TECHNICAL REPORT
NATICK/TR-83/026

LOWER EXTREMITY DISORDERS AMONG MEN AND WOMEN IN ARMY BASIC TRAINING AND EFFECTS OF TWO TYPES OF BOOTS

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JANUARY 1983

UNITED STATES ARMY NATICK
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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: NATICK/TR-83/026 — 2. GOVT ACCESSION NO.: AD-A133002	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): LOWER EXTREMITY DISORDERS AMONG MEN AND WOMEN IN ARMY BASIC TRAINING AND EFFECTS OF TWO TYPES OF BOOTS	5. TYPE OF REPORT & PERIOD COVERED: Final
	6. PERFORMING ORG. REPORT NUMBER: IPL-264
7. AUTHOR(s): Carolyn K. Bensel, Ph.D., US Army Natick Research & Development Laboratories, and Robert N. Kish, DPM, Moncrief Army Hospital, Fort Jackson, SC	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Individual Protection Laboratory, US Army Natick Research & Development Laboratories, Natick, Massachusetts 01760	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 6.2, 1L162723AH98AJ008
11. CONTROLLING OFFICE NAME AND ADDRESS: US Army Natick Research & Development Laboratories, ATTN: DRDNA-ICCH, Natick, Massachusetts 01760	12. REPORT DATE: January 1983
	13. NUMBER OF PAGES: 97
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report): Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

EXTREMITIES (FEET)	INJURY	STRESS (PHYSIOLOGY)
LOWER EXTREMITY DISORDERS	MILITARY PERSONNEL	BOOTS (LEATHER)
MILITARY TRAINING	BOOTS	BOOTS (HOT WEATHER)
PHYSICAL FITNESS	MALES	
FOOTWEAR	FEMALES	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This study was conducted to determine the nature and the frequency of lower extremity disorders incurred by men and women undergoing Army basic training and to analyze the differential effects of two types of combat boots on lower extremity disorders. The feet and lower legs of 2,074 men and 767 women were examined by medical personnel prior to the initiation of training and on three other occasions over the eight weeks of training. The data from these examinations were augmented by the diagnoses and case dispositions associated

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20. Abstract (cont'd)

with sick call visits for lower extremity problems. It was found that the rates of occurrence of blisters and lace lesions were higher among the test participants who wore hot weather boots than among those who wore black leather boots. Of 27 types of lower extremity disorders diagnosed among the participants, two were incurred only by men and two only by women. The remaining disorders were identified in both sexes and statistical analyses revealed that 12 of these disorders were experienced by a significantly higher proportion of women than men. None of the disorders diagnosed in both sexes were incurred by a significantly higher proportion of men than women. The number of sick call visits and duty restrictions for lower extremity problems were also analyzed as a function of gender and boot type.

SUMMARY

This study was conducted to determine the nature and the frequency of lower extremity disorders incurred by men and women undergoing Army basic training and to analyze the differential effects of two types of combat boots on lower extremity disorders.

The major findings from this study are as follows.

1. **Sick Call Visits and Disposition.** Approximately 23% of the 2,074 men and 42% of the 767 women who participated in this study attended sick call at least once during their time in basic training seeking medical attention for a lower extremity problem. The regular training activities of approximately 11% of the men and 22% of the women were curtailed for one or more days because of lower extremity disorders. Of the men in this study, .43% received medical discharges because of foot or lower leg problems. The comparable figure for the women is 1.30%. Statistical analyses indicated that significantly higher percentages of the women than the men attended sick call, were restricted in their training activities, and received medical discharges for lower extremity problems.

2. **Previous Disorders.** Examination of the feet and lower legs of the test participants prior to the beginning of basic training revealed that the women had significantly higher incidences of hallux valgus, callouses, and bunions than the men did, while a significantly higher proportion of men than women had previously sustained ankle fractures or sprains.

3. **Disorders Exclusive to Each Sex.** Of 27 types of lower extremity disorders diagnosed over the course of this study, ganglionic cysts and water retention were identified only among the women; osteochondritis dessicans and Osgood Schlatter's disease were identified only among the men. The remaining disorders were experienced by both men and women.

4. **Disorders by Gender.** The highest percentages of the men's sick call visits were made for treatment of blisters, chondromalacia patellae, and pes planus pain. Blisters, chondromalacia patellae, and stress reactions of the calcaneus accounted for the highest proportions of the women's sick call visits. Among the men, the highest proportions of days spent on restricted duty were due to chondromalacia patellae, lateral ankle sprains, and medial tibial flare stress reactions. The highest percentages of the women's restricted duty days were for chondromalacia patellae, lateral ankle sprains, and stress reactions of the calcaneus.

A significantly higher proportion of women than men were diagnosed for blisters, stress reactions of the calcaneus, callouses, lace lesions, metatarsal stress reactions, pes planus pain, chondromalacia patellae, lateral ankle sprains, tendinitis Achilles, shin splints, plantar fascial strain, and pes cavus pain. The largest differences between the sexes were in the rates of occurrence of blisters and stress reactions of the calcaneus. No lower extremity disorders diagnosed in members of both sexes were incurred by a significantly higher proportion of men than women.

5. **Factors in Morbidity by Gender.** Examination of the literature pertaining to the etiologies of the lower extremity disorders diagnosed among the test participants revealed that there are a number of factors which could be associated with the higher morbidity of the women relative to the men. Among these are anatomical structure, physical fitness level, and fit of the footwear.

6. **Disorders by Boot Type.** Comparison of the effects of two types of combat boots on lower extremity disorders revealed higher rates of occurrence of blisters and lace lesions among the men and the women who wore hot weather boots than among those who wore black leather boots. The hot weather boots were also associated with higher sick call and restricted duty rates than were the black leather boots.

PREFACE

The execution of this study would not have been possible without the support of Major General Lucien E. Bolduc, Jr., then Commander of the US Army Training Center and Fort Jackson, and the cooperation and participation of the civilian and military personnel of Fort Jackson.

Colonel Carl W. Hance and Colonel William L. Bryant, who served in turn as Director of Industrial Operations during the planning and execution of the study, provided invaluable guidance and directed the many activities entailed in initiating and terminating the study. Lieutenant Colonel William C. Ferguson, Mr. J. Larry Kyzer, and Master Sergeant William U. Worthington of the Directorate of Industrial Operations were instrumental in the success of the day-to-day operation of the study. A sizable number of people at the Clothing Initial Issue Point, both military and civilian, worked diligently to accomplish the issuing of footwear for this study and the establishment of study-related records. The efforts of Mr. Moir Martin, Mrs. Ida Rish, Master Sergeant Joe W. Manning, Staff Sergeant Wanda Wakefield, Messrs. Kenneth Pitts, Lonnie Turner, Sampson Chai, Joe Burns, and Henry G. Hall are gratefully acknowledged.

The Officers and Noncommissioned Officers of the First and Second Basic Training Brigades evidenced outstanding cooperation and professionalism in carrying out the additional responsibilities entailed in the conduct of this study. It is through their efforts that the extensive data were acquired. Particularly worthy of mention are the Officers and Noncommissioned Officers of the First, Second, and Fourth Battalions, First Basic Training Brigade, and of the Seventh Battalion, Second Basic Training Brigade.

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INTRODUCTION*

It was the opinion of the Duke of Wellington that the three most essential parts of a soldier's equipment are: A pair of good shoes, a second pair of good shoes, and a pair of half soles.[1] No doubt, Wellington's concern derived from the shortages of supplies that have historically been experienced during times of war. However, even when soldiers have been shod, injuries to the feet have taken a heavy toll in military campaigns. For example, during a period in the early part of the Franco-Prussian War, the German Army suffered the loss of 60,000 men, either killed or wounded, and, during that same time period, 30,000 men were rendered unfit for duty because of injuries to their feet.[2] In peacetime also, military personnel operate in physically stressful environments and, as a result, incur lower extremity problems. In terms of potential for development of foot and lower leg disorders, one of the more stressful environments to which an individual can be exposed in peacetime is that of basic military training. Here, recruits experience, for the first time, prolonged periods of drilling, the use of military footwear, and the general rigors of a regimen of physical and field training.[3]

Lower Extremity Disorders among Men in Military Training

Much of the research on lower extremity disorders occurring among recruits has been focused on the male populations of the military services. Based upon a survey conducted at the Great Lakes Naval Training Center, Hockstein[4] estimated that six out of every 100 men in training had foot complaints of such severity that they were referred to a podiatrist. About 30% of all these sick calls were for such problems as foot strain, metatarsalgia, and tendinitis, 20% for dermatologic incidences, 10% for corns and callouses, and 20% for ingrown nails. The remaining 20% were for traumatic injuries such as sprains and stress fractures. As an update and an extension of Hockstein's findings, Schnitzer and Hoeffler[5] further evaluated

*Descriptions of the lower extremity disorders cited in this and other sections of the report are presented in the appendix.

[1] E.E. Hume. **Victories of Army medicine.** Philadelphia: J.B. Lippincott, 1943.

[2] W.J. Mabrito. Foot by foot through the wars. **Military Medicine, 123,** 141–148, 1958.

[3] H.M. Delany and L.O. Travis. A clinical evaluation of one hundred cases of infection of the lower leg and foot in military personnel. **Military Medicine, 130,** 1184–1190, 1965.

[4] E.S. Hockstein. The role of the podiatrist in the Naval Service. **Journal of the American Podiatry Association, 51,** 488–492, 1961.

[5] J.S. Schnitzer and D.F. Hoeffler. The distribution and etiology of foot disorders in a Navy recruit population. **Journal of the American Podiatry Association, 64,** 845–853, 1974.

the lower extremity disorders found among men at the Great Lakes Naval Training Center. Over a period of 1.5 years, approximately 26% of all recruits reported to the podiatry clinic with foot-related complaints. Approximately 65% of these complaints were attributed to a structural abnormality of the foot. Dermatologic problems accounted for 30% of all disorders, and traumatic injury for 5%.

With regard to men undergoing Marine Corps training, Bensel[6] found that 37% of the recruits attended sick call at least once for treatment of foot or lower leg problems. The most common disorders occurring among the approximately 900 men studied included blisters, identified in 34% of the recruits, and the traumatic injuries of stress reactions or stress fractures, identified in 18% of the recruits.

There is documentation, as well, of lower extremity disorders occurring among Army trainees. Delany and Travis[3] evaluated the types of foot infections that resulted in hospitalizations of 100 men in Army training at Fort Dix. They found that ulcers due to abrasion of broken blisters accounted for 52% of the foot problems, blisters accounted for 21% of the foot problems, and cellulitis accounted for 22% of the foot problems.

Of all the lower extremity disorders occurring among men in recruit training, blisters, cellulitis, and stress fractures have been the most widely studied by medical personnel responsible for treating this segment of the military population. Interest in these disorders is due not only to their prevalence, but also to the fact that they can prevent individuals from performing their normal duties for a prolonged period of time. The blister generally seem among recruits is referred to as a friction blister because it is attributed to shearing forces between the tough, superficial layer of skin and the deeper, more firmly held layers. These forces eventually result in a cleft into which fluid flows.[7] Cellulitis, often accompanied by elevated body temperatures and the presence of staphylococcus aureus, is a secondary infection associated with blisters.[8]

Blisters and cellulitis. Both of these disorders tend to occur early in training and the latter disorder often requires hospitalization. Seventy-eight percent of the men in Army training identified by Delany and Travis[3] as having either blisters or cellulitis were in the first four weeks of training. Among those hospitalized for the disorders, the average stay was 6.4 days. Men in Navy training evidenced a similar temporal distribution of the onset of blisters and cellulitis; morbidity was higher in the initial weeks of training than in the later weeks. However,

[6] C.K. Bensel. **The effects of tropical and leather combat boots on lower extremity disorders among US Marine Corps recruits** (Tech. Rep. TR 76–49–CEMEL). Natick, Massachusetts: US Army Natick Research and Development Command, March 1976.

[7] W.A. Akers and M.B. Sulzberger. The friction blister. **Military Medicine, 137**, 1–7, 1972.

[8] D.F.Hoeffler. Friction blisters and cellulitis in a Navy recruit population. **Military Medicine, 140**, 333–337, 1975.

there was a second peak in the frequencies of the disorders during the fifth week of the seven-week training cycle when the men returned to regular training after having spent approximately nine days performing maintenance duties. An average of 3.4 days of hospitalization was associated with cases of cellulitis among these Navy recruits.[8,9] Cases of cellulitis identified among Air Force recruits were also found to occur early in training and they involved hospital stays averaging 4.5 days.[10]

The most common sites of friction blisters and cellulitis among the recruits in all the military services studied were the posterior heel, the Achilles region, and the dorsal surface of the foot and ankle.[3,8,9,10] Because of the sites of blisters and cellulitis and their times of onset, the rubbing of feet unused to military footwear against stiff, new boots as the recruits walk, run, and march from place to place has been implicated as a critical factor in the etiology of these disorders.[3,9,10] Therefore, it has been proposed that careful attention be paid to the fitting of footwear and that some method of reducing the stiffness of new footwear be devised.[3,8,10] Some success in reducing blistering has been achieved through the use of insoles, teflon sprays applied to the interior surfaces of boots, and double sock combinations.[11] It is theorized that these techniques reduce the differential movement of footwear against the skin and thus the shearing forces within the epidermis.[7,11] Foot problems experienced prior to entry into military service have also been implicated in the development of blisters and cellulitis pointing to the need for careful preenlistment screening.[8] A complementary finding is that the better the foot condition, as indicated by the amount of running an individual did prior to basic training, the less severe will be the blisters experienced.[11]

Stress fractures. As was mentioned previously, stress fractures also prevent men from engaging fully in basic training activities for prolonged periods of time. The disorder, a partial or complete fracture of the bone, is attributed to rhythmically-repeated, subthreshold, mechanical insult to a bony structure.[12] A stress fracture has been referred to as an example of accelerated bone remodeling with the fracture occurring as the bone attempts to adapt to changes in form and function.[13,14] Clinical findings include localized pain, tenderness, and,

[9]G.R. Hodges, T.W. DuClos, and J.S. Schnitzer. Inflammatory foot lesions in Naval recruits: Significance and lack of response to antibiotic therapy. **Military Medicine, 140**, 94–97, 1975.

[10]J.G. Marks, W.N. Miller, and R.L. Garcia. March cellulitis. **Military Medicine, 143**, 314–316, 1978.

[11]A. Jagoda, H. Madden, and C. Hinson. A friction blister prevention study in a population of Marines. **Military Medicine, 146**, 42–44, 1981.

[12]R.G. MacDonald. Early diagnosis and treatment of stress fractures of the calcaneus. **Journal of the American Podiatry Association, 56**, 533–536, 1966.

[13]S.D. Fordham. Stress fracture affects variety of exercisers. **The Physician and Sportsmedicine, 4**, 79–82, 1976.

[14]A.M. McBryde. Stress fractures in athletes. **Journal of Sports Medicine, 3**, 212–217, 1975.

possibly, swelling.[15] Radiologic evidence of a fracture may be delayed for a week or more after the initial onset of symptoms.[16] The term stress reaction has been coined to indicate situations in which the clinical symptoms of a stress fracture are present, but positive radiological findings are lacking.[17] In the military, stress reactions are considered to be suspected stress fractures and are managed as such.[16] Unlike cases of cellulitis, most recruits are not hospitalized for stress injury, rather their physical activities are limited for three or more weeks depending upon the location of the injury.[16,18,19] Thus, the recruit does not engage in drilling, foot marches, and physical fitness training for a significant period of time.

The time of onset of symptoms of stress fractures varies somewhat among the military services as a function of their respective training regimens but, like blisters and cellulitis, the symptoms tend to appear early in the training cycle. Allen[15] and MacDonald[12] reported that, among Army recruits, the symptoms of stress fractures generally occur within the first two weeks of basic training. Hockstein[4] estimated that stress fractures among Naval trainees occurred in the third and fifth training weeks, the most active phases of training. For Marine recruits at Parris Island, O'Donnell[20] found that stress fractures generally occurred within the first three weeks, but could occur as late as the sixth or the eighth week of training. The primary location of the fracture also varies among the military services. The metatarsals have been reported to be the most common site among Army and Navy trainees, while, among Marine recruits, the majority of cases involved fractures of the calcaneus.[15,16] Stress fractures of the femur, tibia, and fibula, while not as frequent, have been reported as occurring among Army, Navy, and Marine trainees.[16,20]

[15] T.S. Allen. Stress fractures. **Texas Medicine, 68**, 125–128, 1972.

[16] R.S. Gilbert and H.A. Johnson. Stress fractures in military recruits – A review of twelve years' experience. **Military Medicine, 131**, 716–721, 1966.

[17] D.B. Clement. Tibial stress syndrome in athletes. **Journal of Sports Medicine, 2**, 81–85, 1974.

[18] P.R. Kimball and A.A. Savastano. Fatigue fractures of the proximal tibia. **Clinical Orthopedics, 70**, 170–173, 1970.

[19] R.H. Lanham. Stress fractures in military personnel. **Journal of the American Podiatry Association, 53**, 192–195, 1963.

[20] T. O'Donnell. Medical problems of recruit training: A research approach. **U.S. Navy Medicine, 58**, 28–34, 1971.

In attempting to identify factors that may be related to the occurrence of stress fractures, Gilbert and Johnson[16] found that the fractures were more common among obese recruits and those with little athletic experience. In their investigation, no relationship with foot structure could be firmly established. MacDonald[12] stated that the calcaneal fractures he identified among Army trainees were probably due to the change of their gait patterns induced by wearing boots. Scully and Besterman[21] maintained that the shock-absorbing capacities of muscles are impaired by fatigue associated with the high level of a recruit's physical activity and that his joint mobility is limited by the wearing of new, stiff boots. In their opinion, these factors result in stress fractures. They, therefore, recommend that the physical training schedule of recruits be cyclic, rather than progressive, with the elimination of running, jumping, and double-timing during the third week of training. Their theory is that physical activities during the initial weeks of training will result in limited bone damage which will repair itself during a period of relative rest prior to the resumption of physical training and the initiation of another cycle of bone remodeling.

