The prevention of shin splints in sports: a systematic review of literature

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ABSTRACT

THACKER, S. B., J. GILCHRIST, D. F. STROUP, and C. D. KIMSEY. The prevention of shin splints in sports: a systematic review of literature. *Med. Sci. Sports Exerc.*, Vol. 34, No. 1, 2002, pp. 32–40. **Purpose:** To review the published and unpublished evidence regarding risk factors associated with shin splints, assess the effectiveness of prevention strategies, and offer evidence-based recommendations to coaches, athletes, and researchers. **Methods:** We searched electronic data bases without language restriction, identified citations from reference sections of research papers retrieved, contacted experts in the field, and searched the Cochrane Collaboration. Of the 199 citations identified, we emphasized results of the four reports that compared methods to prevent shin splints. We assessed the methodologic quality of these reports by using a standardized instrument. **Results:** The use of shock-absorbent insoles, foam heel pads, heel cord stretching, alternative footwear, as well as graduated running programs among military recruits have undergone assessment in controlled trials. There is no strong support for any of these interventions, and each of the four controlled trials is limited methodologically. Median quality scores in these four studies ranged from 29 to 47, and serious flaws in study design, control of bias, and statistical methods were identified. **Conclusion:** Our review yielded little objective evidence to support widespread use of any existing interventions to prevent shin splints. The most encouraging evidence for effective prevention of shin splints involves the use of shock-absorbing insoles. However, serious flaws in study design and implementation constrain the work in this field thus far. A rigorously implemented research program is critically needed to address this common sports medicine problem. **Key Words:** INJURY, LOWER EXTREMITY, ATHLETES

Published studies have shown that shin splints account for 6–16% of injuries among runners (34,47,60,88,94,107,108), and this problem was the third most common injury reported in a 1977 Runners' World survey (82). The most common diagnosis among 495 adult patients reporting leg pain at a Swedish sports medicine clinic was medial tibial syndrome (58%) and, together with stress fractures, accounted for 75% of all shin pain (108). Some researchers consider shin splints to be the most common cause of disabling leg pain in young competitive athletes (1,56). Shin splints accounted for 19.5% of 41 injuries seen in 257 track athletes competing for 17 high school teams during a 77-d season (158). Shin splints were also the most common injury reported in a national survey of ballet companies (157). In military studies, 4–10% of recruits were diagnosed with shin splints in 8- to 12-wk basic training (5,49).

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DEFINITION OF SHIN SPLINTS

Described in 1913 as "spike soreness" in runners (54), the meaning of the term shin splints is controversial. In 1966, the American Medical Association defined shin splint syndrome as "pain and discomfort in the leg from repetitive activity on hard surfaces, or due to forceful, excessive use of foot flexures. The diagnosis should be limited to musculoskeletal inflammations excluding stress fractures or ischemic disorders" (3). The AMA definition, however, has not been accepted universally. Some clinicians argue that the term "shin splints" should be applied to any exertional pain that occurs in the shins (7). Others argue that the term should be used only to describe a few specific clinical entities (95). And still others content that the term "shin splints" should be reserved as a generic term for lower leg pain once stress fractures, specific compartment syndromes, and muscle herniae have been excluded (8,10,45). In our literature search, we used the broadest definition of shin splints, in order to identify all potentially relevant studies. In the intervention studies, we specify the definitions used by the investigators.

Although the pathophysiology of shin splint syndrome remains unclear (83), it is an important performance-constraining injury among athletes that warrants careful study. Clinical and pathological studies have contributed to our understanding of the etiology of shin splints, but these studies remain incomplete. For example, several studies of medial tibial (or mediotibial) stress syndrome indicate that it is not a compartment syndrome, suggesting to some researchers that periostitis is a likely etiology (97,102). Findings on bone scans, however, do not correlate well with histological observations on specimens obtained during surgery (14). Others believe morphologic bone changes are the basis for shin splints and attribute the pain to stress microfractures (61). In some patients with medial tibial pain, symptoms are relieved by fasciotomy, but surgery is not always successful, and pain is often relieved without surgery (117,153). Some clinical and cadaver studies locate the site of pain at the origin of either the tibialis posterior muscle, the soleus muscle, or the area of the osseous attachment to these muscles (30,99,132), but these findings are not consistent (9). Another hypothesis relates to muscle weakness at the origin of the flexor digitorum longus muscle (43), but this also is speculative.

The purpose of this paper is to review what is known about the pathophysiology of shin splints syndrome, present the evidence regarding associated risk factors, assess the effectiveness of prevention strategies, and offer recommendations for prevention of shin splints. We focus in particular on the assessment of interventions to prevent shin splints.

The cause of shin splints has also been a source of disagreement among clinicians. A variety of conditions, both acute and chronic, have been placed under the rubric of shin splints. Acute conditions include tibial stress reaction or periostitis, enthesis, fibrositis, myositis, traction periostitis, interosseous membrane pain, bone strains, tenosynovitis, and tendonitis of the tibialis anterior, the tibialis posterior, soleus, or the flexor hallucis longus muscles. Chronic conditions include a periosteal reaction that may lead to microfracture, traction periostalgia, chronic tendonitis, fatigue tears of collagen fibers that bridge the connection of muscle fibers to bone, and chronic compartment syndrome (9,32,102,112). Through the years, various theories about the etiology of shin splints have emerged, including stress fractures (33), ischemia of deep compartments (117), or soft tissue injuries (23,136,141).

Despite the AMA statement in 1968, differing opinions about shin splints continue for several reasons (137). First, the definition of "shin" is confusing, varying from "the front part of the leg below the knee," to "the front edge of the tibia," to "the lower part of the leg." Second, specific symptoms may vary by sport activity as different muscles and tendons are stressed. Finally, coaches and trainers usually see the athlete earlier in the clinical course than physicians and, consequently, may be confronted with a different clinical presentation. Understanding this complex problem clearly requires additional clinical and physiological research.

MATERIALS AND METHODS

We identified citations from the reference sections in 20 textbooks of sports medicine, family practice, and other primary care specialties, orthopedics, and general surgery. To identify papers for review, we use OVID version 2 and Internet-based Grateful Med to access several electronic databases: MEDLINE, 1966 to 2000; Current Contents, 1996 to 2000; Biomedical Collection, 1993 to 1999; and Dissertation Abstracts. We searched, without language limitations, for the subject terms "shin splints," "stress fractures," and "sports injury." We further narrowed the search by using the terms "etiology," "epidemiology," and "injury prevention and control." We then identified additional citations from the reference sections of papers retrieved and contacted experts in the field, including the first authors of randomized controlled trials (RCTs) addressing prevention of shin splints. Finally, we contacted the Center for Sports and History in Birmingham, UK, a part of the Cochrane Collaboration (an international network of experts who manually search the literature). We excluded papers that did not provide primary research data, that addressed treatment and rehabilitation rather than prevention, or that provided previously published data (53).

