the reader started in the area of sports medicine. I think it would make an excellent source for an introductory sports medicine course, but it should be supplemented by a much more detailed text.

I think that this publication can claim a certain amount of uniqueness. I have not seen a book like it in quite a while.

Douglas B. McKeag, MD, MS
University of Pittsburgh
School of Medicine
Pittsburgh, PA
The last two chapters walk the reader through as the technique is used on specific muscle groups. The pictures in chapter 5 are very helpful in showing exactly how to touch the client in order to produce the desired effect. There are four thorough examples provided, explaining how the four steps of the STT method should be implemented. The instructions given with each example in chapter 5 should be adapted for the 23 exercises offered in the appendix or with any other strengthening exercise. Also, it would be helpful if the appendix also included pictures to illustrate exactly how to apply the technique to each of the 23 exercises.

The unique STT method focuses on the importance of exciting the central nervous system in order to improve strength and muscle function. It is theorized that the STT method will maximize strength gains in target muscles, minimize compensatory muscle tension, improve patient or athlete concentration, and enhance coordination through biofeedback. It should be stated that this method has no scientific evidence to prove that it works, only anecdotal reports by the authors and their colleagues.

I recommend this book for personal trainers or strength coaches who are looking to explore a technique that could bring out specific muscle actions in their patients or athletes. I can see how the Systematic Touch Training method would be especially helpful to a personal trainer who is looking to improve the client’s focus while performing individual strength training exercises. The book is worth a look by those professionals who want to provide closer one-on-one assistance to their clients and add some variety to their athletes’ prescribed workouts.

Ellen Epping, MA, ATC
Eastern Illinois University
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The Journal of Athletic Training welcomes the submission of manuscripts that are of interest to persons engaged in or concerned with the progress of the athletic training profession (athletic injury prevention, evaluation, management, and rehabilitation; administration of athletic training facilities and programs; and athletic injury counseling and education).
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