Lower Extremity Disorders among Women in Military Training

Based upon the studies which have explored the type, the frequency, and the disposition of lower extremity disorders occurring among men in military training, there can be little doubt that such disorders are costly in terms of the use of medical personnel, hospital and clinic facilities, and recruits' time lost for sick calls, hospitalization, and other duty restrictions. The data that have been acquired pertaining to military women, though limited, substantiate the high cost attributable to lower extremity disorders. Indeed, in those instances in which morbidity rates have been compared, it has been found that lower extremity disorders are even more prevalent among women recruits than they are among men. In a study published in 1943, Marwil and Brantingham[22] reported that 52% of all sick call visits which were made at a women's Naval training installation were for complaints related to the feet. This figure was three times greater than that recorded during the same time frame at a men's Naval training installation. Marwil and Brantingham determined that one factor contributing to the high incidence of foot disorders was the poor condition of the feet of these women entering military service. Of 1,637 women who had passed the physical requirements for enlistment in the Navy, Marwil and Brantingham found that only 15% had normal feet. Among the problems identified in this large sample of women were metatarsalgia (39%), callouses (39%), hallux valgus (12%), hammertoes (10%), and ingrown nails (8%). Marwil and Brantingham's findings are in consonance with results of research done on the civilian segment of the US population. Using data acquired through the Health Interview Surveys administered by the National Center for Health Statistics, the American Podiatry Association[23] determined that foot problems such as corns, callouses, and bunions occur more frequently in women than in the population at large.

[21] T.J. Scully and G. Besterman. Stress fracture – A preventable training injury. **Military Medicine, 147,** 285–287, 1982.

[22] T.B. Marwil and C.R. Brantingham. Foot problems of women's reserve. **Hospital Corps Quarterly, 16,** 98–100, 1943.

[23] American Podiatry Association. An assessment of foot health problems and related health manpower utilization and requirements. **Journal of the American Podiatry Association, 67,** 102–114, 1977.

During World War II, the time frame in which Marwil and Brantingham conducted their research, just over 2% of the US military personnel on active duty were women.[24] It was not until the 1970's that women again represented this high a proportion of the military population,[25] and that studies again investigated the nature and frequency of lower extremity disorders among military women. The research was also stimulated by other events of the 1970's. These included the admission of women to the service academies, an increase in the military occupational specialties open to women, and the adoption of basic training programs for women that were identical in most respects to those established for men. The service academies were charged to apply the same standards for admission, training, and graduation to both genders, except for "minimum essential adjustments" required because of physiological differences between men and women (Public Law 94–106). This general approach was applied by the military services to the recruitment and training of women outside of the academies as well. Several investigations were conducted to assess the impact on lower extremity disorders of the more rigorous training regimens to which military women were being exposed as a result of these events.

The entrance of women into the US Military Academy provided the opportunity for studying women being trained together with men. During the eight-week Reveille Exercise Training, which precedes the start of a cadet's first school year and places great emphasis on physical conditioning, it was found that both men and women sustained shin splints, ankle sprains, tendinitis Achilles, and blisters. All of these disorders were more prevalent among the women than among the men.[26] Also, during 1976, the first year women were accepted into the US Military Academy, 10% of the women vs. 1% of the men undergoing Reveille Exercise Training sustained stress fractures. The sites of these injuries were the tibia, fibula, femur, calcaneus, and metatarsals.[27] The second summer that women participated in this training program, their incidence of stress fractures was reduced to 3%. This decrease was attributed to several factors including a better level of physical conditioning in the second group of women, assignment of most of the women to the slowest group during daily runs, and the use of running shoes, rather than military boots, during these conditioning runs.[26]

[24]W. Lerner. **Statistical abstract of the United States, 1969, 90th annual edition.** Washington, DC: US Department of Commerce, 1969.

[25]Bureau of the Census. **Statistical abstract of the United States, 1980, 101st edition.** Washington, DC: US Department of Commerce, 1980.

[26]J.L. Anderson. Women's sports and fitness programs at the US Military Academy. **The Physician and Sportmedicine, 7,** 72–78, 1979.

[27]R.R. Protzman and C.G. Griffis. Stress fractures in men and women undergoing military training. **Journal of Bone and Joint Surgery, 59A,** 825, 1977.

In a study of Army enlisted personnel, Reinker and Ozburne[28] tracked lower extremity injuries occurring among recruits in two all-male basic training battalions and one all-female training battalion at Fort Jackson, South Carolina. Although these men and women trained separately, their programs of activities were the same in most respects. The data acquired consisted of cases of disorders that were of sufficient magnitude to be referred to the Physical Therapy, the Orthopedic, or the Podiatry Departments of the base hospital. Reinker and Ozburne found that, compared to the men, the women had five times the incidence of tendinitis Achilles, two times the incidence of chondromalacia patellae, and three times the incidence of stress reactions. Stress reactions of the calcaneus and the tibia were diagnosed among the women. In addition to these two sites, the men had stress reactions of the metatarsals. Further examination of injury patterns by Reinker and Ozburne revealed that the individuals who incurred lower extremity disorders did not differ significantly in age, height, or weight from the respective means of these variables for the trainees at Fort Jackson.

In 1977, shortly after Reinker and Ozburne[28] had completed collection of their data, men and women recruits at Fort Jackson were integrated into the same companies where they not only followed the same program of activities, but trained together on a daily basis. Kowal[29] conducted a study of the frequencies of lower extremity injuries experienced by 347 women training under these conditions. Limited data were also acquired on 770 men undergoing training with these women. The results of a self-report, medical injury questionnaire administered to the test participants revealed that 54% of the women vs. 26% of the men sustained lower extremity injuries requiring medical attention over the course of the eight-week training cycle. Kowal found that the women who incurred injuries had higher percentages of body fat and lower levels of leg strength than the women who completed basic training without suffering injuries.

Lower Extremity Disorders among Civilian Women

Recent investigations done on the civilian population appear to corroborate the findings from the research involving men and women in military training. Studies of medical problems associated with participation in high school and college athletic programs also indicate that women may be at greater risk than men in terms of potential for lower extremity injury. Although attempts at direct comparisons of the nature and frequency of lower extremity disorders are constrained by differences in women's and men's sports,[30] it has been reported

[28] K.A. Reinker and S. Ozburne. A comparison of male and female orthopaedic pathology in basic training. **Military Medicine, 144**, 523–536, 1979.

[29] D.M. Kowal. Nature and causes of injuries in women resulting from an endurance training program. **American Journal of Sports Medicine, 8**, 265–269, 1980.

[30] J.G. Garrick and R.K. Requa. Girls' sports injuries in high school athletics. **The Journal of the American Medical Association, 239**, 2245–2248, 1978.

that knee and ankle injuries in particular are more prevalent in women than in men.[31,32] This finding has been attributed, in part, to low levels of fitness and conditioning among women, reflecting a lack of athletic experience relative to their male contemporaries.[30,33,34] It has also been suggested that, because the woman's greater pelvic width necessitates greater inclination of the axis of the femoral shaft relative to the axis of the head and neck of the femur, there is a resultant lateral body sway and poor running mechanics.[33] In addition, it has been reported that the wider pelvis gives women a tendency toward genu valgum, the patellae are close together while the ankles are far apart. Thus, the line of pull of the quadriceps muscle groups passes to the outside of the patellae, rather than through them, and the feet are chronically inverted. This tendency has been said to interfere with transmission of forces directly up the leg.[33,35] Women also have more joint laxity than men, a slighter bone structure, and a lower ratio of muscle to adipose tissue. These have all been cited as factors which may predispose women engaged in sports programs to lower extremity injury.[32]

Thus, studies have indicated that, in either a military or a civilian environment, women are at greater risk than men in terms of the probability of lower extremity disorders. The high level of physical activity associated with military training may exacerbate the risk among women relative to men, as may military women's use of footwear designed for men. Since 1977, women entering the Army have been issued a boot developed to accommodate men and have worn this boot throughout their training, including during physical fitness activities.

The MIL–5 Boot Last

The last, a wooden or plastic form over which footwear is fabricated, controls the shape, the fit, and the basic design of the footwear. The boots issued to men and women entering Army training are made over the MIL–5 last which was developed to conform to the

[31] K.S. Clarke and W.E. Buckley. Women's injuries in collegiate sports. **American Journal of Sports Medicine, 3,** 187–191, 1980.

[32] R.A. Shively, W.A. Grana, and D. Ellis. High school sports injuries. **The Physician and Sportsmedicine, 9,** 46–50, 1981.

[33] M. Albohm. How injuries occur in girls' sports. **The Physician and Sportsmedicine, 4,** 46–49, 1976.

[34] J. Gillette. When and where women are injured in sports. **The Physician and Sportsmedicine, 3,** 61–63, 1975.

[35] J.E. Taunton, D.B. Clement, and D. Webber. Lower extremity stress fractures in athletes. **The Physician and Sportsmedicine, 9,** 77–86, 1981.

anthropometric dimensions of the feet of American men.[36,37] Before work was begun on the last itself, measurements were taken of the feet of almost 7,000 Army enlisted men.[38] The mean values for the various foot measurements taken on the men were calculated and applied to the development of a three-dimensional model of the "average" foot. Subsequently, a bench model of a last was made that reflected the dimensions of this foot. The length of the last was approximately 2 cm greater than the length of the foot to allow for toe room in the boots to be made over the last, and the girth of the last was approximately 1 cm less than that of the foot to allow for stretching of the upper leather in the boots.[39] Analyses of the foot measurements were also performed to determine relationships among foot dimensions and the frequencies of these relationships. These analyses entailed identifying, for a specific value of one foot dimension, the values of the other foot dimensions. The results were used to produce a series of lasts which were graded up and down from the bench model to accommodate the ranges and the interrelationships of the foot dimensions of the Army men.[39] A geometric system of grading was employed. It is based on proportional changes in last dimensions between sizes, rather than on constant increments or decrements. Thus, the ratio of length to girth is maintained from size to size, together with all other dimensions of the last.[40] Leather boots made over MIL–5 lasts were subjected to large-scale tests involving their wear by male Army and Marine Corps personnel and subsequently adopted for military boot production.[36,37,41]

[36]W.A. Potter. Report on Department of Defense research project relative to combat boots made over a new type of last. **Journal of the American Podiatry Association, 51, 493–497, 1961.**

[37]W.A. Potter. Final report on Department of Defense research project relative to combat boots made over a new type of last. **Journal of the American Podiatry Association, 52, 122–125, 1962.**

[38]A. Freedman, E.C. Huntington, G.C. Davis, R.B. Magee, V.M. Milstead, and C.M. Kirkpatrick. **Foot dimensions of soldiers. Third partial report. Project T–13.** Fort Knox, Kentucky: Armored Medical Research Laboratory, March 1946.

[39]C.W. Mann and W.B. Zacharias. **Application of foot measurements in the development of last systems** (Footwear and Leather Series Rep. No. 7). Washington, DC: Office of the Quartermaster General, 1952.

[40]United Shoe Machinery Corporation. **An introduction to the USMC geometric two-part last.** Boston: United Shoe Machinery Corporation, April 1955.

[41]J.C. Perkins. **Joint US Marine Corps, US Army test of standard USMC combat boots in USMC tariff, standard USA combat boots in Army tariff, and USMC and USA combat boots made over Fort Knox V Last in reduced tariff** (Tech. Rep. T–192). Fort Lee, Virginia: Quartermaster Field Evaluation Agency, June 1961.

As the last came into regular use and experience was gained in the fitting of footwear produced on the last, it was found that the vast majority of boots issued to military men were whole and half sizes ranging from 5 through 14 in five widths (extra-narrow, narrow, regular, wide, and extra-wide). These sizes and widths were therefore maintained in the military supply system. In 1977, as military women were being introduced into the same regimens under which men were being trained, it was decided that, for protection of their feet from environmental hazards, Army women required rugged footwear and they were issued the men's boot. Using MIL–5 lasts, leather boots of sizes 3, 3½, 4, and 4½ in all widths except extra-narrow were produced and introduced into the military supply system.

Although smaller sizes of boots have been produced to accommodate the smaller foot dimensions of women relative to men, the fact remains that the MIL–5 last, developed from measurements made on men, incorporates the interrelationships of men's foot dimensions. That is, the last is proportioned for men's feet. Therefore, boots made over these lasts can be expected to fit men and women differently insofar as the interrelationships of women's foot dimensions differ from those of men's foot dimensions.

Some insight into differences between the genders in foot proportions can be obtained by exercising linear regression equations. These were derived from the data of anthropometric surveys conducted to acquire body dimension information on Army men and women.[42,43,44] Linear regression equations are a method of estimating the value of one foot dimension from the value of another foot dimension. The same value for men and for women was entered into their respective equations and the difference in the predicted values was calculated. The results revealed that the greatest differences between the men and the women are associated with circumferential dimensions. Given equal foot lengths, foot breadths, or heel breadths, the ball of foot, instep, and heel-ankle circumferences of men are predicted to be, on the average, at least 1 cm greater than those of women. This finding indicates that there may be differences between men and women in foot volume even when their foot lengths or widths are equal.

[42] E. Churchill, T. Churchill, J.T. McConville, and R.M. White. **Anthropometry of women of the US Army – 1977; Report No. 2 – The basic univariate statistics** (Tech. Rep. NATICK/TR–77/024). Natick, Massachusetts: US Army Natick Research and Development Command, June 1977.

[43] R.M. White. **Comparative anthropometry of the foot** (Tech. Rep. NATICK/TR–83/010). Natick, Massachusetts: US Army Natick Research and Development Laboratories, December 1982.

[44] R.M. White and E. Churchill. **The body size of soldiers: US Army anthropometry – 1966** (Tech. Rep. 72–51–CE). Natick, Massachusetts: US Army Natick Laboratories, December 1971.

A difference in foot proportions is not the only factor that may affect the fit of the boot on women relative to men. In the extensive Army survey of men's feet, data were acquired on foot flare, arch height, lateral foot contour, toe curvature, and posterior heel contour, and the findings were incorporated into the MIL–5 last.[38,39] These measurements have not been included in any anthropometric surveys of female populations. Thus, comparisons of women's values for these variables with those for men and for the last cannot be made. Based upon the information that is available, it can be stated that there are differences between the sexes in the basic foot dimensions and their interrelationships. However, the extent to which use of the MIL–5 last, which incroporates men's dimensions, will result in differential morbidity between men and women for lower extremity disorders cannot be predicted since data relating the occurrence of such disorders to the fit characteristics of footwear do not exist.

Purposes and Overview of the Present Study

There is a dearth of even more basic information than that described above: The differences in the type and frequency of specific lower extremity disorders incurred by men and women who undergo military training together outfitted in the same footwear, a boot developed for men. The study reported here is an attempt to compare the morbidity for lower extremity problems of Army enlisted men and women under these conditions. Unlike the earlier work of Reinker and Ozburne[28] in which the test participants were members of all-male or all-female battalions, the men and women in the present study were members of the same basic training companies. Also, rather than limiting the data to disorders of sufficient magnitude to be referred to medical specialists in hospital departments as Reinker and Ozburne did, the data acquired here included all lower extremity disorders diagnosed at sick calls. In Kowal's[29] investigation of disorders among men and women trainees, the basic data were generated through administration of a questionnaire to the study participants. It was determined that more complete information could be acquired by maintaining medical records for all study participants listing diagnoses and treatment dispositions related to their lower extremity disorders. Therefore, this method, rather than a questionnaire technique, was employed in the present study.

Health survey research has revealed that there are difficulties associated with assessing the results of studies such as this one in which men and women are compared with regard to the occurrence of medical problems. Although no adequate biological explanation has been proposed, it has consistently been found that women report more acute illness and make greater use of health services than men do, while men have the higher mortality and the higher rates of chronic conditions.[45,46] It has been estimated from patient records that, exclusive of

[45] C.A. Nathanson. Illness and the feminine role: A theoretical review. **Social Science and Medicine, 9,** 57–62, 1975.

[46] C.A. Nathanson. Sex, illness, and medical care: A review of data, theory, and method. **Social Science and Medicine, 11,** 13–25, 1977.

utilization associated with pregnancy, women of reproductive age make 1.5 times the number of visits to office-based physicians as men in this age group.[47] Total rates of hospitalization are also higher for women than men even when the rates are age-standardized and exclude obstetrical conditions.[46] Examination of physician visits for diagnosed conditions revealed that women seek health care proportionately more often than do men with the same conditions.[47] Through investigations of large samples of men and women, it has also been found that women report more symptoms of illness than men. In a study conducted on a sample of the US civilian population, Phillips and Segal[48] administered a test of psychological functioning that uses, as psychoneurotic indicators, symptoms of emotional and physical distress. The higher scores achieved by the women indicated that they reported experiencing more of the symptoms than the men reported. McCarroll, Kowal, and Phair[49] gave a similar test to Army enlistees at the beginning of their training. They subsequently found that women, whether they successfully completed training or were discharged for medical or administrative reasons, had higher scores on the test than men with the same training outcome.

The lack of an adequate biological basis for differences between the genders in reported illness and utilization of health services has led researchers to advance hypotheses that socio-cultural variables may be affecting illness and sick role behavior of those seeking medical assistance as well as the behavior of the physician providing the treatment.[45,46,50,51] Several steps were taken in recognition of the fact that behavioral differences between men and women could be expected to influence the data of the present study. One of these was mentioned previously: Medical records, rather than self-report questionnaires, were used as the means of acquiring information on lower extremity disorders. Also, in recording the dispositions of all sick call visits for lower extremity complaints, those instances in which study participants

[47] B.K. Cypress. Office visits by women: The national ambulatory medical care survey. **Vital and Health Statistics, 13,** 1–66, 1979.