All articles were screened by one author (SBT). Of the 199 citations identified, 154 articles reported the pathophysiology and etiology of shin splints, the risk for shin splints in different sports, the identification of risk factors for shin splints, or methods for preventing shin splints. Of these, four compared methods of preventing shin splints.

We modified a scoring instrument previously used to evaluate the methodologic quality of the cohort studies and RCTs in sports medicine (143). Reviewers were blinded to the primary authors' names and affiliations but not to the study results (which have been shown to have little effect on the validity of quality scores) (13). Each citation was then evaluated independently by three reviewers. After independent evaluation, the reviewers met to reconcile substantive differences in interpretation. There were no differences in rank order of the studies, only in absolute scores.

Two authors independently extracted data from the RCTs to determine when pooling was appropriate. Because of differences in the interventions used, we elected not to pool any of the individual study-effect estimates.

RESULTS

Risk factors. Risk factors that play a part in sports injuries can be categorized as either intrinsic (or personal) risk factors, such as anatomic variations and physical fitness, or extrinsic (or environmental) factors related to the type of sport, such as the status of the athletic field or floor (147,148) (Table 1). Some of these risk factors can be related specifically to the occurrence of shin splints, whereas others are more generically related to overuse injuries. Numerous reviews published about factors associated with lower limb injuries among athletes, particularly runners, generally agree that several intrinsic factors are significantly associated with injuries. These factors include lack of running experience, competitive running, excessive weekly running distances, poor physical condition, and previous injury (4,17,22,38,51,58,62,63,68,71,76,77,89,100,104,105,106,109,110,116,119,120,122,125,126,142,147,148,

TABLE 1. Intrinsic (personal) and extrinsic (environmental) risk factors that may increase the risk of shin splints.

Intrinsic Factors	Extrinsic Factors
Demographics	Sports-related factors
	Type of sport
Age	Exposure (e.g., running on one side of the road)
	Nature of event (e.g., running on hills)
Sex	
	Equipment
Physical build	Shoe/surface interface
Height	Venue/supervision
	Playing surface
Weight	Safety measures
Body fat	Weather conditions
	Temperature
Physical defects/anatomic variations	Relative humidity
Femoral neck anteversion	
Genu valgus	
Pes clavus	
Hyperpronation	
Joint laxity	
Previous fitness	
Aerobic endurance/conditioning	
Fatigue	
Strength of and balance between flexors and extensors	
Flexibility of muscles/joints	
Sporting skill/coordination	
Psychological factors	

152,160). Other intrinsic factors that have been proposed but with less consensus among these same experts include the following: older age, female gender, extremes in height and body fat, body build, structural abnormalities such as hyperpronation and femoral neck anteversion, participation in other sports, inadequate warm-up, incomplete stretching, increased running frequency, intensity of performance, lesser skill, instability of running patterns, sudden increase in training mileage, inadequate weight training, lesser strength, poor coordination, lack of flexibility training, imbalance between quadriceps and hamstring muscles, muscle fatigue, psychological factors, and smoking. Proposed extrinsic factors include type of sport, time of day, always running on the same side of the road, hard running surface or uneven terrain, shoes, in-shoe orthoses, climate, and weather conditions.

Epidemiologic studies support the increased risk of overuse injury with younger age (77,93,96), female gender (11,15,67,81,90,91,92,128,134), anatomical variations such as genu valgus and pes clavus (26,27,60,72,128), excess pronation (31,55,98), smoking (2,66), increasing weekly mileage in runners (18,25,52,59,79,93,129,131,155), more hours of aerobic dance (42,123), decreased physical fitness (15,19,20,35,38,42, 64,65,66,77,81,96,113,128,130), and previous injury (42,86, 91,93,121,128,155). A few contradictory findings suggest that age is not a factor (15,89,154), nor is gender (19,20,28,130, 144,154); warming up, cooling down, or stretching (15,114, 115,135,148); excess running mileage (98); running on hills (155); running surface (15,93,154); previous athletic activity (101); or joint laxity (57). Psychosocial factors and life stress are not related consistently to injury in the literature (16,29,40,48,73,74,75,87,111,145,146,159,161).

A few studies focus specifically on risk factors for shin splints, rather than on the general area of overuse injuries in lower limbs (31,41,44,84,103,139,151). Several of these studies point to the role of increased pronation of the foot as a risk factor for shin splints (31,44,84,139). In addition, the clinical studies suggest other possible risk factors including an increased varus tendency (139), increased muscular strength of the plantar flexor muscles (44), increased double heel strikes during dance among ballet dancers (41), increased angular displacement during running due to structural or functional differences in the foot and ankle (151), and increased external rotation of the femur with the hip extended (84). Some external risk factors include low calcium intake among female athletes, increased training intensity, hard running surface (123), and use of worn or inadequate shoes (103,140).

Prevention strategies. Textbooks and review articles present many recommendations for the prevention of shin splints. These recommendations, based primarily on expert opinion and clinical experience, include the following: screening for anatomical risks such as hyperpronation with appropriate adaptations for these risks, adequate overall physical conditioning, adequate diet, warm-up exercises, stretching exercises, activities to increase flexibility and strength, good running techniques, training techniques that promote balanced muscle development and do not overstress poorly conditioned athletes, minimization of running on hills and hard surfaces, rehabilitation for those injured previously, generic risk factor prevention activities related to behavioral and psychological stress, appropriate footwear, adaptation to physical factors such as heat and wet surfaces, and, in military settings, the time of day of exercise and the use of boots and running shoes (6,24,25,50,71, 118,124,127,148). However, the evidence of effectiveness for any of these interventions is limited.

Methods to prevent shin splints. We found four RCTs (and no cohort studies) that compared methods to prevent shin splints (Table 2 summarizes study results). The first RCT was conducted at the United States Naval Academy in 1972 and 1973 (5). Investigators randomly assigned 2777 first-year midshipmen to one of four intervention groups or to a control group. Midshipmen in the intervention groups used some combination of foam heel pads, heel cord stretching exercises, or a graduated running program. The assignment to each group was done randomly with stratification for previously tested scholastic and athletic aptitude. A series of spot checks of individual platoons and physical education programs were made to ensure compliance. Platoons that were originally allocated to an intervention group but were found not to have carried out the prophylactic regimen were moved to the control group for the purposes of statistical analysis. The authors used the AMA criteria to define shin splints. During the 8-wk summer program, 97 cases of shin splints were recorded (4.1%) with no evidence of a protective effect of any regimen. After injured midshipmen completed an initial treatment regimen and returned to duty, 51 were assigned randomly to use heel pads and 46 were not. Shin splints reoccurred among 11 (22%) of the midshipmen with heel pads and among 5 (11%) of those without, but this difference was not statistically significant.