[48] D.L. Phillips and B.E. Segal. Sexual status and psychiatric symptoms. **American Sociological Review, 34,** 58–72, 1969.

[49] J.E. McCarroll, D.M. Kowal, and P.W. Phair. The Health Opinion Survey: Predicting illness in military trainees. **Military Medicine, 146,** 463–468, 1981.

[50] R. Cooperstock. Sex differences in psychotropic drug use. **Social Science and Medicine, 12B,** 179–186, 1978.

[51] R. Cooperstock. A review of women's psychotropic drug use. **Canadian Journal of Psychiatry, 24,** 29–34, 1979.

were judged by medical personnel to be fit for full duty were noted. The rates at which men and women who reported disorders were returned to regular training activities may be some index of their respective approaches to health service utilization. In addition, data on lower extremity disorders were acquired not only through sick call records, but also through four examinations of the lower extremities of study participants. The examinations, scheduled over the course of the training cycle, were conducted to insure that cases of disorders were noted even though trainees did not seek treatment for them at sick call. The goal in implementing these procedures, was to document as fully as possible the types and frequencies of lower extremity disorders occurring among the trainees in this study. It was not expected that the procedures would obviate the differences between men and women revealed through health survey research or result in data free of the influence of behavioral effects.

In addition to obtaining information on the effects of gender on lower extremity disorders in this study, data were acquired on these disorders as they relate to boot design. The boot issued to Army trainees has a grain-out, black leather upper with a rigid box toe and a one-piece, combined backstay and counter pocket. The outsole of black rubber is direct-molded to the leather upper using a method of vulcanization. This boot is one of two types in the Army's inventory made over the MIL–5 last. The other boot, referred to as the hot weather boot, was developed for use under high-temperature, high-humidity conditions and is normally issued to personnel operating in tropical environments. The hot weather boot has a leather vamp and counter pocket and a direct-molded sole, as does the black leather boot. However, the upper of the hot weather boot is made of a cotton/nylon blend which is softer, thinner, and more flexible than a leather upper.

Some comparative data on the black leather and the hot weather boots were obtained by de Moya[52] who subjected the boots to impact testing using a drop apparatus. For this test, the boot uppers were cut away and a vertically-positioned shaft, instrumented with an accelerometer, was dropped on the rearfoot or the forefoot regions of the boots. de Moya found that the impact cushioning and energy absorption characteristics of the black leather boots were superior to those of the hot weather boots. Bensel[6] tested both types of boots in a study of lower extremity disorders occurring among men in Marine Corps training. The principal purpose of that study was to determine whether use of the hot weather boot would reduce the number of cases of cellulitis and tendinitis Achilles compared to the number occurring when the black leather boot was worn. It was found that the frequencies of these two disorders did not differ significantly as a function of boot type. Both the black leather and the hot weather boots were included in the present study in order to acquire data regarding their effects on the type and frequency of lower extremity disorders incurred by women, as well as by men, in an Army training environment.

[52] R.G. de Moya. A biomechanical comparison of the running shoe and the combat boot. **Military Medicine, 147, 380–383, 1982.**

Boot type and gender of the participants were the independent variables in the present study. The specific purposes of the study were as follows:

a. To determine whether men and women differ significantly with regard to the nature and frequency of lower extremity disorders which they incur over the course of Army basic training;

b. To analyze the differential effects of two types of boots, made over the same last, on morbidity for lower extremity disorders;

c. To document the ramifications of lower extremity disorders insofar as they affect the basic training of Army men and women.

METHOD

Participants

The test participants were 2,841 Army basic trainees, 2,074 men and 767 women. This sample included all men who reported for basic training at the US Army Training Center, Fort Jackson, South Carolina, between June 12 and June 20, 1980, and, with one exception, all women who reported for basic training between June 12 and June 27, 1980. The woman excluded from the study could not be accommodated in any of the sizes of boots produced. Her foot measurements indicated that she required a size 2 and the smallest boot is a size 3. Following normal Army procedures in such cases, boots were manufactured specifically for this trainee. However, this process requires some time and the trainee used civilian footwear until she received her boots. All other individuals who reported for training during the time periods noted were issued boots prior to the beginning of training and were included as participants in this study.

The ages of 1,291 of the men and 451 of the women were obtained and an analysis of these data indicated that the men were significantly younger than the women, $t\ (1,740) = 3.75$, $p<.01$. The ages of the men ranged from 16 years to 41 years with the mean age being 18.9 years (S D = 2.6), while those of the women ranged from 17 to 35 years with a mean of 19.5 years (S D = 3.2).

All of the men and 272 of the women comprised 10 basic training companies, five companies in each of two battalions. These companies (Cos) will be referred to as A through E and the battalions (Bns) as 1 and 2. Four of the 10 companies consisted of men only, while six companies included both men and women. Each company was trained as a unit, all individuals within it, regardless of their gender, being exposed to the same training regimen and schedule of activities. However, men and women were not assigned within the same platoons. The remaining 495 women in the study were assigned throughout eight other companies, four companies in each of two additional battalions. The companies will be referred to as A through D and the battalions as 3 and 4. These companies also included men. Again, all men and women in a company were trained together and a platoon consisted of men or of women only. The men in Bns 3 and 4 were not included as participants in this study. However, limited data were acquired on them for use in some comparative analyses.

For the purposes of this study, the 2,074 men and the 767 women serving as test participants were randomly divided into two footwear groups; 728 men and 342 women were issued hot weather boots and the remainder of the participants were issued black leather combat boots. All of the men in Bns 3 and 4 were issued black leather boots.

Table 1 is a listing of the number of study participants as a function of company, gender, and boot assignment. The number of men in each company of Bns 3 and 4 is also presented.

Table 1. Company and Boot Assignments of Study Participants

Company-Battalion	Men			Women		
	Leather	Hot Weather	Total	Leather	Hot Weather	Total
A–1	180	55	235	–	–	–
B–1	103	92	195	19	22	41
C–1	94	82	176	18	16	34
D–1	146	41	187	28	21	49
E–1	147	48	195	19	29	48
Battalion Total	670	318	988	84	88	172
A–2	150	91	241	–	–	–
B–2	163	86	249	–	–	–
C–2	122	52	174	26	21	47
D–2	136	103	239	–	–	–
E–2	105	78	183	30	23	53
Battalion Total	676	410	1,086	56	44	100
Battalions 1 + 2 Total	1,346	728	2,074	140	132	272
A–3	194	–	194	24	28	52
B–3	124	–	124	62	19	81
C–3	144	–	144	54	38	92
D–3	186	–	186	33	17	50
Battalion Total	648	–	648	173	102	275
A–4	193	–	193	27	32	59
B–4	182	–	182	38	21	59
C–4	172	–	172	29	28	57
D–4	168	–	168	18	27	45
Battalion Total	715	–	715	112	108	220
Battalions 3 + 4 Total	1,363	–	1,363	285	210	495
Grand Total	2,709	728	3,437	425	342	767

Descriptions of Combat Boots

Hot weather boot. This boot (Boot, Hot Weather, Spike Resistant), made over the MIL–5 last, has a black leather, plain toe vamp and counter pocket (Figure 1). The leather is treated with silicone for resistance to water penetration. The uppers have a full, lace closure system and are of a cotton/nylon blend with a 2.54-cm wide, nylon tape up the back and around the top and 5.08-cm wide, nylon webbing diagonally across the ankle. The leather insole is split into two pieces and a .28-cm thick, stainless steel plate is inserted between the pieces for spike protection and stitched around the periphery. The rubber outsole is direct-molded to the upper using a method of vulcanization. The sole is of a "Panama" design, patterned after the heavy treads on military vehicles, to allow quick release of mud, pebbles, and other debris (Figure 1). The boot is produced in full and half sizes ranging from 5 to 14 and five widths (extra-narrow, narrow, regular, wide, and extra-wide). A size 3½ extra-wide and a 4 regular are also manufactured as is size 4½ in widths from narrow through extra-wide. Each boot is issued with a ventilating insole which may be retained or removed at the wearer's discretion. Some of these boot sizes could not be obtained at the time of the study and the boots used in the study comprised an abbreviated tariff.

Black leather boot. This boot (Boot, Combat, Leather, Black, Direct Molded Sole), made over the MIL–5 last, has a full, lace closure system and a grain-out leather upper (Figure 2). The upper has a rigid box toe without a toe cap and a one-piece, combined backstay and counter pocket. The leather is treated with silicone for water resistance. The rubber outsole is direct-molded to the upper and consists of a full, transverse "chevron," outer sole and heel (Figure 2). Removeable ventilating insoles are provided with the boots. This leather boot is produced in full and half sizes from 3 to 14. Sizes 5 through 14 are made in five widths (extra-narrow, narrow, regular, wide, and extra-wide) and sizes 3 through 4½ are made in four widths (narrow, regular, wide, and extra-wide). A full range of sizes was available for use in this study.

Procedure

An individual's participation in the study began on the day he or she was issued Army uniform clothing and footwear to replace the civilian attire that had been worn until this time. The issuing of Army clothing and footwear occurred during one of the approximately five processing days preceding the formal start of basic training. Before trainees were fitted for footwear, their feet were examined by podiatrists affiliated with Moncrief Army Hospital, Fort Jackson, or by their medical technicians. The medical personnel noted foot problems, the presence of certain body structures, and any history of lower extremity disorders on a record sheet established for each test participant and signed the sheet to indicate that Exam 1 had been conducted. The trainee, wearing cushion soled socks, was then fitted for either the hot weather or the leather combat boot. The fitting was accomplished by personnel of Fort Jackson's Clothing Initial Issue Point according to their standard procedures of measuring the feet for initial sizing, followed by inspection of the fit of the boots, with re-sizing as required. The men and the women were fitted for their boots by different personnel. When a proper fit had been achieved, the trainee was given a second pair of boots of the same type and size as the first and the size issued was to be entered on the individual's record sheet.

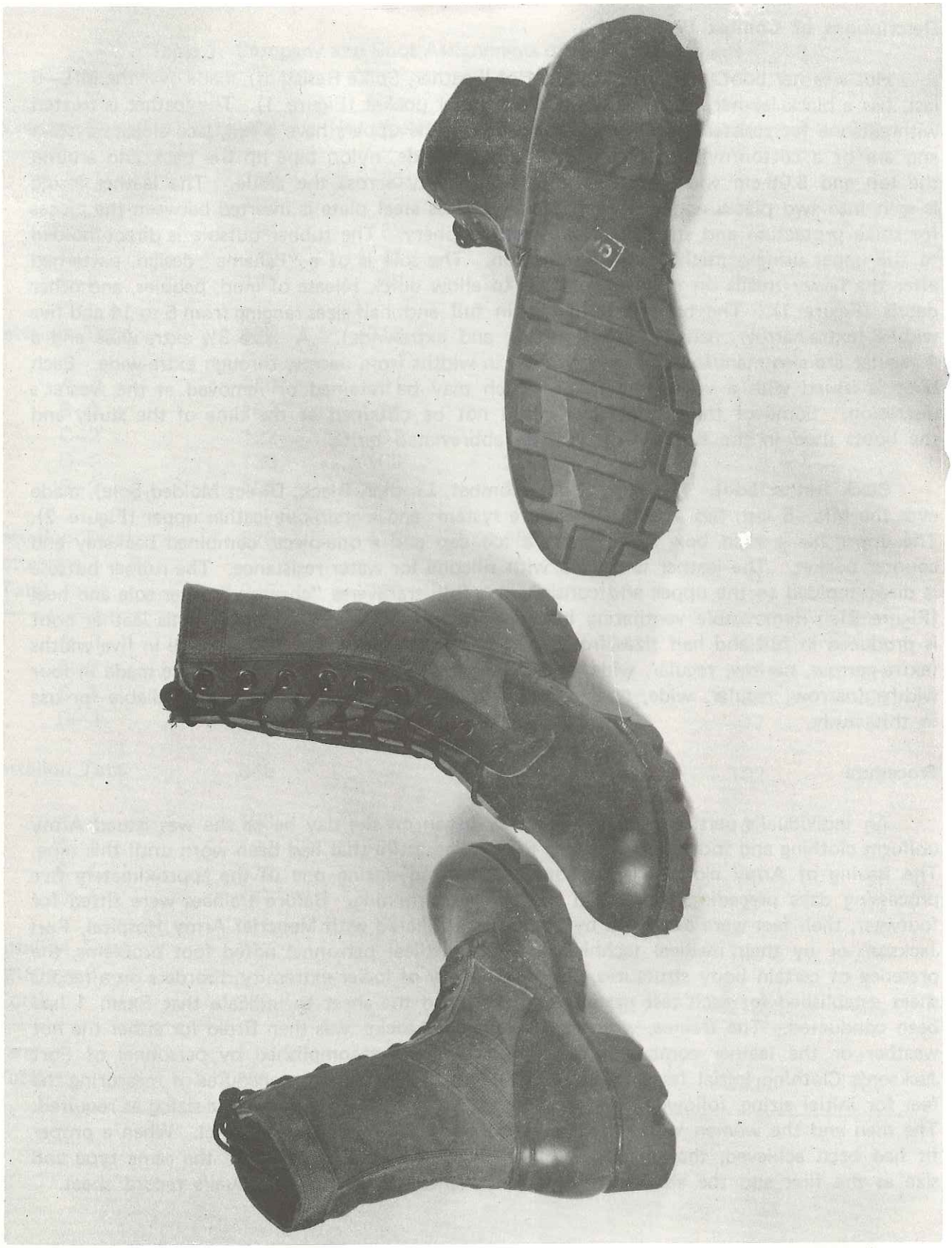

Figure 1. Hot weather boot.

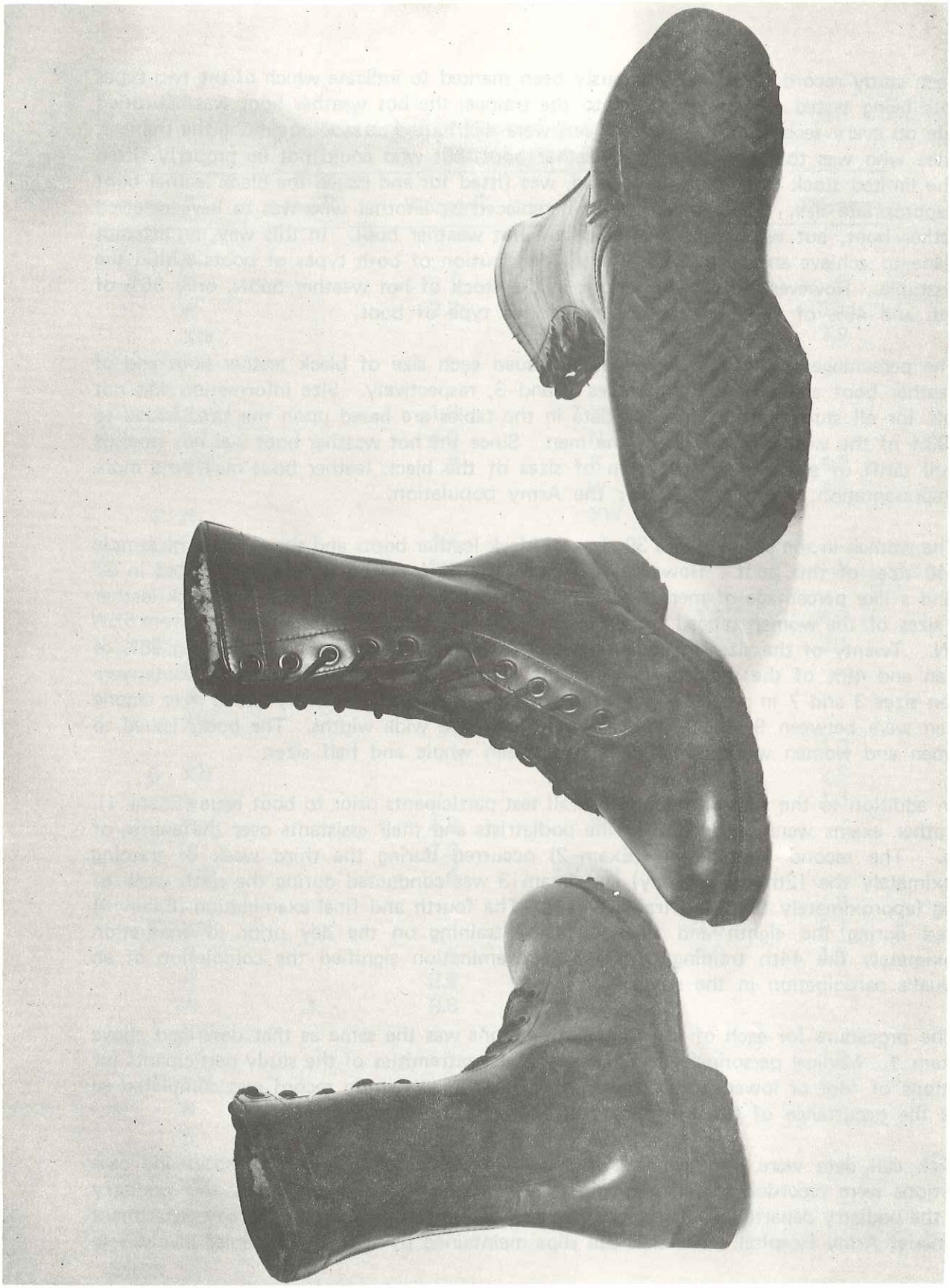

Figure 2. Black leather boot.

Each study record sheet had previously been marked to indicate which of the two types of boots being tested was to be issued to the trainee; the hot weather boot was identified for issue on every second sheet and the sheets were distributed at random among the trainees. A trainee who was to receive the hot weather boot, but who could not be properly fitted with the limited stock of this boot on hand, was fitted for and issued the black leather boot in an appropriate size. The trainee was then replaced by another who was to have received the leather boot, but who could be fitted in a hot weather boot. In this way, an attempt was made to achieve an approximately equal distribution of both types of boots within the study sample. However, due to limitations in the stock of hot weather boots, only 35% of the men and 45% of the women were issued this type of boot.

The percentages of men and of women issued each size of black leather boot and of hot weather boot are presented in Tables 2 and 3, respectively. Size information was not available for all study participants; the data in the tables are based upon the sizes issued to some 93% of the women and 81% of the men. Since the hot weather boot was not stocked in a full tariff of sizes, the distribution of sizes of the black leather boot may be a more valid representation of a size tariff for the Army population.

The women in the sample wore 39 sizes of black leather boots and the men in the sample wore 46 sizes of this boot. However, approximately 95% of the women were fitted in 27 sizes and a like percentage of men in 24 sizes. As can be seen in Table 3, the black leather boot sizes of the women ranged from 3R to 10½R and those of the men ranged from 5½W to 14N. Twenty of the sizes in these ranges were used by both sexes, representing 56% of the men and 48% of the women. Among the women, the most widely issued boots were between sizes 3 and 7 in regular and wide widths, and the most frequently issued sizes among the men were between 9 and 11½, again in regular and wide widths. The boots issued to both men and women were evenly divided between whole and half sizes.

In addition to the foot examination of all test participants prior to boot issue (Exam 1), three other exams were conducted by the podiatrists and their assistants over the course of testing. The second examination (Exam 2) occurred during the third week of training (approximately the 12th training day) and Exam 3 was conducted during the sixth week of training (approximately the 32nd training day). The fourth and final examination (Exam 4) occurred during the eighth and final week of training on the day prior to graduation (approximately the 44th training day). This examination signified the completion of an individual's participation in the study.

The procedure for each of the foot examinations was the same as that described above for Exam 1. Medical personnel examined the lower extremities of the study participants for indications of foot or lower leg problems. Each individual's study record was completed to denote the occurrence of the exam and the presence of disorders, if any.

Sick call data were also acquired on the test participants. The diagnoses and case dispositions were recorded for all participants seen at the troop general clinic, the podiatry clinic, the podiatry department of Moncrief Army Hospital, or the physical therapy department of Moncrief Army Hospital. The sick call slips maintained by the 18 companies involved in

Table 2. Percentages of Men and Women Issued Each Size Black Leather Boot

Size[a]	Men[b]	Women[c]	Size	Men	Women
3 N			6½ XN		
R		2.1	N		.5
W		2.3	R	.1	3.1
XW			W	.3	3.9
			XW		
3½ N					
R		1.0	7 XN		
W		4.9	N		
XW		.8	R	.4	4.9
			W	.8	3.6
4 N			XW		
R		4.7			
W		3.1	7½ XN		
XW			N		
			R	1.1	4.9
4½ N			W	.7	2.1
R		3.9	XW	.1	
W		7.3			
XW		.2	8 XN		
			N		1.0
5 XN			R	2.5	2.8
N			W	5.8	1.3
R		4.9	XW		
W		7.0			
XW		.5	8½ XN		
			N	.1	.8
5½ XN			R	3.0	2.1
N		.5	W	4.9	1.6
R		2.6	XW		
W	.1	8.6			
XW			9 XN		
			N	.2	.5
6 XN			R	6.2	1.3
N		.5	W	6.5	
R		3.9	XW	.1	
W	.1	5.2			
XW	.1				

Table 2. Percentages of Men and Women Issued Each Size Black Leather Boot (cont'd)

Size[a]	Men[b]	Women[c]	Size	Men	Women
9½ XN			12 XN		
N	.1	.2	N	.2	
R	6.7		R	1.6	
W	6.8	.2	W	.4	
XW			XW		
10 XN			12½ XN		
N	.4		N	.5	
R	7.4	.2	R	.8	
W	4.9	.2	W	.1	
XW	.1		XW		
10½ XN			13 XN		
N	.5		N	.9	
R	10.6	.2	R	.6	
W	4.7		W	.2	
XW			XW		
11 XN			13½ XN		
N	1.1		N		
R	7.4		R	.1	
W	2.2		W		
XW			XW		
11½ XN			14 XN		
N	1.0		N	.1	
R	6.8		R		
W	.5		W		
XW			XW		

[a]XN=Extra-narrow; N=Narrow; R=Regular; W=Wide; XW=Extra-wide

[b]n=966

[c]n=385

Table 3. Percentages of Men and Women Issued Each Size Hot Weather Boot

Size[a]	Men[b]	Women[c]	Size	Men	Women
3½ XW[d]			7 XN[d]		
			N		.9
4 R[d]			R	1.0	7.0
			W	1.8	3.0
4½ N[d]			XW[d]		
R[d]					
W[d]			7½ XN[d]		
XW[d]			N		.3
			R	1.8	5.8
5 XN[d]			W	2.4	2.4
N		.3	XW[d]		
R	.1	7.6			
W		5.2	8 XN[d]		
XW[d]			N		.9
			R	4.4	6.1
5½ XN[d]			W	3.6	1.2
N		.6	XW[d]		
R		12.1			
W		5.4	8½ XN[d]		
XW[d]			N		
			R	7.6	2.7
6 XN[d]			W	3.2	.6
N		.3	XW[d]		
R		12.4			
W	.3	3.9	9 XN[d]		
XW[d]			N	.8	.6
			R	9.8	.6
6½ XN[d]			W	3.5	
N		1.2	XW[d]		
R	.6	13.6			
W	.1	5.2	9½ XN[d]		
XW[d]			N	1.1	
			R	10.1	
			W	3.5	
			XW[d]		

Table 3. Percentages of Men and Women Issued Each Size Hot Weather Boot (cont'd)

Size[a]	Men[b]	Women[c]	Size	Men	Women
10 XN[d]			12½ XN[d]		
N	.8		N		
R	10.3		R	1.1	
W	3.7		W		
XW[d]			XW[d]		
10½ XN[d]			13 XN[d]		
N	1.4		N[d]		
R	8.0		R	.7	
W	2.1		W[d]		
XW[d]			XW[d]		
11 XN[d]			13½ XN[d]		
N	1.1		N[d]		
R	6.4		R[d]		
W	1.1		W[d]		
XW[d]			XW[d]		
11½ XN[d]			14 XN[d]		
N	1.1		N[d]		
R	1.0		R[d]		
W	1.0		W[d]		
XW[d]			XW[d]		
12 XN[d]					
N	.7				
R	3.2				
W	.6				
XW[d]					

[a]XN=Extra-narrow; N=Narrow; R=Regular; W=Wide; XW=Extra-wide

[b]n=721

[c]n=330

[d]Size unavailable

the test were also reviewed. Information on lower extremity disorders experienced by the men in Bns 3 and 4 was obtained solely from this source.

The training of the men and the women participating in this study was in accord with the normal procedures and schedules. Following standard practice at Fort Jackson, boots were worn daily for all training activities, including physical readiness training, and the test participants wore whichever of the two types of boots had been issued to them. Use of the boots during physical readiness training provided an opportunity to investigate the relative effects of the two types of footwear on the physical performance of the trainees. Specifically, scores were recorded for one subtest included within the basic physical fitness test, which was administered during the week prior to graduation. This subtest was a 2.4-km run. The run times of 1,677 men in Bns 1 and 2 and 458 women in Bns 1, 2, 3, and 4 were recorded for subsequent analysis.

If a trainee was reassigned during the course of testing to a company not originally involved in the study, his or her participation in the study was terminated. The individual's sick call data were no longer recorded and the individual did not participate in any further foot examinations. The testing of the trainees was completed at the time of their fourth foot examinations; these occurred on the day prior to the graduation of their individual companies. The first of the 18 companies completed testing on August 1, 1980, and the last on August 25, 1980.

To summarize the principal factors in this study, the independent variables were boot type (black leather and hot weather) and gender of the participants. The dependent measures were the frequencies of various types of lower extremity disorders identified during foot examinations or sick calls and the run times achieved on the basic physical fitness test.

RESULTS

Overview of Test Participants

Eighty-nine percent of the men and 81% of the women who began their training in Bns 1 and 2 completed the training cycle within their original battalions and thus completed the entire study. Eighty-six percent of the women in Bns 3 and 4 did so. Table 4 is a listing, by company, of the percentages of trainees who completed the cycle (Graduates). Those individuals who did not complete the study (Nongraduates) had been transferred to other battalions or had been discharged from military service for medical or administrative reasons. The percentages of trainees from each company who received medical discharges (Medical Dropouts) and the percentages who received administrative discharges or were transferred to other battalions (Other Dropouts) are also presented in Table 4. For comparison purposes, the percentages of men in Bns 3 and 4 who were Graduates, Medical Dropouts, or Other Dropouts are included in Table 4 as well.

Chi-square (χ^2) tests for two independent samples[53] were carried out on the data presented in Table 4 to determine whether or not the cycle completion or the dropout rates varied significantly as a function of gender, boot type, or battalion assignment. No significant differences were found when the men or the women in Bns 1 and 2 were compared with individuals of the same gender in Bns 3 and 4, nor did any of the three measures differ significantly with the type of boot worn. However, differences were found between the sexes that were significant; these are indicated in Table 4. In Bns 1 and 2, a significantly greater percentage of men than of women completed the training cycle, $\chi^2(1) = 13.068$, $p<.001$, and a significantly lower percentage of men than of women were among those dropped for medical or for other reasons, $\chi^2(1) = 13.771$, $p<.001$ and $\chi^2(1) = 4.652$, $p<.05$, respectively. In Bns 3 and 4, again a significantly higher percentage of men than of women completed the cycle, $\chi^2(1) = 7.350$, $p<.01$, and a lower percentage of men were terminated for medical reasons, $\chi^2(1) = 4.964$, $p<.05$. However, the men and the women in Bn 3 and 4 did not differ in their dropout rates for other reasons.

The ages of the men in Bns 1 and 2 and the women in all four battalions were examined to determine whether or not there was a significant difference in age between the Graduates and the Nongraduates. The mean age of the men who completed training within their original battalions was 18.8 years (S D = 2.6); the mean for those who did not was slightly higher, 19.0 years (S D = 2.8). This difference in mean ages was not significant, t (1,289) = .90. The women Graduates were also younger, by almost one year, than the women Nongraduates. The Graduates had a mean age of 19.3 years (S D = 2.9) and the mean age of the Nongraduates was 20.2 years (S D = 3.3). The difference in the mean age of these two groups of women was not significant, t (196) = 1.95. A t-test contrasting the mean ages of the men and the

[53] S. Siegel. **Nonparametric statistics for the behavioral sciences.** New York: McGraw-Hill, 1956.

Table 4. Percentages of Men and Women Who Completed Training Cycle or Who Were Dropped

Company-Battalion	Original No.		Graduates (%)		Nongraduates (%)			
					Medical Dropouts		Other Dropouts	
	Men	Women	Men	Women	Men	Women	Men	Women
A–1	235	–	91.06	–	2.13	–	6.81	–
B–1	195	41	92.82	80.49	2.56	7.32	4.61	12.20
C–1	176	34	92.04	76.47	.57	5.88	7.39	17.65
D–1	187	49	81.82	83.67	1.60	4.08	16.58	12.24
E–1	195	48	92.82	81.25	.51	0.00	6.67	18.75
Battalion Total	988	172	90.18	80.81	1.52	4.07	8.30	15.12
A–2	241	–	86.72	–	2.07	–	11.20	–
B–2	249	–	87.55	–	1.61	–	10.84	–
C–2	174	47	86.78	85.11	1.15	4.26	12.07	10.64
D–2	239	–	86.61	–	.84	–	12.55	–
E–2	183	53	89.62	77.36	.55	7.55	9.84	15.09
Battalion Total	1,086	100	87.38	81.00	1.29	6.00	11.32	13.00
Battalions 1 and 2 Total	2,074	272	88.72	80.88***	1.40	4.78***	9.88	14.34*
A–3	194	52	84.02	65.38	2.06	1.92	13.92	32.69
B–3	124	81	89.52	90.12	.81	1.23	9.68	8.64
C–3	144	92	84.03	77.17	2.78	5.43	13.19	17.39
D–3	186	50	83.33	84.00	2.69	4.00	13.98	12.00
Battalion Total	648	275	84.88	80.00	2.16	3.27	12.96	16.73
A–4	193	59	97.41	93.22	1.55	1.69	1.04	5.08
B–4	182	59	91.76	94.92	1.65	5.08	6.59	0.00
C–4	172	57	93.02	89.47	2.32	5.26	4.65	5.26
D–4	168	45	98.21	93.33	0.00	4.44	1.78	2.22
Battalion Total	715	220	95.10	92.73	1.40	4.09	3.50	3.18
Battalions 3 and 4 Total	1,363	495	90.24	85.66**	1.76	3.64*	8.00	10.71
Grand Total	3,437	767	89.32	83.96	1.54	4.04	9.14	11.99

*$p<.05$
**$p<.01$
***$p<.001$

women who completed training indicated that the women Graduates were not significantly older than the men, $t(1,258) = 1.81$. However, the women who were dropped from training were significantly older than the men who were dropped, $t(229) = 2.58$, $p<.01$.

The findings of the first foot examination, which was conducted prior to the issuing of boots and the initiation of formal basic training, were analyzed principally to ascertain whether or not the physical status of the individuals in the two footwear groups was comparable at that time. Additional analyses were conducted to compare Graduates with Nongraduates and men with women. Tables 5 through 7 each contain a listing of the more common physical characteristics, previous lower extremity fractures or sprains, and lower extremity disorders identified during Exam 1. The percentages in the tables were computed using the total number of trainees within a category who were identified from the study record sheets as having attended Exam 1. The characteristic of ankle fracture and/or sprain reflects reports by trainees of the previous occurrence of an ankle fracture, a recent ankle sprain, or a history of chronic ankle sprain. The characteristic of foot fracture includes reports of the fracture of any bones of the foot.

For Graduates, Nongraduates, and both groups combined, χ^2 tests were employed to determine whether those trainees who were issued the black leather boot differed in the rates of occurrence of the various physical characteristics from those trainees of the same sex who used the hot weather boot; no significant differences ($p>.05$) were found (Tables 5 and 6). Thus, the two footwear groups were comparable at the time of Exam 1. The data of the two footwear groups were then combined and χ^2 tests were performed to compare Graduates with Nongraduates of the same sex. There were no significant differences in the rates of occurrence of the physical characteristics as a function of whether or not an individual completed the training cycle. To assess the effects of gender, the data of men and of women Graduates were compared as were the data of men and of women Nongraduates and of both groups combined. There were no significant differences between the men and the women Nongraduates, but some significant differences were obtained for the Graduates. A significantly higher percentage of women than men Graduates evidenced hallux valgus, $\chi^2(1) = 21.942$, $p<.001$; callouses, $\chi^2(1) = 4.025$, $p<.05$; and bunions, $\chi^2(1) = 8.093$, $p<.01$. A significantly higher percentage of men than women Graduates had previously experienced ankle fractures or sprains or reported a history of chronic ankle sprains, $\chi^2(1) = 6.074$, $p<.02$. The men Graduates also had a significantly higher rate of occurrence of ingrown nails than the women Graduates, $\chi^2(1) = 4.407$, $p<.05$. The analyses performed on the combined data of Graduates and Nongraduates also yielded significantly higher rates of occurrence among the women than among the men of hallux valgus, $\chi^2(1) = 25.024$, $p<.001$; callouses, $\chi^2(1) = 5.131$, $p<.05$; and bunions, $\chi^2(1) = 10.014$, $p<.01$. For the characteristic of ankle fractures and/or sprains, the men again evidenced a significantly higher incidence than the women, $\chi^2(1) = 8.094$, $p<.01$. There was no significant difference between the sexes in the occurrence of ingrown nails (Table 7).