TABLE 2. Results of randomized controlled trials comparing methods to prevent shin splints.

Author	Year Published	Population	Study Groups	Outcomes	Median Quality Score
Andrish et al. (5)	1974	2777 M navy midshipmen in 8-wk basic training	1) foam heel pad 2) heel stretching 3) heel pad and heel stretching 4) graduated running 5) control	97 with shin splints 1) 15/344 (4.4%) 2) 12/300 (4.0%) 3) 14/463 (3.0%) 4) 13/217 (6.0%) 5) 43/1,453 (3.0%)	29
Bensel and Kish (11)	1983	2074 M, 767 F army trainees in 9-wk basic training	1) hot weather boots 2) standard black leather boots	27 with shin splints or tibial stress reaction 1) M 5/728 (0.60%) F 6/342 (1.75%) 2) M 8/1,346 (0.59%) F 8/425 (1.89%)	45
Bensel and Kaplan (12)	1986	555 F Army trainees in 9-wk basic training	1) urethane foam 2) molded grid 3) standard mesh	37 with shin splints 1) 11/186 (5.9%) 2) 14/198 (7.1%) 3) 12/171 (7.0%)	40
Schwellnus et al. (133)	1990	1388 M miliary recruits in 9-wk basic training	1) neoprene insoles 2) control	71 with tibial stress syndrome 1) 6/237 (2.8/1000 recruits/wk) 2) 65/1151 (6.8/1000 recruits/wk)	47

Among midshipmen who developed shin splints, 64 (66%) had no physical training immediately before the study compared with 33 (34%) who had prior training ($P < 0.001$).

The second RCT included 2074 men and 767 women in U.S. Army basic training at Fort Jackson, SC, in 1980 (11). Hot weather combat boots consisting of canvas uppers were assigned at random to 728 men and 342 women; the remaining 1346 men and 425 women wore standard black all-leather combat boots. Randomization was compromised by the availability of appropriate-sized hot weather boots and by an unreported number of switches that were made in the boot assignments. This study not only assessed the relative effect of bootwear on injury rates but also compared injury rates between male and female recruits. Shin splints were defined to include pain and discomfort around the anterior portion of the tibia. There were no significant differences in the rates of shin splints or tibial stress reactions (i.e., a suspected stress fracture lacking radiologic confirmation) in either men or women based on the type of boot worn. Women had greater rates of shin splints and virtually all other lower extremity injuries than did men, probably due to lower physical fitness levels on entry compared with men. Men reported more serious consequences of tibial stress reactions than did women (viz., higher rates of restricted duty days, 11% vs 4%).

A third RCT involved 555 women in U.S. Army basic training at Fort Jackson in 1985 (12). The trainees were assigned randomly to use one of three types of boot inserts: urethane foam with fiber backing, a molded network of lever-like projections attached at their base to material in the form of a grid, or the standard multilayered plastic mesh with a top covering of nylon. Injury data were obtained during special examinations in the 3rd, 5th, and final weeks of the 9-wk program as well as from sick-call records. The definition for shin splints is not cited but is likely to have been the same as the 1980 study from the same authors (11). No significant difference was found in the occurrence of shin splints (5.9–7.1%) among any of the study groups. A questionnaire concerning comfort of the inserts was distributed in the 5th week of training. The group wearing urethane foam inserts reported increased comfort compared with trainees wearing other inserts, but the difference was not statistically significant.

The fourth RCT, published in 1990, was conducted among 1511 South African military recruits during a 9-wk training period (133). Neoprene-impregnated flat insoles were provided to 250 randomly selected recruits to wear with their standard footwear. After transfers and exclusions of those with biomechanical problems or previous major injury or illness, 237 remained in the intervention group and were compared with 1151 remaining in the control group. Injuries were defined as an occurrence resulting from physical conditioning during basic training that was severe enough to prevent return to normal activities for at least 1 d after medical consultation. All injuries were monitored and reported to the base hospital where diagnosis was established and treatment instituted by a panel of eight doctors. Uniform diagnostic criteria were established before the intervention period, and all injuries were recorded on an injury report form. A random sample ($N = 260$) of both intervention and control groups completed a questionnaire to document physical activity patterns in the 12 months preceding the study. Injuries were diagnosed among 54 (22.8%) recruits in the experimental group and among 367 (31.9%) in the control group. The rate of injury was increased in the control group (36.3 per thousand per week vs 25.8 per thousand per week) ($P < 0.05$). Tibial stress syndrome (shin splints) was documented in 65 (20.4%) recruits in the control group and 6 (12.8%) recruits in the intervention group. The rates of tibial stress syndrome were 6.8 per thousand per week in the control group compared with 2.8 per thousand per week in the intervention group ($P < 0.05$). The critical finding of the study was that shock-absorbing neoprene insoles can significantly reduce the overall incidence of over-use injury and specifically prevent tibial stress syndrome. The authors noted that the overall incidence of injuries was considerably less than the 37.9% reported 3 yr earlier in a population undergoing similar training in South Africa (46). The authors hypothesized that the reduction of injuries in the control group was a result of changes made in the physical training program after the previous report and that the use of the insole produced an additional reduction in the overall incidence of injury.

Quality of reported studies. Quality scores for the RCTs ranged from 28 to 53 (of a possible 100) for the individual rater scores; the median scores for the four studies ranged from 29 to 47. None of the RCTs reported adequate methods of randomization, nor did they report whether the assignment of subjects was blinded. Also, interpretation of results was hampered by the lack of attention to possible confounding factors and by both information and selection biases. For example, in the U.S. Naval Academy study (5), if members of an intervention group failed to comply with the study protocol, they were moved to the control group for the analysis, thus compromising the random allocation and introducing the possibility of selection bias. Statistical methods were inadequate in all four studies; indeed, none of the RCTs described basic statistical testing methods. In addition, power calculations were not reported, bias and confounding were addressed inadequately, multivariate analysis was not used even when factors were correlated, and the potential effect of multiple interventions was not assessed.

DISCUSSION

The most important conclusion one draws from this systematic, comprehensive review of the literature is that although many measures are recommended to prevent the occurrence of shin splints in sports, few have been examined rigorously. To date, only shock-absorbent insoles, foam heel pads, heel cord stretching, alternative footwear, and graduated running programs among military troops have undergone assessment in RCTs. Indeed, only four RCTs have been done in this field, and all have serious methodologic flaws. Also, the inclusion of only military populations in these studies limits our ability to extrapolate findings to both younger and older age groups and to civilian populations.