Table 5. Percentage of Men in Each Footwear Group Exhibiting Physical Characteristics Assessed during Exam 1

Characteristic	Graduates		Nongraduates		Total	
	Leather[a]	Hot Weather[b]	Leather[c]	Hot Weather[d]	Leather	Hot Weather
Pes planus	37.53	34.52	31.58	26.00	36.97	33.75
Pes cavus	7.27	7.89	8.42	6.00	7.37	7.72
Subtalar pronation syndrome	4.88	2.76	3.16	2.00	4.72	2.69
Hammertoes	4.66	4.14	3.16	8.00	4.52	4.49
Hallux valgus	1.74	1.78	3.16	2.00	1.87	1.80
Ankle fracture/sprain	8.46	8.88	9.47	6.00	8.55	8.62
Foot fracture	2.60	2.17	3.16	4.00	2.65	2.33
Leg fracture	.11	.00	.00	2.00	.10	.18
Obesity	1.41	.59	2.11	2.00	1.47	.72
Ingrown nail	2.17	3.55	5.26	6.00	2.46	3.77
Blister	3.69	2.96	4.21	.00	3.74	2.69
Callous	2.82	2.76	3.16	8.00	2.85	3.23
Corn	2.17	2.76	2.11	2.00	2.16	2.69
Bunion	.33	.00	.00	.00	.29	.00
Tinea pedis	1.63	2.17	1.05	2.00	1.57	2.15

[a] $n=922$

[b] $n=507$

[c] $n=95$

[d] $n=50$

Table 6. Percentage of Women in Each Footwear Group Exhibiting Physical Characteristics Assessed during Exam 1

Characteristic	Graduates		Nongraduates		Total	
	Leather[a]	Hot Weather[b]	Leather[c]	Hot Weather[d]	Leather	Hot Weather
Pes planus	27.73	35.16	32.61	31.82	28.57	34.80
Pes cavus	5.45	5.49	10.87	9.09	6.39	5.88
Subtalar pronation syndrome	6.82	3.30	6.52	13.64	6.77	4.41
Hammertoes	3.18	4.40	4.35	4.55	3.38	4.41
Hallux valgus	5.91	6.59	4.35	13.64	5.64	7.35
Ankle fracture/sprain	5.00	4.40	2.17	4.55	4.51	4.41
Foot fracture	2.73	3.30	4.35	.00	3.01	2.94
Leg fracture	.45	.00	.00	.00	.38	.00
Obesity	.91	.00	2.17	.00	1.13	.00
Ingrown nail	.91	.55	4.35	4.55	1.50	.98
Blister	4.55	2.20	2.17	9.09	4.14	2.94
Callous	5.45	4.40	10.87	.00	6.39	3.92
Corn	4.09	2.20	8.70	4.55	4.89	2.45
Bunion	1.82	1.10	2.17	.00	1.88	.98
Tinea pedis	.00	.00	.00	.00	.00	.00

[a] $n=220$

[b] $n=182$

[c] $n=46$

[d] $n=22$

Table 7. Percentages of Men and Women Exhibiting Physical Characteristics Assessed during Exam 1

Characteristic	Graduates		Nongraduates		Total	
	Men[a]	Women[b]	Men[c]	Women[d]	Men	Women
Pes planus	36.46	31.09	29.66	32.35	35.85	31.28
Pes cavus	7.49	5.47	7.59	10.29	7.50	6.17
Subtalar pronation syndrome	4.13	5.22	2.76	8.82	4.00	5.74
Hammertoes	4.48	3.73	4.83	4.41	4.51	3.83
Hallux valgus	1.75	6.22****	2.76	7.35	1.84	6.38****
Ankle fracture/sprain	8.61	4.73**	8.28	2.94	8.58	4.47***
Foot fracture	2.45	2.99	3.45	2.94	2.54	2.98
Leg fracture	.07	.25	.69	.00	.13	.21
Obesity	1.12	.50	2.07	1.47	1.21	.64
Ingrown nail	2.66	.75*	5.52	4.41	2.92	1.28
Blister	3.43	3.48	2.76	4.41	3.37	3.62
Callous	2.80	4.98*	4.83	7.35	2.99	5.32*
Corn	2.38	3.23	2.07	7.35	2.35	3.83
Bunion	.21	1.49***	.00	1.47	.19	1.49***
Tinea pedis	1.82	.00	1.38	.00	1.79	.00

[a] n=1,429 *p<.05

[b] n=402 **p<.02

[c] n=145 ***p<.01

[d] n=68 ****p<.001

Sick Call Visits for Lower Extremity Problems and Their Disposition

Attendance at sick calls and days spent recuperating from illness represent losses of time available for participation in basic training activities. In this section, the impact of lower extremity problems on scheduled training is examined. The focus here is on the proportion of individuals who reported to sick call for some lower extremity complaint over the course of the training cycle and the number of sick calls these individuals attended. Data are also presented on the disposition of cases seen at sick calls. The proportion of individuals whose participation in regular training activities was restricted to some extent due to lower extremity disorders which they had incurred is examined, as well as the duration of their curtailed participation in regular training activities.

These data pertaining to sick call attendance and sick call dispositions were analysed to assess the relative effects on these measures of the two independent variables of interest in this study, gender and footwear type. The results are presented here. Analyses were performed which included only the Graduates or the Nongraduates; analyses were also carried out on the combined data of these groups. Thus, the findings related to the individuals who finished basic training, and therefore completed this entire test, could be examined independently of the data of trainees whose participation in the study was terminated prematurely through transfer to a battalion which was not included in the study or through discharge from military service.

In compiling the sick call visits and dispositions, visits made by the test participants for the purpose of seeking medical attention for any complaints associated with the feet, lower legs, or knees were included. Findings regarding the specific lower extremity disorders identified among the participants are presented in the following section.

The procedure at Fort Jackson was such that all trainees attending a sick call for any reason reported first to a troop general clinic. Depending upon the nature and severity of their conditions, they were either treated there and released, referred to a specialized clinic, or referred to a hospital department. In the case of trainees with lower extremity disorders, the referrals were made to the hospital's physical therapy (P.T.) department or to the podiatry clinic. Again depending upon the nature and severity of the condition, cases seen at the podiatry clinic were treated there or referred to the hospital's podiatry department. Arrangements for any follow up visits were made with the trainee by the particular clinic or hospital department. Therefore, the trainee did not go through the referral process for subsequent visits required in the course of receiving treatment for a particular disorder.

In compiling the sick calls attended for lower extremity problems, the numbers of individuals who visited any of the treatment facilities mentioned above were tabulated. Separate tallies were also made of visits to the podiatry clinic and to the hospital's podiatry department, along with a combined tally of troop general clinic and hospital P.T. visits. If, in the course of a sick call visit, a trainee was referred from one facility to another, the visit was charged to the facility in which treatment was received. The data analyzed included the proportions of test participants attending any of the treatment facilities and those attending particular facilities at least once over the course of the training cycle. The mean numbers of visits made by those who attended sick call at least once were analyzed as well.

The ages of the test participants were also examined to determine whether or not those trainees who attended at least one sick call for a lower extremity complaint differed in age from those who did not attend any sick calls for this type of problem. To analyze these data, the mean ages of the women in Bns 1, 2, 3, and 4 and the men in Bns 1 and 2 who attended a sick call were computed and compared with the mean age of those of the same gender who did not. The women sick call attendees had a mean age of 19.6 years (S D = 3.4) and that of the nonattendees was 19.3 years (S D = 2.8). A t-test for large, uncorrelated samples revealed that this difference was not significant ($p>.05$). For the men who attended sick call, the mean age was 19.1 years (S D = 3.1) and, for the nonattendees, the mean was 18.8 years (S D = 2.5). As was the case among the women, this difference was not significant ($p>.05$).

Additional analyses in the form of Pearson product-moment correlation coefficients (r) were performed to assess the relationship between age and sick call attendance. In this case, the raw data used were the age of the test participant and the total number of sick call visits made by that individual for lower extremity complaints. All participants for whom age was known were included in the analysis, whether or not they had attended sick call for lower extremity problems. Correlations were computed separately for the men and the women. Both were low, positive, and significant. The result for the men was $r\ (1,289) = +.0691$, $p<.05$, and for the women it was $r\ (449) = +.1185$, $p<.05$.

A sick call visit for a lower extremity disorder could result in the trainee being judged fit to participate fully in all training activities, being discharged from the Army for medical reasons, or being restricted from participating in some or all training for a period of time. There were four categories of training restriction. One of these was hospitalization. Under a second category, the trainee was not to perform any of the physical activities associated with training, including marching, running, jumping, prolonged standing, and obstacle and confidence course exercises. Under a third category, limited physical activity was permitted, but participation in the more strenuous training activities, such as obstacle course runs, was not. The fourth category was comprised of restrictions pertaining to one specific activity. For example, the trainee might have been permitted to participate in all aspects of training except those that involved running.

In tabulating the data related to these training restrictions, counts were made of the numbers of individuals who received any type of restriction. Separate tallies were also made of those who received each of the four categories of training restriction. The sick call disposition data analyzed included the proportions of test participants who received any restricted duty and those receiving each type. The mean number of days for which their training was curtailed was also analyzed. In addition, the percentages of participants who, on at least one occasion, attended a sick call and were allowed to return to regular, unrestricted training were tallied and analyzed. The percentages of participants who received medical discharges for lower extremity disorders were also computed.

As was done with the ages of the sick call attendees and nonattendees, the mean ages of those test participants who received at least one day of restricted duty for a lower extremity problem were contrasted with the ages of the participants whose training was not restricted.

The mean age of the women placed on restricted training status was 20.0 years (S D = 3.5) and the mean age of the women who did not have any duty restrictions was 19.3 years (S D = 3.0). A t-test for large, uncorrelated samples revealed that this age difference was significant, $t(449) = 2.19$, $p<.05$. The men placed on restricted duty were also significantly older than those who were not restricted, $t(1,289) = 2.79$, $p<.01$. The mean for the men who received a duty restriction was 19.6 years (S D = 3.7); the men who did not had a mean age of 18.8 years (S D = 2.4).

The relationship between age and duty restrictions was further examined using a correlational approach. The raw data were an individual's age and total number of restricted training days attributable to lower extremity disorders. All test participants for whom age was known were included in the analysis, whether or not they had received any duty restrictions. For those who had not, the total number of restricted days was set equal to zero. Pearson product-moment correlation coefficients (r) were computed separately for the men and the women. As was the case in the analyses of age and total sick call visits, both correlations were low, positive, and significant. The results for the men were $r(1,289) = +.1418$, $p<.01$. For the women, the results were $r(449) = +.1094$, $p<.05$.

Information was available on the number of men in Bns 3 and 4 who attended sick call at least once for a lower extremity problem and on the number of these men whose training activities were restricted because of the disorders they had incurred. These data of the men in Bns 3 and 4, all of whom wore leather boots, were contrasted with data of the male test participants in Bns 1 and 2 who wore leather boots to assess whether or not the participants were comparable to trainees who had not been exposed to the test environment. Separate χ^2 tests were performed comparing the Graduates, the Nongraduates, and both of these groups combined. No significant differences ($p>.05$) were obtained between the men in Bns 3 and 4 and those in Bns 1 and 2 who wore leather boots in terms of the proportions of individuals who attended sick call at least once for a lower extremity complaint or the proportions of individuals whose training was restricted on at least one occasion because of a lower extremity disorder.

Visits and disposition as a function of boot type — Men. To assess the effects of the type of boot worn on sick call visits and their disposition, the data of the men in Bns 1 and 2 who wore the hot weather boots were contrasted with the data of the men in these two battalions who wore the black leather boots. The percentages of men in each footwear group who attended sick call at least once for a lower extremity problem and the mean number of visits they made are presented in Table 8. Individual χ^2 tests were performed on the data of the Graduates, the Nongraduates, and both of these groups combined to determine whether or not the rates of sick call attendance at any treatment facility or at a particular facility varied significantly as a function of boot type. Although a higher proportion of men using the hot weather boots than those using the leather boots attended sick call at least once for a lower extremity complaint, there were no significant differences ($p>.05$) between the two groups. The mean numbers of visits made were compared using t-tests for large, uncorrelated samples. Again, the men wearing hot weather boots who attended sick call tended to make a slightly, but not a significantly, greater number of visits than those wearing black leather boots did.

Table 8. Sick Call Visits of Men in Each Footwear Group

	Graduates		Nongraduates		Total	
	Leather[a]	Hot Weather[b]	Leather[c]	Hot Weather[d]	Leather	Hot Weather
Percentage Attending:						
Any Treatment Facility	20.18	21.52	37.50	50.00	22.14	24.73
Podiatry Clinic	5.03	5.73	13.82	19.51	6.02	7.28
Hospital Podiatry Dept.	1.84	2.17	8.55	14.63	2.60	3.57
Other Facility (Troop General Clinic, Hospital P.T. Dept.)	17.00	17.65	31.58	42.68	18.65	20.47
Mean No. of Visits of Those Attending:						
Any Treatment Facility	1.52	1.59	2.12	2.24	1.63	1.74
Podiatry Clinic	1.22	1.27	1.24	1.44	1.22	1.32
Hospital Podiatry Dept.	1.27	1.29	1.23	1.42	1.26	1.35
Other Facility (Troop General Clinic, Hospital P.T. Dept.)	1.44	1.45	1.88	1.77	1.53	1.52

Note. Some participants were treated at more than one facility during their training. Thus, the sum of the percentages of individuals who attended each of the particular treatment facilities is greater than the percentage of individuals who attended any treatment facility.

[a] $n = 1,194$ [c] $n = 152$

[b] $n = 646$ [d] $n = 82$

Another aspect of sick call attendance was investigated in comparing the effects of the two types of boots. This was the distribution of the visits over the course of the training cycle. The cumulative sick call visits of the Graduate and the Nongraduate men in each footwear group are presented in Figure 3 as a function of processing days and training week. It can be seen that the distribution of visits for the Graduates in the footwear groups were very similar; this was not the case for the Nongraduates. Those Nongraduates wearing the hot weather boots tended to have made more of their sick call visits earlier in training than those men wearing the leather boots did. For example, the hot weather boot group had made over 60% of their visits by the end of the second week of training, while the men wearing the black leather boots had completed 45% of their total visits by this time.

The data pertaining to the sick call dispositions for the men in each footwear group are presented in Table 9. Compared to those using leather boots, a somewhat higher percentage of men with hot weather boots received medical discharges for lower extremity disorders and restrictions of their training activities. A higher percentage of men with hot weather boots were also returned to training without any restrictions. The χ^2 tests performed on these data yielded one significant difference between the footwear groups. This difference was for the combined data of Graduates and Nongraduates. The percentage of men wearing hot weather boots who received a limited physical activity restriction was significantly higher than the percentage of men using black leather boots who received this restriction, $\chi^2(1) = 4.195$, $p<.05$. With regard to the mean number of days of restricted training, the t-tests did not yield any significant differences between the footwear groups. The greatest difference between the groups was in the number of hospitalization days. However, a statistical test was not performed on these data since they included only two men in the leather boot group and one man in the hot weather boot group.

Visits and disposition as a function of boot type — Women. As was done with the men's data on sick call visits and their disposition, the data of the women in Bns 1, 2, 3, and 4 who were issued the hot weather boots were compared with the data of the women in these four battalions who used the black leather boots. Sick call findings for the women in each footwear group are presented in Table 10. The χ^2 tests performed on the data of the Graduates indicated that the percentage of women using the hot weather boots who attended the podiatry clinic at least once was significantly higher than the percentage of women wearing the leather boots who attended this facility, $\chi^2(1) = 5.093$, $p<.05$. A significant difference between the footwear groups in attendance at this facility was also obtained in the analysis performed on the data of the Nongraduates, $\chi^2(1) = 4.108$, $p<.05$. In addition, a significantly higher percentage of Nongraduates with hot weather boots attended some treatment facility compared to those with leather boots, $\chi^2(1) = 6.015$, $p<.05$. The combined data of the Graduates and the Nongraduates revealed one significant difference; the attendance rate at the podiatry clinic was significantly higher among the women in the hot weather boot group than it was among the women wearing the black leather boot, $\chi^2(1) = 8.027$, $p<.01$. With regard to the number of sick call visits, the Graduates using leather boots made a significantly higher mean number of visits to the troop clinic and/or the hospital P.T. department than those using hot weather boots did, $t(183) = 2.46$, $p<.02$. The only other significant difference between means was obtained in a t-test performed on the combined data of the Graduates and

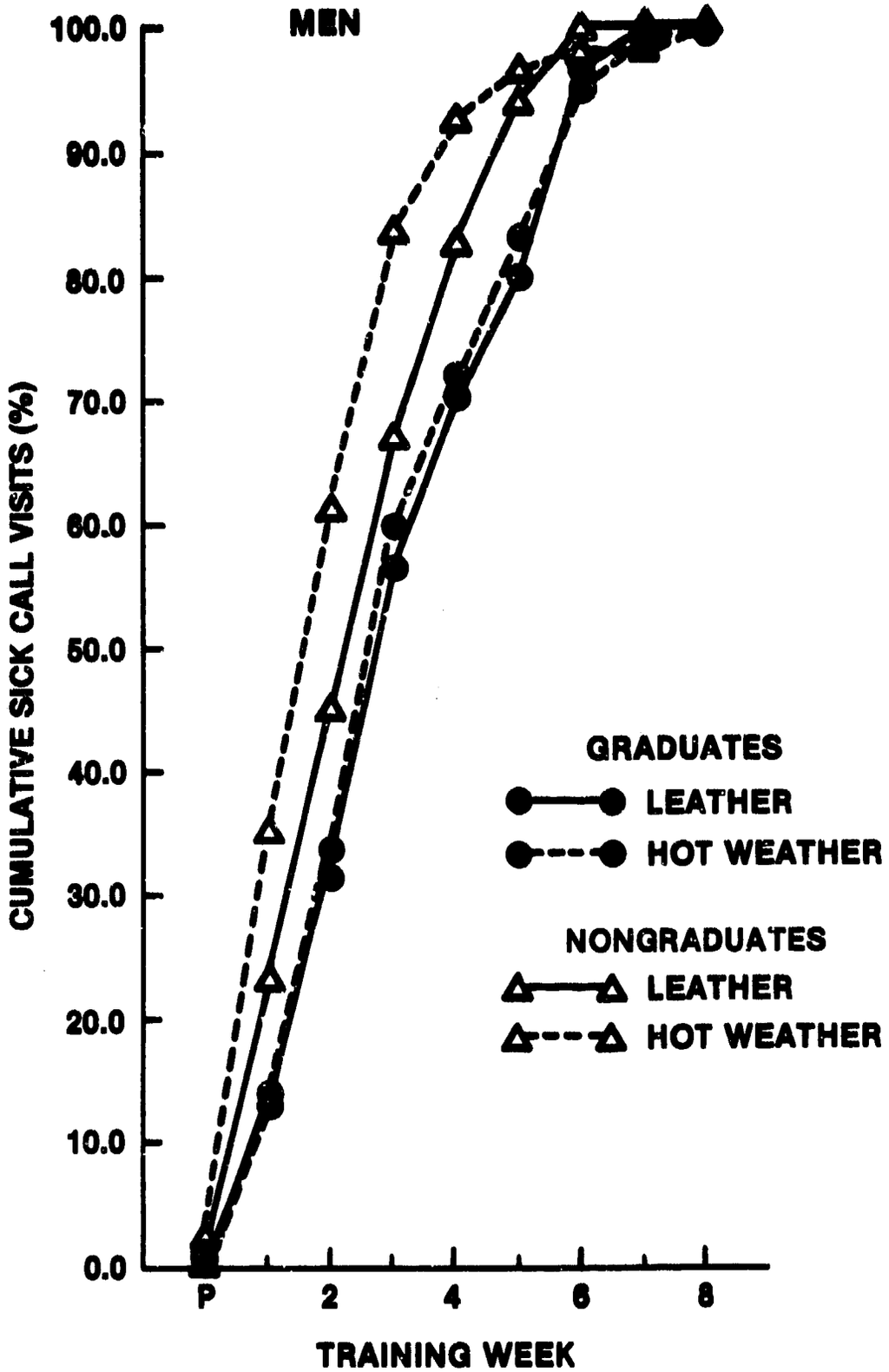

Figure 3. Cumulative percentages of the total sick call visits made by men Graduates and Nongraduates in each footwear group during processing days (P) and each training week.

Table 9. Sick Call Disposition of Men in Each Footwear Group

Disposition	Graduates		Nongraduates		Total	
	Leather[a]	Hot Weather[b]	Leather[c]	Hot Weather[d]	Leather	Hot Weather
Percentage Receiving:						
Any Restriction	8.63	9.75	19.74	30.49	9.88	12.09
Hospitalization	.17	.00	.00	1.22	.15	.14
No Physical Activity	2.26	2.17	9.87	9.76	3.12	3.02
Limited Physical Activity	6.03	7.74	11.18	20.74	6.61	9.20*
Other Training Restriction	.42	.46	.66	.00	.45	.41
No Restriction — Regular Training	11.81	14.24	15.13	23.17	12.18	15.25
Medical Discharge	—	—	2.63	6.10	.30	.69
Mean No. of Days of Those Receiving:						
Any Restriction	4.12	3.57	4.53	5.56	4.21	4.14
Hospitalization	5.00	.00	.00	22.00	5.00	22.00
No Physical Activity	6.15	7.14	6.20	8.63	6.19	7.68
Limited Physical Activity	3.13	2.40	2.41	2.82	2.99	2.51
Other Training Restriction	4.20	1.67	1.00	.00	3.83	1.67

Note. Some participants received more than one category of training restriction. Thus, the sum of the percentages of individuals who received each type of restriction is greater than the percentage of individuals who received any type of restriction.

[a] $n = 1,194$ [c] $n = 152$ *$p < .05$

[b] $n = 646$ [d] $n = 82$

Table 10. Sick Call Visits of Women in Each Footwear Group

	Graduates		Nongraduates		Total	
	Leather[a]	Hot Weather[b]	Leather[c]	Hot Weather[d]	Leather	Hot Weather
Percentage Attending:						
Any Treatment Facility	40.35	42.09	39.37	64.44*	40.24	45.03
Podiatry Clinic	22.48	30.64*	26.92	46.67*	23.29	32.75***
Hospital Podiatry Dept.	9.80	10.10	10.26	15.56	9.88	10.82
Other Facility (Troop General Clinic, Hospital P.T. Dept.)	29.68	27.61	32.05	40.00	30.12	29.24
Mean No. of Visits of Those Attending:						
Any Treatment Facility	2.57	2.47	2.26	2.21	2.51	2.42
Podiatry Clinic	1.47	1.66	1.33	1.43	1.44	1.62
Hospital Podiatry Dept.	1.94	1.67	1.63	1.71	1.88	1.68
Other Facility (Troop General Clinic, Hospital P.T. Dept.)	2.03	1.56**	1.56	1.50	1.94	1.55**

Note. Some participants were treated at more than one facility during their training. Thus, the sum of the percentages of individuals who attended each of the particular treatment facilities is greater than the percentage of individuals who attended any treatment facility.

[a] $n = 347$ [c] $n = 78$ *$p < .05$

[b] $n = 297$ [d] $n = 45$ **$p < .02$

***$p < .01$

Nongraduates. Again, it was found that those women in the black leather boot group made a higher mean number of visits to the troop clinic and/or the P.T. department than those in the hot weather boot group did, $t\ (226) = 2.40$, $p<.02$.

As was done with the men's data, the distribution of sick call attendance over training was graphed for the Graduate and the Nongraduate women in each footwear group (Figure 4). During the third and fourth weeks of training, the Graduates using hot weather boots attended sick calls at a somewhat higher rate than those using black leather boots did. The two footwear groups had similar attendance rates during the remaining training weeks. For the Nongraduates, the women with leather boots showed a higher attendance rate than those with hot weather boots from the second through the fifth week of training.

With regard to sick call dispositions (Table 11), a lower percentage of women Graduates in the hot weather boot group received a limited activity restriction compared to the Graduates using the leather boots, $\chi^2(1) = 4.223$, $p<.05$. For the Nongraduates, both the percentage of women who received a duty restriction and the percentage who were not permitted any physical activity were significantly higher for the hot weather boot than for the leather boot group, $\chi^2(1) = 6.436$, $p<.02$ and $\chi^2(1) = 7.090$, $p<.01$, respectively. There were no other significant differences between the footwear groups nor did the groups differ in terms of duration of restricted duty.

Visits and disposition as a function of gender. To examine the influence of gender on sick call visits for lower extremity disorders and their disposition, the data of the two footwear groups were combined. Table 12 contains the sick call findings for the men in Bns 1 and 2 and the women in Bns 1, 2, 3, and 4.

The χ^2 tests performed to contrast the men and the women Nongraduates yielded one significant difference: a higher percentage of women than men attended the podiatry clinic at least once, $\chi^2(1) = 14.681$, $p<.001$. There were no significant differences between the men and the women Nongraduates in terms of the mean number of sick call visits made.

For the Graduates, the percentage of women who attended sick call at least once was more than double that of the men; this difference was significant, $\chi^2(1) = 103.190$, $p<.001$. With regard to attendance at the particular facilities, a significantly higher percentage of women than men Graduates attended the podiatry clinic, $\chi^2(1) = 217.209$, $p<.001$; the hospital's podiatry department, $\chi^2(1) = 76.599$, $p<.001$; and the troop general clinic and/or the hospital's P.T. department, $\chi^2(1) = 38.404$, $p<.001$. The women Graduates who attended some treatment facility also made a significantly higher mean number of visits than the men did, $t\ (643) = 7.82$, $p<.001$. A significant difference was obtained between the mean number of visits of the men and the women Graduates to each treatment facility as well (podiatry clinic: $t\ (264) = 4.22$, $p<.001$; hospital podiatry department: $t\ (98) = 2.85$, $p<.01$; troop clinic and/or hospital P.T. department: $t\ (500) = 3.26$, $p<.01$).

The combined data of the Graduates and the Nongraduates again revealed that the percentage of women attending sick call at least once was significantly greater than the

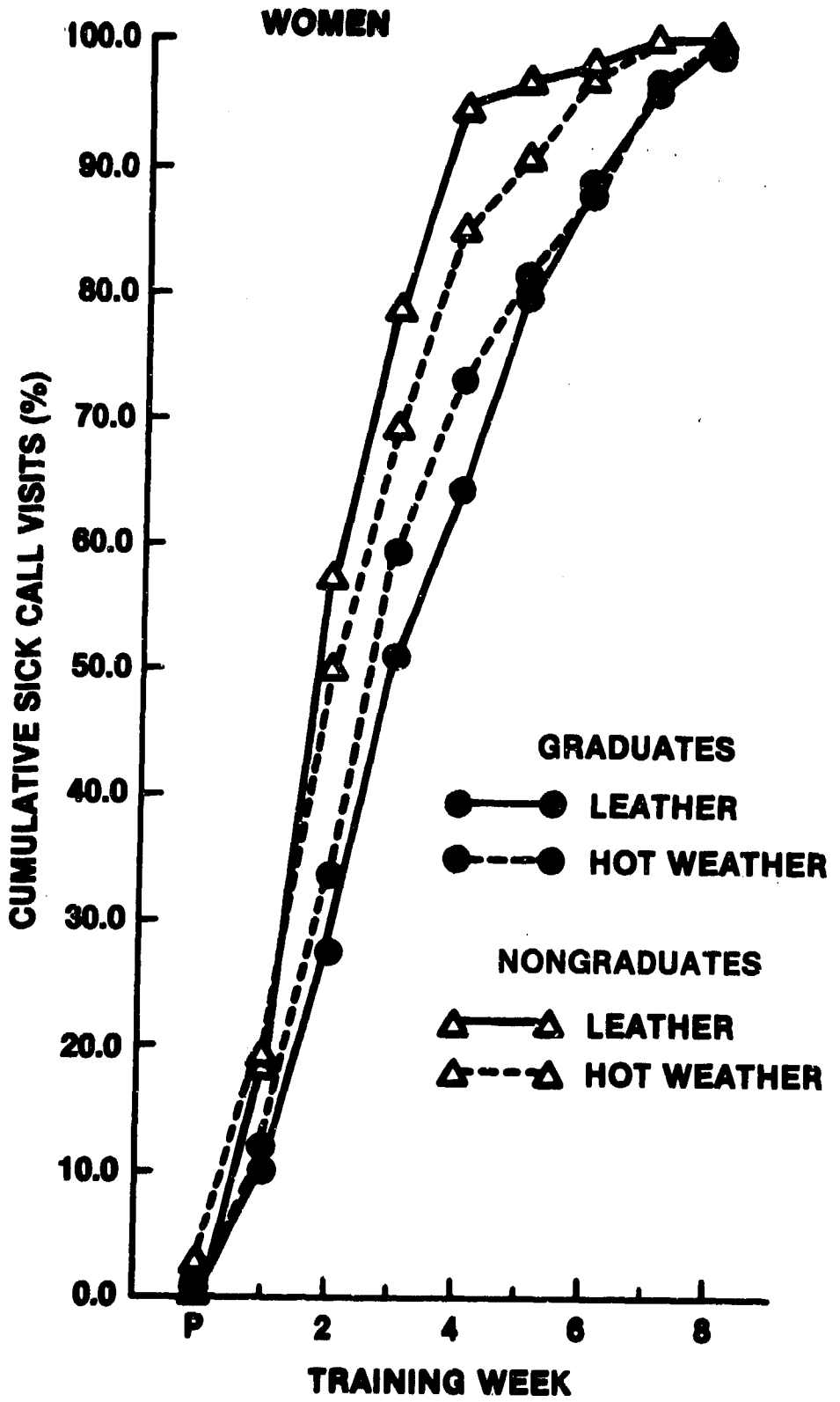

Figure 4. Cumulative percentages of the total sick call visits made by women Graduates and Nongraduates in each footwear group during processing days (P) and each training week.

Table 11. Sick Call Disposition of Women in Each Footwear Group

Disposition	Graduates		Nongraduates		Total	
	Leather[a]	Hot Weather[b]	Leather[c]	Hot Weather[d]	Leather	Hot Weather
Percentage Receiving:						
Any Restriction	22.77	19.53	19.23	42.22**	22.13	22.51
Hospitalization	.58	1.01	.00	.00	.47	.88
No Physical Activity	12.68	14.14	10.26	31.11***	12.24	16.37
Limited Physical Activity	10.09	5.39*	8.97	15.56	9.88	6.72
Other Training Restriction	4.03	2.36	5.13	.00	4.24	2.05
No Restriction — Regular Training	23.92	28.96	28.20	28.89	24.70	28.95
Medical Discharge	—	—	3.85	15.56	.70	2.05
Mean No. of Days of Those Receiving:						
Any Restriction	7.97	7.62	7.07	8.84	7.83	7.92
Hospitalization	10.00	7.00	.00	.00	10.00	7.00
No Physical Activity	9.80	8.12	7.13	10.36	9.38	8.68
Limited Physical Activity	3.20	2.94	5.00	3.29	3.50	3.04
Other Training Restriction	4.00	4.71	3.51	.00	3.89	4.71

Note. Some participants received more than one category of training restriction. Thus, the sum of the percentages of individuals who received each type of restriction is greater than the percentage of individuals who received any type of restriction.

[a] $n = 347$ [c] $n = 78$ *$p < .05$

[b] $n = 297$ [d] $n = 45$ **$p < .02$

***$p < .01$

Table 12. Sick Call Visits of Men and Women

	Graduates		Nongraduates		Total	
	Men[a]	Women[b]	Men[c]	Women[d]	Men	Women
Percentage Attending:						
Any Treatment Facility	20.65	41.15***	41.88	48.78	23.05	42.37***
Podiatry Clinic	5.27	26.24***	15.81	34.15***	6.46	27.51***
Hospital Podiatry Dept.	1.96	9.94***	10.68	12.20	2.94	10.30***
Other Facility (Troop General Clinic, Hospital P.T. Dept.)	17.23	28.73***	35.47	34.96	19.29	29.73***
Mean No. of Visits of Those Attending:						
Any Treatment Facility	1.54	2.52***	2.17	2.23	1.67	2.47***
Podiatry Clinic	1.24	1.57***	1.32	1.38	1.26	1.54***
Hospital Podiatry Dept.	1.28	1.81**	1.32	1.67	1.30	1.78**
Other Facility (Troop General Clinic, Hospital P.T. Dept.)	1.44	1.82**	1.83	1.53	1.53	1.77*

Note. Some participants were treated at more than one facility during their training. Thus, the sum of the percentages of individuals who attended each of the particular treatment facilities is greater than the percentage of individuals who attended any treatment facility.

[a] $n = 1,840$ [c] $n = 234$ *$p<.05$

[b] $n = 644$ [d] $n = 123$ **$p<.01$

***$p<.001$

percentage of men, $\chi^2(1) = 102.188$, $p<.001$. The proportions of women attending the various treatment facilities were also significantly greater than those of the men (podiatry clinic: $\chi^2(1) = 230.555$, $p<.001$; hospital podiatry department: $\chi^2(1) = 63.157$, $p<.001$; troop general clinic and/or hospital P.T. department: $X^2(1) = 34.830$, $p<.001$). The mean number of visits made by the women to any treatment facility was significantly higher than the mean for the men, $t(801) = 6.67$, $p<.001$. In addition, the mean visits of the women to each facility was higher than the mean for the men (podiatry clinic: $t(343) = 4.00$, $p<.001$; hospital podiatry department: $t(138) = 3.02$, $p<.01$; troop general clinic and/or hospital P.T. department: $t(626) = 2.22$, $p<.05$).

A plot of the distribution of sick call visits for men and women is presented in Figure 5. The Nongraduate men and women evidenced similar trends throughout the training cycle. The Graduate men and women were also similar to each other in the distributions of sick call visits through the fifth training week. However, by the end of the sixth week, the men had completed over 95% of their visits while the women had completed only approximately 87% of theirs.

Findings regarding the dispositions of the sick calls made by the men and the women are presented in Table 13. The percentage of women among the Graduates who, on at least one occasion, attended sick call and were judged to be fit for regular training was more than double the percentage of men. This difference was significant, $\chi^2(1) = 63.851$, $p<.001$. The proportion of women Graduates whose training was restricted was also more than double that of the men Graduates and this difference was significant, $\chi^2(1) = 65.717$, $p<.001$. With regard to the types of restricted duty the Graduates received, there was no significant difference in the proportions of men and women who were allowed only limited physical activity. However, a higher proportion of women than men Graduates were placed under the other categories of restricted duty (no physical activity: $\chi^2(1) = 119.435$, $p<.001$; other training restriction: $\chi^2(1) = 30.616$, $p<.001$; hospitalization: $X^2(1) = 5.379$, $p<.05$). These women Graduates who received some type of training restriction spent almost twice the number of days on restricted duty status as the men Graduates did. The difference between these means was significant, $t(263) = 4.93$, $p<.001$. Although the mean durations of the women's restricted times were longer than those of the men Graduates for each type of restricted duty, the difference between the means was significant only for the category of no physical activity, $t(125) = 2.03$, $p<.05$.

For the Nongraduates, a significantly higher percentage of women than men were returned to full duty on at least one occasion after attending a sick call, $\chi^2(1) = 4.658$, $p<.05$. A significantly higher proportion of women than men Nongraduates also received a restriction of no physical activity, $\chi^2(1) = 4.048$, $p<.05$. The only other significant difference between the men and the women Nongraduates obtained in the analyses of sick call dispositions was the mean number of days spent on restricted duty status; the mean duration for the women was longer than that for the men, $t(87) = 2.14$, $p<.05$.

Analyses performed on the combined data of the Graduates and the Nongraduates revealed that a significantly higher percentage of women than men were returned to full duty at least once after a sick call visit, $\chi^2(1) = 70.111$, $p<.001$. In addition, a significantly higher percentage of the women were put on restricted duty status, $\chi^2(1) = 62.797$, $p<.001$. Those particular

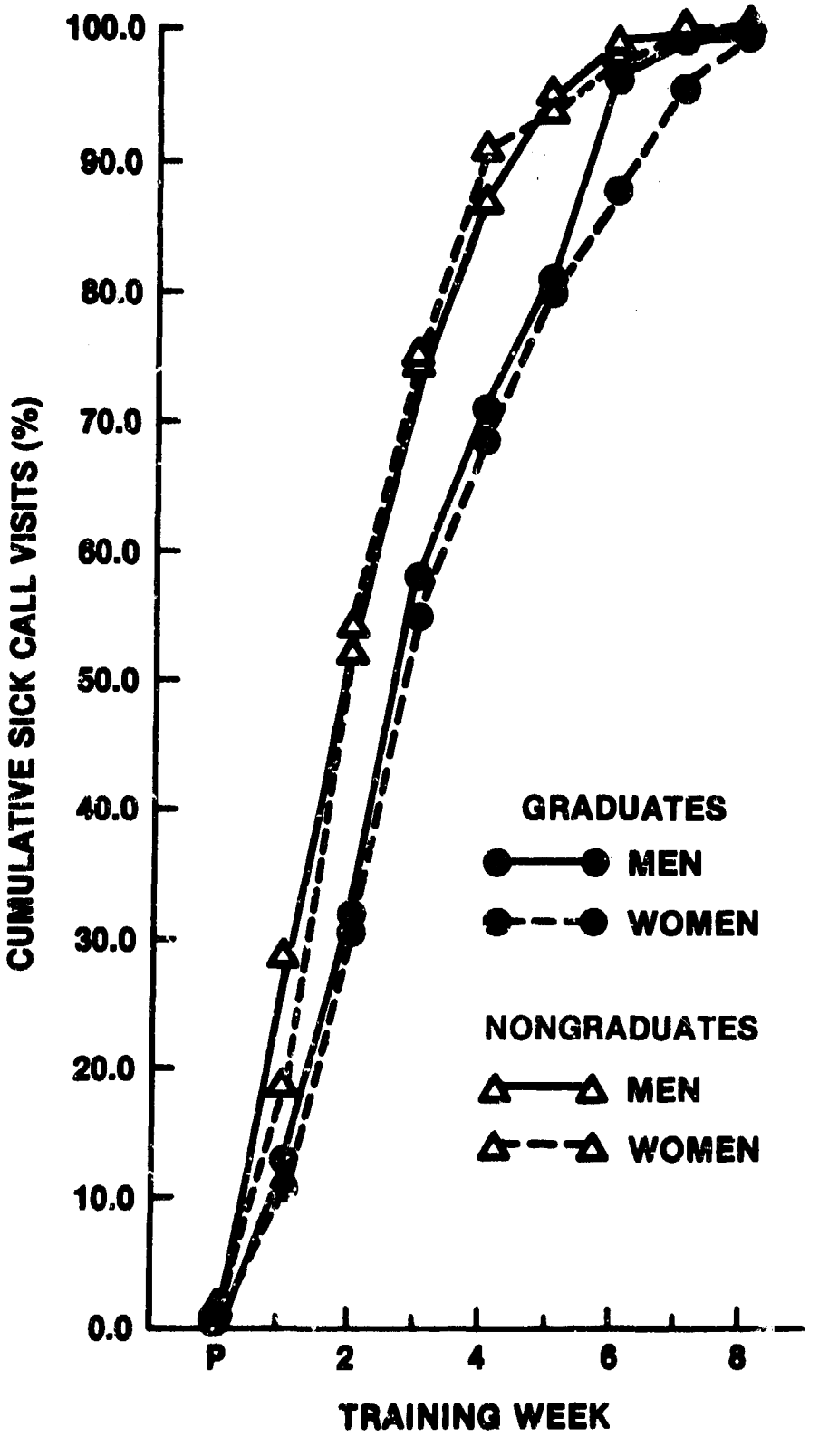

Figure 5. Cumulative percentages of the total sick call visits made by men and women Graduates and Nongraduates during processing days (P) and each training week.