For future studies of this problem, attention to study design, implementation, and reporting is critical (85,116). Subjects in both intervention and control groups should be subject to uniform, consistent, and ongoing monitoring for the occurrence of injuries. Randomization should be blinded and the method of randomization described clearly. Whereas a double-blind study is often not feasible for studies of athletic injuries (for example, users of orthoses know they are wearing them), blinded allocation of subjects is essential to enhance the strength of the evidence. Case definitions must be explicit and easily replicable. In calculating rates of injury, careful consideration must be given to the choice of the denominators. Appropriate statistical methods should be used for data analysis and described clearly in publications. Finally, the reporting of the results should be improved so that the published data clearly support the conclusions.

The following research questions need to be addressed to inform coaches and athletes about injury prevention strategies:

1. Will any of the other interventions often recommended to prevent shin splints—such as specialized training methods, preseason conditioning, new shock-absorbent insoles, or alternative orthoses–prove effective in RCTs?
2. What are the dose response considerations (viz., frequency, duration, intensity of activity) in the prevention of shin splints?
3. Will RCTs conducted outside of the military setting generate different results?
4. What orthoses are most acceptable in terms of cost and comfort?
5. Are the same interventions equally effective for girls and women? (Few studies include women.)
6. Are the same interventions appropriate for all athletes, or do kinesiological and sports-specific considerations require different interventions for different populations?
7. Are the potential interventions as effective for athletes with a history of previous shin splints?
8. What clinical indicators can be used to help coaches and athletes determine when a player can return to competition or training without increased risk of reinjury?
9. What, if any, biologic or anatomic measures can be used as screening measures before a sports season that would warrant specific preventive actions (e.g., sports-specific training or orthoses)?
10. Do inherent behavioral factors associated with sports injuries present particular challenges of access to data and compliance of study subjects (e.g., will coaches or platoon leaders give priority to injury prevention, or what will motivate athletes to use preventive measures such as orthoses)?

On the basis of this review, we make one qualified recommendation to coaches, trainers, and athletes: the use of shock-absorbent orthoses inserts may reduce the occurrence of shin splints in young male athletes, possibly by absorbing shock and/or stabilizing the subtalar joint and by decreasing pronation (36,69,70,160). Effectiveness and acceptability of alternative inserts need to be assessed in different populations (138). On the other hand, interventions often endorsed for prevention of shin splints could well prove to be effective but cannot be supported by this review of available evidence. Some interventions, such as adequate shoes or shock-absorbing inserts, may have benefits beyond the prevention of shin splints, including the prevention of other overuse injuries such as stress fractures (39). Preseason conditioning has been demonstrated to optimize performance and prevent ankle sprains and knee injuries (21,37); evidence suggested in this review indicates that it may also help prevent shin splints. Strength, agility, and flexibility should be emphasized both in preseason training and during the season to optimize performance; they also should be emphasized for injury prevention. Whether general or targeted training will reduce the rate of shin splints awaits further research.

Sports at all levels are popular and health-promoting activities practiced by millions of persons worldwide, but these activities are also an important cause of preventable injury. When coaches and athletes make the effort to prevent athletic injuries, they will seek advice from experts in the field. When weighing this advice, coaches and athletes must be aware of the limits of the data.

After careful scrutiny, what is appealing intuitively can prove unhelpful in practice (150). For example, stretching before running is a standard recommendation; yet, a recently published RCT conducted among more than 1500 Australian military recruits found no decrease in injury risk with stretching (114). In fact, there is evidence that stretching may affect performance adversely (78). Research into the most effective means of preventing injury is crucial, as is effective interpretation of the science and its translation into practice (80,85,149,156). This review of the prevention of shin splints, one of the most common injuries among athletes, suggests that much work still needs to be done in this field.