Table 13. Sick Call Disposition of Men and Women

Disposition	Graduates		Nongraduates		Total	
	Men[a]	Women[b]	Men[c]	Women[d]	Men	Women
Percentage Receiving:						
Any Restriction	9.02	21.27***	23.50	27.64	10.66	22.29***
Hospitalization	.11	.78*	.43	.00	.14	.65
No Physical Activity	2.23	13.35***	9.83	17.89*	3.08	14.08***
Limited Physical Activity	6.63	7.92	14.53	11.38	7.52	8.47
Other Training Restriction	.43	3.26***	.43	3.25	.43	3.26***
No Restriction — Regular Training	12.66	26.24***	17.95	28.46*	13.26	26.60***
Medical Discharge	—	—	3.85	8.13	.43	1.30*
Mean No. of Days of Those Receiving:						
Any Restriction	3.91	7.82***	5.00	8.06*	4.18	7.87***
Hospitalization	5.00	8.20	22.00	.00	10.67	8.20
No Physical Activity	6.49	8.98*	7.04	9.18	6.70	9.02*
Limited Physical Activity	2.83	3.12	2.62	4.14	2.55	3.34*
Other Training Restriction	3.25	4.24	1.00	3.50	3.11	4.12

Note. Some participants received more than one category of training restriction. Thus, the sum of the percentages of individuals who received each type of restriction is greater than the percentage of individuals who received any type of restriction.

[a] n = 1,840 [c] n = 234 *p<.05

[b] n = 644 [d] n = 123 **p<.02

***p<.001

categories of restricted duty received by a significantly higher percentage of women than men were no physical activity, $\chi^2(1) = 117.086$, $p<.001$, and other training restriction, $\chi^2(1) = 35.453$, $p<.001$. A significantly higher percentage of women than men were also discharged because of lower extremity problems, $\chi^2(1) = 5.135$, $p<.05$. In terms of the durations of restricted training, the mean number of days the women spent in some restricted status was significantly greater than the mean for the men, $t(390) = 5.35$, $p<.001$. The duration of the women's no physical activity and limited physical activity restrictions were significantly longer than the men's, $t(170) = 2.32$, $p<.05$ and $t(219) = 2.17$, $p<.05$, respectively.

Types of Lower Extremity Disorders and Their Frequency

In this section, results are presented pertaining to the particular lower extremity disorders that occurred among the study participants. To derive the data, the medical diagnoses made during Exams 2, 3, or 4 and during sick call visits were examined and disorders were identified that occurred among at least three study participants from the time that they were issued boots. Twenty-seven disorders met this criterion. They are listed in Table 14 and also appear in Tables 15 through 21. The disorders include those which medical personnel found by visual inspection or by more extensive clinical evaluation, as well as those identified through the verbal reports of study participants. Numb feet or toes and pes planus pain are examples of lower extremity problems based upon the participants' verbal reports. One entry in the list of disorders, boot fit check, has been included for completeness, although it does not reflect a medical problem in the strictest sense. This category includes sick call visits or foot examinations at which a trainee reported that the boots did not fit properly. In these instances, medical personnel examined the fit of the boots and determined that the trainee's boots were properly sized, prescribed an exchange of boots for another size, or adjusted the fit by adding heel pads or the like.

The data on lower extremity disorders were compiled and analyzed to assess the effects of gender and footwear type on the rate of occurrence of each of the 27 disorders. Counts were made as a function of these two variables of the number of individuals who were identified as having a particular disorder on at least one occasion, either at a sick call or during Exams 2, 3, or 4. Counts were also made that were limited to the sick call data. For this, the number of individuals who were diagnosed for a particular disorder at least once during sick call was determined. Separate tallies were made of disorders which occurred among the Graduates and those which occurred among the Nongraduates, the individuals who did not complete basic training within their original battalions and therefore did not complete the study. The data of both groups combined were also compiled.

The sick call data were examined independently of the foot examination data in order to gain some insight into the nature and the frequency of the lower extremity problems for which the basic trainees sought medical attention. The combined foot examination and sick call findings are more comprehensive. The sick call data represent confirmed cases of disorders. The foot examination data include incidences of disorders of such a minor nature that medical treatment was not sought and symptoms indicating the possibility of a disorder, rather than a confirmed case.

Information was available on the lower extremity problems diagnosed at sick calls among the men in Bns 3 and 4. These data of the men in Bns 3 and 4, all of whom wore black leather boots, were contrasted with the sick call data of the male test participants in Bns 1 and 2 who wore black leather boots to assess whether or not the disorders identified among the participants were comparable to those experienced by trainees who had not been exposed to the test environment. Separate χ^2 tests for two independent samples were performed on each of the 27 disorders comparing the Graduates, the Nongraduates, and both of these groups combined. No significant differences ($p>.05$) were obtained between the men in Bns 3 and 4 and those in Bns 1 and 2 who wore leather boots.

Disorders as a function of boot type — Men. To assess the effects of the type of boot worn on the incidence of lower extremity problems, the disorders identified among the men in Bns 1 and 2 who wore the hot weather boots were compared with those experienced by the men in these two battalions who used the black leather boots. Analyses were performed on the data of the Graduates, the Nongraduates, and both of these groups combined.

Tables 14 and 15 contain listings of the percentage of men out of the total number in each footwear group who experienced the lower extremity problems. The combined foot examination and sick call data are included in Table 14, while Table 15 contains the sick call data only. The χ^2 tests performed on the disorders diagnosed during sick call visits did not reveal any significant differences ($p>.05$) as a function of the type of boot worn (Table 15). However, for the analyses that included both the foot examination and the sick call data, it was found that the men Graduates wearing hot weather boots experienced a significantly higher incidence of lace lesions than did the men Graduates wearing the black leather boots (Table 14). Examination of the combined data of the Graduates and the Nongraduates did not reveal any significant differences between the footwear groups.

Disorders as a function of boot type — Women. As was done with the men's data, the lower extremity disorders which occurred among the women in Bns 1, 2, 3, and 4 who were issued hot weather boots were compared with those which occurred among the women in these four battalions who used black leather boots. Analyses were performed on the data of the Graduates, the Nongraduates, and both of these groups combined.

The proportions of women in each footwear group who had lower extremity disorders diagnosed at sick call or during the foot examinations are presented in Table 16. Data limited to sick calls are presented in Table 17. Neither comparisons of the Graduates nor comparisons of the Nongraduates revealed any significant differences ($p>.05$) in the occurrence of lower extremity disorders as a function of the type of boot used. Some significant differences were obtained in the analyses of the combined data of the women Graduates and Nongraduates. For the disorders diagnosed during sick calls or during foot examinations, there was a significantly higher percentage of blisters among those women who wore hot weather boots, as well as a significantly higher percentage of lace lesions (Table 16). With regard to the sick call data, again a significantly higher percentage of women wearing the hot weather boot were diagnosed as having blisters (Table 17).

Disorders as a function of gender. In order to examine the influence of gender on lower extremity disorders, the data of the two footwear groups were combined to obtain the rates

Table 14. Percentage of Men in Each Footwear Group with Lower Extremity Disorders Identified during Foot Exams or Sick Calls

Disorder	Graduates		Nongraduates		Total	
	Leather[a]	Hot Weather[b]	Leather[c]	Hot Weather[d]	Leather	Hot Weather
Blister	20.52	23.68	7.89	8.54	19.09	21.98
Callous	6.36	4.80	3.29	2.44	6.02	4.53
Lace lesion	4.10	6.35*	2.63	.00	3.94	5.63
Calcaneal stress reaction	2.60	3.56	.00	1.22	2.30	3.30
Numb feet/toes	4.77	2.94	1.97	1.22	4.46	2.75
Metatarsal stress reaction	1.93	2.17	1.32	.00	1.86	1.92
Pes planus pain	1.00	2.17	2.63	3.66	1.19	2.34
Corn	2.09	1.55	.00	1.22	1.86	1.51
Tinea pedis	2.51	2.17	.00	1.22	2.23	2.06
Chondromalacia patellae	1.42	.77	3.95	3.66	1.71	1.10
Ingrown nail	2.43	1.39	1.32	2.44	2.30	1.51
Lateral ankle sprain	.84	1.08	1.32	1.22	.89	1.10
Boot fit check	1.42	1.39	.00	1.22	1.26	1.37
Tendinitis Achilles	.59	.93	.66	2.44	.59	1.10
Shin splints	.17	.31	.66	.00	.22	.27
Medial tibial flare stress reaction	.25	.31	1.32	1.22	.37	.41
Plantar fascial strain	.00	.46	.00	.00	.00	.41
Cellulitis	.42	.15	.66	1.22	.45	.27
Pes cavus pain	.00	.31	.00	.00	.00	.27
Sesamoiditis	.25	.31	.00	1.22	.22	.41
Water retention	.00	.00	.00	.00	.00	.00
Bunion	.34	.00	.00	.00	.30	.00
Toe fracture	.25	.15	.00	.00	.22	.14
Metatarsalgia	.17	.00	.00	.00	.15	.00
Osteochondritis dessicans	.00	.00	1.32	1.22	.15	.14
Osgood Schlatter's disease	.08	.00	1.32	.00	.22	.00
Ganglionic cyst	.00	.00	.00	.00	.00	.00

[a] $n = 1,194$

[b] $n = 646$

[c] $n = 152$

[d] $n = 82$

*$\chi^2(1) = 3.841 - 5.411$, $p < .05$

Table 15. Percentage of Men in Each Footwear Group with Lower Extremity Disorders Identified at Sick Calls

Disorder	Graduates		Nongraduates		Total	
	Leather[a]	Hot Weather[b]	Leather[c]	Hot Weather[d]	Leather	Hot Weather
Blister	1.17	2.17	1.31	2.44	1.19	2.20
Callous	.17	.00	.00	1.21	.15	.14
Lace lesion	.00	.31	.00	.00	.00	.27
Calcaneal stress reaction	.17	.31	.00	1.21	.15	.41
Numb feet/toes	.25	.46	1.96	.00	.45	.41
Metatarsal stress reaction	.00	.00	.65	.00	.07	.00
Pes planus pain	1.00	2.17	2.63	2.44	1.19	2.20
Corn	.00	.15	.00	.00	.00	.14
Tinea pedis	.17	.15	.00	.00	.15	.14
Chondromalacia patellae	1.42	.77	3.92	3.66	1.71	1.10
Ingrown nail	.67	.46	1.31	1.21	.74	.55
Lateral ankle sprain	.50	.93	.65	1.21	.52	.96
Boot fit check	.75	.62	.00	.00	.67	.55
Tendinitis Achilles	.25	.15	.65	.00	.30	.14
Shin splints	.08	.31	.65	.00	.15	.27
Medial tibial flare stress reaction	.25	.31	.65	1.21	.30	.41
Plantar fascial strain	.00	.15	.00	.00	.00	.14
Cellulitis	.17	.15	.00	1.21	.15	.27
Pes cavus pain	.00	.31	.00	.00	.00	.27
Sesamoiditis	.08	.00	.00	.00	.07	.00
Water retention	.00	.00	.00	.00	.00	.00
Bunion	.08	.00	.00	.00	.07	.00
Toe fracture	.17	.00	.00	.00	.15	.00
Metatarsalgia	.00	.00	.00	.00	.00	.00
Osteochondritis dessicans	.00	.00	1.31	1.21	.15	.14
Osgood Schlatter's disease	.08	.00	1.31	.00	.22	.00
Ganglionic cyst	.00	.00	.00	.00	.00	.00

[a] n = 1,194

[b] n = 646

[c] n = 152

[d] n = 82

Table 16. Percentage of Women in Each Footwear Group with Lower Extremity Disorders Identified during Foot Exams or Sick Calls

Disorder	Graduates		Nongraduates		Total	
	Leather[a]	Hot Weather[b]	Leather[c]	Hot Weather[d]	Leather	Hot Weather
Blister	27.66	35.02	11.54	20.00	24.71	33.04*
Callous	6.05	8.08	1.28	.00	5.18	7.02
Lace lesion	4.61	9.76	2.56	6.67	4.24	9.36**
Calcaneal stress reaction	8.36	13.13	11.54	11.16	8.94	12.87
Numb feet/toes	5.48	6.73	1.28	.00	4.71	5.85
Metatarsal stress reaction	6.05	7.74	2.56	6.67	5.41	7.60
Pes planus pain	3.17	5.05	3.85	4.44	3.29	4.97
Corn	2.59	2.69	5.13	.00	3.06	2.34
Tinea pedis	1.15	2.69	.00	2.22	.94	2.63
Chondromalacia patellae	3.46	2.36	3.85	2.22	3.53	2.34
Ingrown nail	1.44	.34	1.28	.00	1.41	.29
Lateral ankle sprain	4.61	3.03	.00	2.22	3.76	2.92
Boot fit check	1.15	1.68	1.28	.00	1.18	1.46
Tendinitis Achilles	2.30	3.03	2.56	4.44	2.35	3.22
Shin splints	1.44	1.35	.00	.00	1.18	1.17
Medial tibial flare stress reaction	.58	.67	1.28	.00	.71	.58
Plantar fascial strain	1.73	.67	1.28	2.22	1.65	.88
Cellulitis	.29	.67	1.28	.00	.47	.58
Pes cavus pain	.58	1.35	1.28	4.44	.71	1.75
Sesamoiditis	.29	.00	.00	.00	.24	.00
Water retention	1.15	.34	2.56	.00	1.41	.29
Bunion	.00	.67	.00	.00	.00	.58
Toe fracture	.00	.34	.00	.00	.00	.29
Metatarsalgia	.00	.67	.00	.00	.00	.58
Osteochondritis dessicans	.00	.00	.00	.00	.00	.00
Osgood Schlatter's disease	.00	.00	.00	.00	.00	.00
Ganglionic cyst	.58	.34	.00	.00	.47	.29

[a] n = 347

[b] n = 297

[c] n = 78

[d] n = 45

*$\chi^2(1) = 5.412 - 6.634$, $p < .02$

**$\chi^2(1) = 6.635 - 10.826$, $p < .01$

Table 17. Percentage of Women in Each Footwear Group with Lower Extremity Disorders Identified at Sick Calls

Disorder	Graduates		Nongraduates		Total	
	Leather[a]	Hot Weather[b]	Leather[c]	Hot Weather[d]	Leather	Hot Weather
Blister	3.46	7.07	2.56	4.44	3.29	6.73*
Callous	.86	.67	1.28	.00	.94	.58
Lace lesion	.58	1.35	1.28	2.22	.71	1.46
Calcaneal stress reaction	2.31	5.39	5.13	6.67	2.82	5.56
Numb feet/toes	.29	1.68	.00	.00	.24	1.46
Metatarsal stress reaction	1.15	2.02	1.28	4.44	1.18	2.34
Pes planus pain	2.88	5.05	3.85	4.44	3.06	4.97
Corn	.00	.67	.00	.00	.00	.58
Tinea pedis	.00	1.35	.00	.00	.00	1.17
Chondromalacia patellae	3.46	2.36	3.85	2.22	3.53	2.34
Ingrown nail	.86	.34	1.28	.00	.94	.29
Lateral ankle sprain	3.46	1.35	.00	2.22	2.82	1.46
Boot fit check	.29	.34	1.28	.00	.47	.29
Tendinitis Achilles	.86	2.02	2.56	4.44	1.18	2.34
Shin splints	1.44	.67	.00	.00	1.18	.58
Medial tibial flare stress reaction	.58	.67	.00	.00	.47	.58
Plantar fascial strain	1.15	.00	1.28	.00	1.18	.00
Cellulitis	.29	.34	1.28	.00	.47	.29
Pes cavus pain	.58	1.35	1.28	4.44	.71	1.75
Sesamoiditis	.00	.00	.00	.00	.00	.00
Water retention	1.15	.34	2.56	.00	1.41	.29
Bunion	.00	.67	.00	.00	.00	.58
Toe fracture	.00	.00	.00	.00	.00	.00
Metatarsalgia	.00	.00	.00	.00	.00	.00
Osteochondritis dessicans	.00	.00	.00	.00	.00	.00
Osgood Schlatter's disease	.00	.00	.00	.00	.00	.00
Ganglionic cyst	.29	.34	.00	.00	.24	.29

[a] $n = 347$

[b] $n = 297$

[c] $n = 78$

[d] $n = 45$

*$\chi^2(1) = 3.841 - 5.411$, $p < .05$

of occurrence of the 27 disorders for the men in Bns 1 and 2 and the women in Bns 1, 2, 3, and 4. Tables 18 and 19 contain listings of the percentages of individuals of each gender who experienced the lower extremity problems. The combined foot examination and sick call data are included in Table 18, while Table 19 contains the sick call data only.