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REFERENCES

1. Albohm, M. How injuries occur in girls' sports. *Physician Sportsmed.* 4:46–49, 1976.
2. Altarac, M., J. W. Gardner, R. M. Popovich, R. Potter, J. J. Knapik, and B. H. Jones. Cigarette smoking and exercise-related injuries among young men and women. *Am. J. Prev. Med.* 18:96–102, 2000.
3. American Medical Association, Committee on the Medical Aspects of Sports, Subcommittee on Classification of Sports Injuries. *Standard Nomenclature of Athletic Injuries.* Chicago: AMA, 1966, p. 126.
4. Anderson, J. L. Women's sports and fitness programs at the U.S. Military Academy. *Physician Sportsmed.* 7:72–79, 1979.
5. Andrish, J. T., J. A. Bergfeld, and J. Walheim. A prospective study of the management of shin splints. *J. Bone Joint Surg.* 56:1697–1700, 1974.
6. Backx, F. J. G., H. Inklaar, M. Koornneef, and W. Van Mechelen. Draft FIMS position statement on the prevention of sport injuries. *Geneeskunde en Sport*; special issue, 1990, pp. 22–27.
7. Bates, P. Shin splints: a literature review. *Br. J. Sports Med.* 19:132–137, 1985.
8. Batt, M. E. Shin splints: a review of terminology. *Clin. J. Sports Med.* 5:53–57, 1995.
9. Beck, B. R., and L. R. Osternig. Medial tibial stress syndrome. *J. Bone Joint Surg.* 76:1057–1061, 1994.
10. Benas, D., and P. Jokl. Shin splints. *Am. Correct. Ther. J.* 32:53–57, 1978.
11. Bensel, C. K., and R. N. Kish. Lower extremity disorders among men and women in Army basic training and effects of two types of boots. Technical Report Natick TR-83/026. Published by United States Army Natick Research and Development Laboratories, Natick, MA, 1983.
12. Bensel, C. K., and D. B. Kaplan. Wear test of boot inserts: memorandum for the record. United States Army Natick Research and Development Laboratories, Natick, Massachusetts, December 1986, pp. 1–8.
13. Berlin, J. A., C. G. Miles, and M. D. Cirigliano. Does blinding of readers affect the results of meta-analyses? Results of a randomized trial. *Lancet* 350:185–186, 1997.
14. Bhatt, R., I. Lauder, D. B. Finlay, M. J. Allen, and I. P. Belton. Correlation of bone scintigraphy and histological findings in medial tibial syndrome. *Br. J. Sport Med.* 34:49–53, 2000.
15. Blair, S. N., H. W. Kohl, and N. N. Goodyear. Rates and risks for running and exercise injuries: studies in three population. *Res. Q. Exerc. Sport* 58:221–228, 1987.
16. Bramwell, S. T., M. Masuda, N. N. Wagner, and T. H. Holmes. Psychosocial factors in athletic injuries: development and application of the social and athletic readjustment rating scale (SARRS). *Hum. Stress* 1:6–20, 1975.
17. Brill, P. A., and C. A. Macera. The influence of running patterns on running injuries. *Sports Med.* 20:365–368, 1995.
18. Brunet, M. E., S. D. Cook, M. R. Brinker, and J. A. Dickinson. A survey of running injuries in 1505 competitive and recreational runners. *J. Sports Med. Phys. Fitness* 30:307–315, 1990.
19. Canham, M. L., J. J. Knapik, M. A. Smutek, and B. H. Jones. Training, physical performance, and injuries among men and women preparing for occupations in the Army. Advances in Occupational Ergonomics and Safety. In: *Proceedings of the 13th Annual International Occupational Ergonomics and Safety Conference.* Washington, DC: Institute of Science, 1998, pp. 711–714.
20. Canham, M. L., M. A. McFerren, and B. H. Jones. The association of injury with physical fitness among men and women in gender integrated basic combat training units. *Med. Surveillance Monthly Rep.* 2:8–10, 12, 1996.
21. Caraffa, A., G. Cerulli, M. Projetti, G. Aisa, and A. Risso. Prevention of anterior cruciate ligament injuries in soccer: a prospective controlled study of proprioceptive training. *Knee Surg. Sports Traumatol. Arthrosc.* 4:19–21, 1996.
22. Clancy, W. G. Runners' injuries: part I. *Am. J. Sports Med.* 8:137–144, 1980.
23. Clement, D. B. Tibial stress syndrome in athletes. *J. Sports Med.* 2:81–85, 1974.
24. Clement, D. B., and J. E. Taunton. A guide to the prevention of running injuries. *Aust. Fam. Physician* 10:156–164, 1981.
25. Clement, D. B., J. E. Tauton, G. W. Smart, and K. L. McNicol. A survey of overuse running injuries. *Physician Sportsmed.* 9:47–58, 1981.
26. Cowan, D. N., B. H. Jones, and J. R. Robinson. Foot morphologic characteristics and risk of exercise-related injury. *Arch. Fam. Med.* 2:773–777, 1993.
27. Cowan, D. N., B. H. Jones, P. N. Frykman, et al. Lower limb morphology and risk of overuse injury among male infantry trainees. *Med. Sci. Sports Exerc.* 28:945–952, 1996.
28. Cox, J. S., and H. W. Lenz. Women midshipmen in sports. *Am. J. Sports Med.* 12:241–243, 1984.
29. Cryan, P. D., and W. F. Alles. The relationship between stress and college football injuries. *J. Sports Med.* 23:52–58, 1983.
30. D'Ambrosia, R. D., R. F. Zelis, R. G. Chuinard, and J. Wilmore. Interstitial pressure measurements in the anterior and posterior compartments in athletes with shin splints. *Am. J. Sports Med.* 5:127–131, 1977.
31. Delacerda, F. G. A study of the anatomical factors involved in shinsplints. *J. Orthop. Sports Phys. Ther.* 2:55–59, 1980.
32. Detmer, D. E. Chronic shin splints: classification and management of medial tibial stress syndrome. *Sports Med.* 3:436–446, 1986.
33. Devas, M. B. Stress fractures of the tibia or "shin soreness." *J. Bone Joint Surg. Br.* 40:227–239, 1958.
34. Devereaux, M. D., and S. M. Lachmann. Athletes attending a sports injury clinic: a review. *Br. J. Sports Med.* 17:137–142, 1983.
35. Dziados, J., S. Norton, B. Jones, J. Harris, and T. Ewart. Epidemiology of training injuries in Army trainees (Abstract). *Med. Sci. Sport Exerc.* 18:S10, 1986.
36. Eggold, J. F. Orthotics in the prevention of runners' overuse injuries. *Phys. Sportsmed.* 8:125–131, 1981.

37. Ekstrand, J., J. Gillquist, and S. O. Liljedahl. Prevention of soccer injuries: supervision by doctor and physiotherapist. *Am. J. Sports Med.* 11:116–120, 1983.
38. Ekstrand, J., and J. Gillquist. Prevention of sports injuries in football players. *Int. J. Sports Med.* 5(Suppl.):140–144, 1984.
39. Fauno, P., S. Kalund, I. Andreasen, and U. Jorgensen. Soreness in lower extremities and back is reduced by use of shock absorbing heel inserts. *Int. J. Sports Med.* 14:288–290, 1993.
40. Fields, K. B., M. Delaney, and J. S. Hinkle. A prospective study of type A behavior and running injuries. *J. Fam. Pract.* 30:425–429, 1990.
41. Gans, A. The relationship of heel contact in ascent and descent from jumps to the incidence of shin splints in ballet dancers. *Phys. Ther.* 65:1192–1196, 1985.
42. Garrick, J. G., D. M. Gillien, and P. Whiteside. The epidemiology of aerobic dance injuries. *Am. J. Sports Med.* 14:67–72, 1986.
43. Garth, W., and S. Miller. Evaluation of claw toe deformity, weakness of the foot intrinsics, and posteromedial shin pain. *Am. J. Sports Med.* 17:821–827, 1989.
44. Gehlesen, G. M., and A. Seger. Selected measures of angular displacement, strength, and flexibility in subjects with and without shin splints. *Res. Q. Exerc. Sport* 51:478–485, 1980.
45. Gerow G., B. Matthews, W. Jahn, and R. Gerow. Compartment syndrome and shin splints of the lower leg. *J. Manipulative Physiol. Ther.* 16:245–252, 1993.
46. Gordon, N., E. Hugo, and J. Cilliers. The South Africa defense force physical training programme. Part III. Exertion-related injuries sustained at an SADF basic training centre. *South Afr. Med. J.* 69:491–494, 1986.
47. Gudas, C. J. Patterns of lower-extremity injury in 224 runners. *Compr. Ther.* 6:50–59, 1980.
48. Hardy, C. J., and R. E. Riehl. An examination of the life stress–injury relationship among noncontact sport participants. *Behav. Med.* 14:113–118, 1988.
49. Heir, T. Musculoskeletal injuries in officer training: one-year follow-up. *Mil. Med.* 163:229–233, 1998.
50. Hlobil, H., W. Van Mechelen, and H. C. G. Kemper. How can sports injuries be prevented? *Natl. Institute for Sports Health Care, Netherlands* pp. 1–134, 1987.
51. Hoeberigs, J. H. Factors related to the incidence of running injuries: a review. *Sports Med.* 13:408–422, 1992.
52. Holmich, P., S. W. Christensen, E. Darre, F. Jahnsen, and T. Hartvig. Non-elite marathon runners: health training and injuries. *Br. J. Sports Med.* 23:177–178, 1989.
53. Huston, P. Cochrane collaboration helping unravel tangled web woven by international research. *C. M. A. J.* 154:1389–1392, 1996.
54. Hutchins, C. P. Explanation of spike soreness in runners. *Am. Phys. Ed. Rev.* 18:31–35, 1913.
55. Ilahi, O. A., and H. W. Kohl III. Lower extremity morphology and alignment and risk of overuse injury. *Clin. J. Sport Med.* 8:38–42, 1998.
56. Jackson, D. W., and D. Bailey. Shin splints in the young athlete: a nonspecific diagnosis. *Physician Sportsmed.* 3:45–51, 1975.
57. Jackson, D. W., H. Jarrett, D. Bailey, J. Kausek, J. Swanson, and J. W. Powell. Injury prediction in the young athlete: a preliminary report. *Am. J. Sports Med.* 6:6–14, 1978.
58. Jackson, D. W., and S. O. Matz. Prevention of running injuries. *J. Musculoskel. Med.* 3:10–19, 1986.
59. Jacobs, S. J., and B. L. Berson. Injuries to runners: a study of entrants to a 10,000 meter race. *Am. J. Sports Med.* 14:151–155, 1986.
60. James, S. L., B. T. Bates, and L. R. Osternig. Injuries to runners. *Am. J. Sports Med.* 6:40–50, 1978.
61. Johnell, O., A. Rausing, B. Wendeberg, and N. Westlin. Morphological bone changes in shin splints. *Clin. Orthop.* 167:180–184, 1982.
62. Johnson, R. Sports medicine, fitness and nutrition corner: common running injuries of the leg and foot. *Minn. Med.* 441–444: 1983.
63. Jones, B. Overuse injuries of the lower extremities associated with marching, jogging, and running: a review. *Mil. Med.* 148: 783–787, 1983.
64. Jones, B. H., M. W. Bovee, and J. J. Knapik. Associations among body composition, physical fitness, and injury in men and women Army trainees. In: *Body Composition and Physical Performance,* B. M. Marriotte and J. Grumstrup-Scott (Eds.). Washington, DC: National Academy Press, 1992, pp. 141–173.
65. Jones, B. H., M. W. Bovee, J. M. Harris III, and D. N. Cowan. Intrinsic risk factors for exercise-related injuries among male and female Army trainees. *Am. J. Sports Med.* 21:705–710, 1993.
66. Jones, B. H., D. N. Cowan, J. P. Tomlinson, J. R. Robinson, D. W. Polly, and P. N. Frykman. Epidemiology of injuries associated with physical training among young men in the Army. *Med. Sci. Sports Exerc.* 25:197–203, 1993.
67. Jones, B. H. Injuries among women and men in gender integrated BCT units: Ft. Leonard Wood 1995. *Med. Surveillance Monthly Rep.* 2:2–3, 7–8, 1996.
68. Jones, B. H., and J. J. Knapik. Physical training and exercise-related injuries. *Sports Med.* 27:111–125, 1999.
69. Jorgensen, U. Body load in heel-strike running: the effect of a firm heel counter. *Am. J. Sports Med.* 18:177–181, 1990.
70. Jorgensen, U., F. Bojsen-Moller. Shock absorbency of factors in the shoe/heel interaction: with special respect to the role of the heelpad. *Foot Ankle* 9:294–299, 1989.
71. Kaufman, K., S. Brodine, and R. A. Shaffer. Outpatient care for training and other injuries In: *Injuries in the Military: A Hidden Epidemic,* B. H. Jones and B. C. Hansen (Eds.). Falls Church, VA: Armed Forces Epidemiological Board, 1996, pp. 1–129.
72. Kaufman, K. R., S. K. Brodine, R. A. Shaffer, C. W. Johnson, and T. R. Cullison. The effect of foot structure and range of motion on musculoskeletal overuse injuries. *Am. J. Sports Med.* 27:585–593, 1999.
73. Kelley, M. J. Psychological risk factors and sports injuries. *J. Sports Med. Phys. Fitness* 30:202–221, 1990.
74. Kerr, G., and H. Minden. Psychosocial factors related to the occurrence of athletic injuries. *J. Sport Exerc. Psychol.* 10:167–173, 1988.
75. Kerr, G., and B. Fowler. The relationship between psychological factors and sports injuries. *Sports Med.* 6:127–134, 1988.
76. Knapik, J. J., B. H. Jones, C. L. Bauman, and J. M. Harris. Strength, flexibility and athletic injuries. *Sports Med.* 14:277–288, 1992.
77. Knapik, J. J., P. Ang, K. Reynolds, and B. Jones. Physical fitness, age, and injury incidence in infantry soldiers. *J. Occup. Med.* 35:598–603, 1993.
78. Knudson, D. Stretching during warm-up: do we have enough evidence? *JOPERD* 70:24–27,51, 1999.
79. Koplan, J. P., K. E. Powell, R. K. Sikes, R. Shirley, and C. C. Campbell. An epidemiologic study of the benefits and risks of running. *JAMA* 248:3118–3121, 1982.
80. Koplan, J. P., D. S. Siscovick, and G. Goldbaum. The risks of exercise: a public health view of injuries and hazards. *Public Health Rep.* 100:189–195, 1985.
81. Kowal, D. M. Nature and causes of injuries in women resulting from an endurance training program. *Am. J. Sports Med.* 8:265–269, 1980.
82. Krissoff, W. B., and W. D. Ferris. Runners' injuries. *Physician Sportsmed.* 7:55–64, 1979.
83. Kues, J. The pathology of shin splints. *J. Orthop. Sports Phys. Ther.* 12:115–121, 1990.
84. Lilletvedt, J., E. Kreighbaum, and R. L. Phillips. Analysis of selected alignment of the lower extremity related to the shin splint syndrome. *Podiatr. Sports Med.* 69:211–217, 1979.
85. Looney, M. A., and B. P. McAllister. Is critical analysis of sports medicine research necessary? *Athl. Train.* 24:333–336, 1989.
86. Lysens, R., J. Lefevre, and M. Ostyn. The predictability of sports injuries: a preliminary report. *Int. J. Sports Med.* 5(Suppl.): 153–155, 1984.
87. Lysens, R., Y. Vanden Auweele, and M. Ostyn. The relationship between psychosocial factors and sports injuries. *J. Sports Med.* 26:77–84, 1986.

88. Lysholm J., and J. Wiklander. Injuries in runners. *Am. J. Sports Med.* 15:168–171, 1987.
89. Macera, C. A. Lower extremity injuries in runners: advances in prediction. *Sports Med.* 13:50–57, 1992.
90. Macera, C. A., K. L. Jackson, G. W. Hagenmaier, J. J. Kronenfeld, H. W. Kohl, and S. N. Blair. Age, physical activity, physical fitness, body composition, and incidence of orthopedic problems. *Res. Q. Exerc. Sport* 60:225–233, 1989.
91. Macera, C. A., R. R. Pate, K. E. Powell, K. L. Jackson, J. S. Kendrick, and T. E. Craven. Predicting lower-extremity injuries among habitual runners. *Arch. Int. Med.* 149:2565–2568, 1989.
92. Macleod, M. A., A. S. Houston, L. Sanders, and C. Anagnostopoulos. Incidence of trauma related stress fractures and shin splints in male and female Army recruits: retrospective case study. *Br. Med. J.* 318:29, 1999.
93. Marti, B., J. P. Vader, C. E. Minder, and T. Abelin. On the epidemiology of running injuries: the 1984 Bern Grand-Prix study. *Am. J. Sports Med.* 16:285–294, 1988.
94. Maughan, R. J., and J. D. B. Miller. Incidence of training-related injuries among marathon runners. *Br. J. Sports Med.* 17:162–165, 1983.
95. McKeag, D. B., and C. Dolan. Overuse syndromes of the lower extremity. *Physician Sportsmed.* 17:108–123, 1989.
96. McKelvie, S. J., P. M. Valliant, and M. E. Asu. Physical training and personality factors as predictors of marathon time and training injury. *Percept. Mot. Skills* 60:551–566, 1985.
97. Melberg, P., and J. Styf. Posteromedial pain in the lower leg. *Am. J. Sports Med.* 17:747–750, 1989.
98. Messier, S. P., and K. A. Patella. Etiologic factors associated with selected running injuries. *Med. Sci. Sports Exerc.* 20:501–505, 1988.
99. Michael, R. H., and L. E. Holder. The soleus syndrome: a cause of medial tibial stress (shin splints). *Am. J. Sports Med.* 13:87–94, 1985.
100. Micheli, L. J. Lower extremity overuse injuries. *Acta. Med. Scand.* 711(Suppl.):171–177, 1986.
101. Milgrom, C., M. Giladi, M. Stein, et al. Medial tibial pain: a prospective study of its cause among military recruits. *Clin. Orthop.* 213:167–171, 1986.
102. Mubarak, S. J., R. N. Gould, Y. F. Lee, D. A. Schmidt, and A. R. Hargens. The medial tibial stress syndrome: a cause of shin splints. *Am. J. Sports Med.* 10:201–205, 1982.
103. Myburgh, K. H., N. Grobler, and T. D. Noakes. Factors associated with shin soreness in athletes. *Physician Sportsmed.* 16: 129–134, 1988.
104. Neely, F. G. Intrinsic risk factors for exercise-related lower limb injuries. *Sports Med.* 26:253–63, 1998.
105. Neely, F. G. Biomechanical risk factors for exercise-related lower limb injuries. *Sports Med.* 26:395–413, 1998.
106. O'Neill, D. B., and L. J. Micheli. Overuse injuries in the young athletes. *Clin. Sports Med.* 7:591–610, 1988.
107. Orava, S. Overexertion injuries in keep-fit athletes. *Scand. J. Rehabil. Med.* 10:187–191, 1978.
108. Orava, S., and J. Puranen. Athletes' leg pains. *Br. J. Sports Med.* 13:92–97, 1979.
109. O'Toole, M. L. Prevention and treatment of injuries to runners. *Med. Sci. Sports Exerc.* 24:S360–S363, 1992.
110. Pagliano, J. Pathological foot types in runners. *Med. Sport* 12:155–168, 1978.
111. Passer, M. W., and M. D. Seese. Life stress and athletic injury: examination of positive versus negative events and three moderator variables. *J. Hum. Stress* 9:11–16, 1983.
112. Paul, W. D., and G. L. Soderberg. The shin splint confusion. In: *Proceedings of the 8th National Conference on Aspects of Sports*, Chicago, IL, Am. Med. Assoc., Chicago, 1967, pp. 19–24.
113. Pollock, M. L., L. R. Gettman, C. A. Milesis, M. D. Bah, L. Durstine, and R. B. Johnson. Effects of frequency and duration of training on attrition and incidence of injury. *Med. Sci. Sports Exerc.* 9:31–36, 1977.
114. Pope, R. P., R. Herbert, J. D. Kirwan, and B. J. Graham. A randomized trial of preexercise stretching for prevention of lower-limb injury. *Med. Sci. Sports Exerc.* 32:271–277, 2000.
115. Popovich, R. M., J. W. Gardner, R. Potter, J. J. Knapik, and B. H. Jones. Effect of rest from running on overuse injuries in Army basic training. *Am. J. Prev. Med.* 18:147–155, 2000.
116. Powell, K. E., H. W. Kohl, C. J. Caspersen, and S. N. Blair. An epidemiological perspective on the causes of running injuries. *Physician Sportsmed.* 14:100–114, 1986.
117. Puranen, J. The medial tibial syndrome: exercise ischemia in the medial fascual compartment of the leg. *J. Bone Joint Surg.* 56B:712–715, 1974.
118. Rasmussen, W. Shin splints: definition and treatment. *J. Sports Med.* 2:111–117, 1974.
119. Reid, D. C. Exercise-induced leg pain. In: *Sports Injury Assessment and Rehabilitation.* New York: Churchill Livingstone, 1992, pp. 269–300.
120. Renstrom, P., and R. J. Johnson. Overuse injuries in sports: a review. *Sports Med.* 2:316–333, 1985.
121. Requa, R. K., L. N. Deavilla, and J. G. Garrick. Injuries in recreational adult fitness activities. *Am. J. Sports Med.* 21:461–467, 1993.
122. Reynolds, K. L., H. A. Heckel, C. E. Witt, et al. Cigarette smoking, physical fitness, and injuries in infantry soldiers. *Am. J. Prev. Med.* 10:145–150, 1994.
123. Richie, D. H., Jr., S. F. Kelso, and P. A. Bellucci. Aerobic dance injuries: a retrospective study of instructors and participants. *Physician Sportsmed.* 13:130–140, 1985.
124. Riddell, D. I. Changes in the incidence of medical conditions at the commando training centre, Royal Marines. *J. R. Nav. Med. Serv.* 76:105–108, 1990.
125. Robbins, S. E., and G. J. Gouw. Athletic footwear: unsafe due to perceptual illusions. *Med. Sci. Sports Exerc.* 23:217–224, 1991.
126. Robbins, S. E., and A. M. Hana. Running-related injury prevention through barefoot adaptations. *Med. Sci. Sports Exerc.* 19: 148–156, 1987.
127. Ross, J. A review of lower limb overuse injuries during basic military training. Part 2: prevention of overuse injuries. *Mil. Med.* 158:415–420, 1993.
128. Ross, J., and A. Woodward. Risk factors for injury during basic military training: is there a social element to injury pathogenesis? *J. Occup. Med.* 36:1120–1126, 1994.
129. Rudzki, S. J. Injuries in Australian Army recruits. Part I: decreased incidence and severity of injury seen with reduced running distance. *Mil. Med.* 162:472–476, 1997.
130. Rudzki, S. J., and M. J. Cunningham. The effect of a modified physical training program in reducing injury and medical discharge rates in Australian Army recruits. *Mil. Med.* 164:648–652, 1999.
131. Samet, J. M., T. W. Chick, and C. A. Howard. Running-related morbidity: a community survey. *Ann. Sports Med.* 1:30–34, 1982.
132. Saxena, A., T. O'Brien, and D. Bunce. Anatomic dissection of the tibialis posterior muscle and its correlation to medial tibial stress syndrome. *J. Foot Surg.* 29:105–108, 1990.
133. Schwellnus, M. P., G. Jordan, and T. D. Noakes. Prevention of common overuse injuries by the use of shock absorbing soles: a prospective study. *Am. J. Sports Med.* 18:636–641, 1990.
134. Shaffer, R. A., S. K. Brodine, I. I. Stanley, and T. L. Anh. Epidemiology of illness and injury among U.S. Navy and Marine Corps female training populations. *Mil. Med.* 164:17–21, 1999.
135. Shrier, I. Stretching before exercise does not reduce the risk of local muscle injury: a critical review of the clinical and basic science literature. *Clin. J. Sports Med.* 9:221–227, 1999.
136. Slocum, D. Overuse syndromes of the lower leg and foot in athletes (Instruct. Lect.). *Am. Acad. Orthop. Surg.* 17:359–367, 1960.
137. Slocum, D. B. The shin splints syndrome: medical aspects and differential diagnosis. *Proceedings of the 8th National Conference on Medical Aspects of Sports*, AMA, Chicago, 1967, pp. 24–31.
138. Smith, W., J. Walter, and M. Bailey. Effect of insoles in Coast Guard basic training footwear. *J. Am. Podiatr. Med. Assoc.* 75:644–647, 1985.

139. Sommer, H. M., and S. W. Vallentyne. Effect of foot posture on the incidence of medial tibial stress syndrome. *Med. Sci. Sports Exerc.* 27:800–804, 1995.
140. Stacy, R., and R. L. Hungerford. A method to reduce work-related injuries during basic recruit training in the New Zealand Army. *Mil. Med.* 149:318–320, 1984.
141. Subotnik, S. I. The shin splints syndrome of the lower extremity. *J. Am. Podiatry Assoc.* 66:43–45, 1976.
142. Taimela, S., U. M. Kujala, and K. Osterman. Intrinsic risk factors and athletic injuries. *Sports Med.* 9:205–215, 1990.
143. Thacker, S. B., D. F. Stroup, C. M. Branche, J. R. Gilchrist, R. A. Goodman, and E. A. Weitman. The prevention of ankle sprains in sports: a systematic review of the literature. *Am. J. Sports Med.* 27:753–760, 1999.
144. Tomasi, L., and J. Peterson. Women's response to Army training. *Physician Sportsmed.* 5:32–37, 1977.
145. Valliant, P. M. Injury and personality traits in non-competitive runners. *J. Sports Med.* 20:341–346, 1980.
146. Valliant, P. M. Personality and injury in competitive runners. *Percept. Mot. Skills* 53:251–253, 1981.
147. van Mechelen, W. Running injuries: a review of the epidemiological literature. *Sports Med.* 14:320–335, 1992.
148. van Mechelen, W. Can running injuries be effectively prevented? (Editorial). *Sports Med.* 19:161–165, 1995.
149. van Mechelen, W., H. Hlobil, and H. C. G. Kemper. Incidence, severity, aetiology and prevention of sports injuries: a review of concepts. *Sports Med.* 14:82–99, 1992.
150. van Mechelen, W., H. Hlobil, H. C. Kemper, W. J. Voorn, and H. R. de Jongh. Prevention of running injuries by warm-up, cool-down and stretching exercises. *Am. J. Sports Med.* 21:711–719, 1993.
151. Viitasalo, J. T., and M. Kvist. Some biomechanical aspects of the foot and ankle in athletes with and without shin splints. *Am. J. Sports Med.* 11:125–130, 1983.
152. Vogel, J. A., L. Vanggaard, and T. Hentze-Eriksen. Injuries related to physical training. *Ann. Med. Mil. Belg.* 8:49–56, 1994.
153. Wallenstein, R., and E. Eriksson. Is medial lower leg pain (shin splints) a chronic compartment syndrome? In: *Symposium on the Foot and Leg in Running Sports*, R. P. Mack (Ed.). St. Louis: Mosby, 1982, pp. 135–140.
154. Walter, S. D., L. E. Hart, J. R. Sutton, J. M. Mcintosh, and M. Gauld. Training habits and injury experience in distance runners: age and sex-related factors. *Physician Sportsmed.* 16:101–113, 1988.
155. Walter, S. D., L. E. Hart, J. M. McIntosh, and J. R. Sutton. The Ontario cohort study of running-related injuries. *Arch. Int. Med.* 149:2561–2564, 1989.
156. Walter, S. D., J. R. Sutton, J. M. McIntosh, and C. Connolly. The aetiology of sport injuries: a review of methodologies. *Sports Med.* 2:47–58, 1985.
157. Washington, E. L. Musculoskeletal injuries in theatrical dancers: site frequency, severity. *Am. J. Sports Med.* 6:75–98, 1978.
158. Watson, M. D., and P. P. Dimartino. Incidence of injuries in high school track and field athletes and its relation to performance ability. *Am. J. Sports Med.* 15:251–254, 1987.
159. Williams, J., P. Tonymon, and W. A. Wadsforth. Relationship of life stress to injury in intercollegiate volleyball. *J. Hum. Stress* 12:38–43, 1986.
160. Winter, D. A., and P. J. Bishop. Lower extremity injury; biomechanical factors associated with chronic injury to the lower extremity. *Sports Med.* 14:149–156, 1992.
161. Young, M. L., and D. A. Cohen. Self-concept and injuries among female high school basketball players. *J. Sports Med.* 21:55–61, 1981.