As can be seen in Table 18 the most common disorder diagnosed among both the men and the women when foot examinations and sick calls were considered was blisters. Out of all test participants, these were identified in approximately 28% of the women and 20% of the men. In addition, the combined foot examination and sick call data indicated that callouses, lace lesions, and calcaneal stress reactions were among the more frequently occurring disorders experienced by both sexes. Blisters were also one of the more common sick call findings for men and women, along with pes planus pain and chondromalacia (Table 19). For the majority of disorders, the percentage of women incurring a lower extremity problem was higher than the percentage of men. There were some disorders diagnosed within one sex only. Cases of osteochondritis dessicans and Osgood Schlatter's disease were specific to the men; water retention and ganglionic cysts were specific to the women.

As was done in the analyses of the effects of boot type, χ^2 tests were performed on the data of the Graduates, the Nongraduates, and both of these groups combined. The analyses which included sick call and foot examination findings yielded a number of significant differences between the men and the women in the rates of occurrence of the disorders (Table 18). Among the Nongraduates, there was a significant difference between the sexes only in the percentages of calcaneal stress reactions. Less than 1% of the men Nongraduates and more than 11% of the women Nongraduates experienced this disorder. For the Graduates, there was also a significantly higher rate of occurrence of stress reactions of the calcaneus among the women than among the men. In addition, a significantly higher percentage of women than of men Graduates were diagnosed for blisters, metatarsal stress reactions, pes planus pain, chondromalacia, lateral ankle sprains, tendinitis Achilles, shin splints, plantar fascial strain, and pes cavus pain. Significant differences between the sexes were obtained for these same disorders in the analyses performed on the combined data of the Graduates and the Nongraduates, and there was also a significantly higher percentage of lace lesions among the women than among the men (Table 18). The combined data revealed that the largest differences between the sexes were in the rates of occurrence of blisters and calcaneal stress reactions. The percentage of women diagnosed for each of these disorders was approximately 8% higher than the percentage of men.

The significant findings obtained in the analyses of the sick call data are indicated in Table 19. There was one significant difference between the men and the women Nongraduates: The women again had a higher incidence of calcaneal stress reactions than the men. The sick call data of the Graduates yielded significantly higher rates of occurrence among the women than among the men of calcaneal stress reactions, blisters, callouses, lace lesions, pes planus pain, chondromalacia, lateral ankle sprains, tendinitis Achilles, shin splints, plantar fascial strain, and pes cavus pain. Significant differences between the men and the women were obtained for these same disorders in the analyses of the combined data of the Graduates and the Nongraduates. In addition, the women had significantly higher incidences of metatarsal stress reactions than the men did (Table 19). The combined data revealed that the largest differences between the sexes were in the rates of occurrence of blisters and stress reactions of the calcaneus.

Table 18. Percentages of Men and Women with Lower Extremity Disorders Identified during Foot Exams or Sick Calls

Disorder	Graduates		Nongraduates		Total	
	Men[a]	Women[b]	Men[c]	Women[d]	Men	Women
Blister	21.63	31.06****	8.12	14.63	20.11	28.42****
Callous	5.82	6.99	2.99	.81	5.50	6.00
Lace lesion	4.89	6.99	1.71	4.06	4.53	6.52*
Calcaneal stress reaction	2.93	10.56****	.43	11.38****	2.65	10.69****
Numb feet/toes	4.13	6.06	1.71	.81	3.86	5.22
Metatarsal stress reaction	2.01	6.83****	.85	4.06	1.88	6.39****
Pes planus pain	1.41	4.04****	2.99	4.06	1.59	4.04****
Corn	1.90	2.64	.43	3.25	1.74	2.74
Tinea pedis	2.39	1.86	.43	.81	2.17	1.69
Chondromalacia patellae	1.20	2.95***	3.85	3.25	1.49	3.00**
Ingrown nail	2.06	.93	1.71	.81	2.03	.91
Lateral ankle sprain	.92	3.88****	1.28	.81	.96	3.39****
Boot fit check	1.41	1.40	.43	.81	1.30	1.30
Tendinitis Achilles	.71	2.64****	1.28	3.25	.77	2.74****
Shin splints	.22	1.40***	.43	.00	.24	1.17***
Medial tibial flare stress reaction	.27	.62	1.28	.81	.39	.65
Plantar fascial strain	.16	1.24***	.00	1.63	.14	1.30****
Cellulitis	.33	.46	.85	.81	.39	.52
Pes cavus pain	.11	.93***	.00	2.44	.10	1.17****
Sesamoiditis	.27	.16	.43	.00	.29	.13
Water retention	.00	.78	.00	1.63	.00	.91
Bunion	.22	.31	.00	.00	.19	.26
Toe fracture	.22	.16	.00	.00	.19	.13
Metatarsalgia	.11	.31	.00	.00	.10	.26
Osteochondritis dessicans	.00	.00	1.28	.00	.14	.00
Osgood Schlatter's disease	.05	.00	.85	.00	.14	.00
Ganglionic cyst	.00	.46	.00	.00	.00	.39

[a] n = 1,840
[b] n = 644
[c] n = 234
[d] n = 123

*$\chi^2(1) = 3.841 - 5.411$, $p<.05$
**$\chi^2(1) = 5.412 - 6.634$, $p<.02$
***$\chi^2(1) = 6.635 - 10.826$, $p<.01$
****$\chi^2(1) \geq 10.827$, $p<.001$

Table 19. Percentages of Men and Women with Lower Extremity Disorders Identified at Sick Calls

Disorder	Graduates		Nongraduates		Total	
	Men[a]	Women[b]	Men[c]	Women[d]	Men	Women
Blister	1.52	5.12****	1.71	3.25	1.54	4.82***
Callous	.11	.78*	.43	.81	.14	.78*
Lace lesion	.11	.93***	.00	1.63	.10	1.04***
Calcaneal stress reaction	.22	3.73****	.43	5.69***	.24	4.04***
Numb feet/toes	.33	.93	1.28	.00	.43	.78
Metatarsal stress reaction	.00	1.55	.43	2.44	.05	1.69***
Pes planus pain	1.41	3.88****	2.56	4.06	1.54	3.91***
Corn	.05	.31	.00	.00	.05	.26
Tinea pedis	.16	.62	.00	.00	.14	.52
Chrondromalacia patellae	1.20	2.95***	3.85	3.25	1.49	3.00**
Ingrown nail	.60	.62	1.28	.81	.68	.65
Lateral ankle sprain	.65	2.48****	.85	.81	.68	2.22***
Boot fit check	.71	.31	.00	.81	.63	.39
Tendinitis Achilles	.22	1.40***	.43	3.25	.24	1.69***
Shin splints	.16	1.09***	.43	.00	.19	.91**
Medial tibial flare stress reaction	.27	.62	.85	.00	.34	.52
Plantar fascial strain	.05	.62*	.00	.81	.05	.65***
Cellulitis	.16	.31	.43	.81	.19	.39
Pes cavus pain	.11	.93***	.00	2.44	.10	1.17***
Sesamoiditis	.05	.00	.00	.00	.05	.00
Water retention	.00	.78	.00	1.63	.00	.91
Bunion	.05	.31	.00	.00	.05	.26
Toe fracture	.11	.00	.00	.00	.10	.00
Metatarsalgia	.00	.00	.00	.00	.00	.00
Osteochondritis dessicans	.00	.00	1.28	.00	.14	.00
Osgood Schlatter's disease	.05	.00	.85	.00	.14	.00
Ganglionic cyst	.00	.31	.00	.00	.00	.26

[a] $n = 1,840$

[b] $n = 644$

[c] $n = 234$

[d] $n = 123$

*$\chi^2(1) = 3.841 - 5.411$, $p<.05$

**$\chi^2(1) = 5.412 - 6.634$, $p<.02$

***$\chi^2(1) = 6.635 - 10.826$, $p<.01$

****$\chi^2(1) \geq 10.827$, $p<.001$

The proportion of women diagnosed for calcaneal stress reactions and for blisters exceeded the proportion of men by 3.80% and 3.28%, respectively.

The sick call data pertaining to specific lower extremity disorders were examined further to assess differences between the men and the women in the outcomes of their sick call visits. For this, the number of men or women placed on restricted duty for a particular problem was divided by the number who attended sick call for that problem. These calculations were performed on the combined data of the Graduates and the Nongraduates. The findings are presented in Table 20. For six of the disorders incurred by both sexes, a higher proportion of women than men were placed on restricted duty status. In the case of blisters, callouses, lace lesions, chondromalacia patellae, ingrown nails, lateral ankle sprains, medial tibial flare stress reactions, plantar fascial strain, and cellulitis, the percentages of men on restricted duty exceeded the percentages of women.

The data pertaining to disorders diagnosed at sick calls among the Graduates and the Nongraduates combined were subjected to further treatment to examine the effects of gender. For each sex, the frequencies of the disorders were summed to obtain the total number of cases of lower extremity problems, and the proportion of that total attributable to each disorder was calculated. The proportion of sick call visits and the proportion of restricted training days attributable to each disorder were also obtained. These proportions were based on the total number of sick calls and restricted days, respectively, associated with all 27 disorders. The findings are presented in Table 21.

Blisters, pes planus pain, and chondromalacia patellae were accountable for the highest proportions of the men's cases and sick call visits; each represented over 16% of the respective totals. High proportions of the women's cases and sick call visits were also attributable to blisters, pes planus pain, and chondromalacia; these represented a relatively high proportion, approximately 13%, of both the women's cases and sick call visits. In addition, calcaneal stress reactions accounted for approximately 13% of the women's cases and sick call visits. With regard to restricted training, the highest proportions of restricted days for the men were due to chondromalacia, lateral ankle sprains, and medial tibial flare stress reactions; these disorders accounted for 11% to 28% of the restricted duty time. The highest percentages of the women's restricted training days were for chondromalacia, lateral ankle sprains, and calcaneal stress reactions.

The individual χ^2 tests performed on each disorder to determine whether or not the men and the women differed from each other in proportions of cases revealed that a significantly higher percentage of the men's cases relative to the women's were attributable to ingrown nails and to checks of boot fit. The women had significantly more of their cases in the categories of calcaneal and metatarsal stress reactions than the men did. There were no other significant differences between the sexes in relative proportions of cases. A significantly higher percentage of the women's than the men's sick call visits were also attributable to calcaneal and metatarsal stress reactions. In addition, the women's sick calls for tendinitis Achilles represented a significantly higher proportion of their total visits than it did the men's. A significantly higher percentage of the men's than the women's visits were attributable to chondromalacia, ingrown nails, checks of boot fit, and medial tibial flare stress reactions. There were no other significant differences between men and women in the relative distribution of their sick call visits. With

Table 20. Percentages of Men and Women Diagnosed for a Particular Disorder Who Were Placed on Restricted Duty

Disorder	Men	Women
Blister	37.50	16.22
Callous	33.33	.00
Lace lesion	50.00	37.50
Calcaneal stress reaction	80.00	93.55
Numb feet/toes	11.11	16.67
Metatarsal stress reaction	.00	76.92
Pes planus pain	9.38	10.00
Corn	.00	.00
Tinea pedis	.00	.00
Chondromalacia patellae	93.55	78.26
Ingrown nail	71.43	40.00
Lateral ankle sprain	85.71	82.35
Boot fit check	.00	.00
Tendinitis Achilles	80.00	84.61
Shin splints	25.00	42.86
Medial tibial flare stress reaction	100.00	75.00
Plantar fascial strain	100.00	60.00
Cellulitis	100.00	66.67
Pes cavus pain	.00	.00
Sesamoiditis	.00	–
Water retention	–	28.57
Bunion	.00	.00
Toe fracture	50.00	–
Metatarsalgia	–	–
Osteochondritis dessicans	100.00	–
Osgood Schlatter's disease	100.00	–
Ganglionic cyst	–	100.00

Note. A dash indicates that the disorder was not diagnosed at a sick call among the test participants of that gender.

Table 21. Percentages of Cases, Sick Call Visits, and Restricted Training Days Attributable to Each Lower Extremity Disorder Occurring among the Men and the Women

Disorder	Cases		Sick Call Visits		Restricted Days	
	Men[a]	Women[b]	Men[c]	Women[d]	Men[e]	Women[f]
Blister	16.58	15.61	16.10	13.49	9.23	1.57****
Callous	1.55	2.53	1.50	1.59	.18	.00
Lace lesion	1.04	3.38	.75	2.38	.37	.84
Calcaneal stress reaction	2.59	13.08****	2.62	13.76****	2.77	28.27****
Numb feet/toes	4.66	2.53	3.74	1.59	.37	.31
Metatarsal stress reaction	.52	5.48***	.37	5.29***	.00	8.06
Pes planus pain	16.58	12.66	17.60	11.90	1.48	.84
Corn	.52	.84	.37	1.06	.00	.00
Tinea pedis	1.55	1.69	1.12	1.06	.00	.00
Chondromalacia patellae	16.06	9.70	19.85	13.22*	27.68	15.08****
Ingrown nail	7.25	2.11**	5.99	1.59***	5.54	.84****
Lateral ankle sprain	7.25	7.17	6.74	9.26	15.87	25.24****
Boot fit check	6.74	1.26***	4.87	1.32**	.00	.00
Tendinitis Achilles	2.59	5.48	1.87	8.20***	2.77	8.48****
Shin splints	2.07	2.95	1.50	3.17	.37	1.99**
Medial tibial flare stress reaction	3.63	1.69	5.62	1.85**	10.89	3.98****
Plantar fascial strain	.52	2.11	.75	2.12	1.29	1.15
Cellulitis	2.07	1.26	2.25	1.06	6.30	1.15****
Pes cavus pain	1.04	3.80	1.12	2.64	.00	.00
Sesamoiditis	.52	.00	.37	.00	.00	.00
Water retention	.00	2.95	.00	2.12	.00	1.15
Bunion	.52	.84	.37	.53	.00	.00
Toe fracture	1.04	.00	1.12	.00	3.14	.00
Metatarsalgia	.00	.00	.00	.00	.00	.00
Osteochondritis dessicans	1.55	.00	1.50	.00	6.83	.00
Osgood Schlatter's disease	1.55	.00	1.87	.00	2.95	.00
Ganglionic cyst	.00	.84	.00	.79	.00	1.05

[a] n = 193

[b] n = 237

[c] n = 267

[d] n = 378

[e] n = 542

[f] n = 955

*$\chi^2(1) = 3.841 - 5.411$, $p<.05$

**$\chi^2(1) = 5.412 - 6.634$, $p<.02$

***$\chi^2(1) = 6.635 - 10.826$, $p<.01$

****$\chi^2(1) \geq 10.827$, $p<.001$

regard to training restrictions, the women received a significantly greater percentage of their restricted duty days for calcaneal stress reactions, lateral ankle sprains, tendinitis Achilles, and shin splints than the men did. In addition, over 8% of the women's restricted training time was attributable to metatarsal stress reactions, while the men did not receive any training restrictions for this disorder. A significantly higher percentage of the men's than the women's restricted days were attributable to blisters, chondromalacia, ingrown nails, medial tibial flare stress reactions, and cellulitis. The men also received approximately 7% of their restricted training time for osteochondritis dessicans, while the women had no restricted duty days for this disorder. Indeed, osteochondritis dessicans was not diagnosed among the women.

Lower Extremity Disorders Associated with Hospitalizations and Medical Discharges

Discharge from military service and hospitalization are two severe and costly impacts of lower extremity disorders on basic training activities. Data have already been presented on the proportions of test participants who were hospitalized or discharged because of some lower extremity problem (Tables 9, 11, and 13). The particular disorders associated with these dispositions are presented here.

The disorders examined in the previous section were those that occurred among at least three of the test participants. Incidences of some of these lower extremity problems resulted in the hospitalization of individuals or in their discharge from military service. Participants were also hospitalized or discharged for other lower extremity disorders which occurred in fewer than three instances and, thus, were not included in the previous section. Table 22 contains a list of all the disorders associated with medical discharges and all associated with hospitalization. Also included are the number of men and women Graduates and Nongraduates who were hospitalized or discharged for each disorder.

Cellulitis was the most common cause of hospitalization. Five of the eight individuals who spent time in the hospital for lower extremity problems were under treatment for this disorder. With regard to medical discharges, three of the nine men released because of lower extremity disorders had osteochondritis dessicans and two had chondromalacia. Pes planus, cellulitis, Legg Perthes disease, and degenerative joint disease accounted for the remaining four discharges. Two of the 10 women released had tendinitis Achilles and two had internal derangements of the knee. Heel stress reactions, lateral ankle sprains, cellulitis, arthritis, hallux valgus, and osteomyelitis were the other disorders for which women received medical discharges.

Time to Complete the Basic Physical Fitness Test Run

The test participants' times to complete the 2.4-km run, one of the subtests included in the basic physical fitness test administered at the end of the training cycle, were analyzed principally to determine if the type of boot worn had a significant effect on scores. The run times of the men in Bns 1 and 2 who wore black leather boots were contrasted with the times of the men in these two battalions who wore hot weather boots. Similarly, the scores of the women in Bns 1, 2, 3, and 4 who used leather boots were compared with the scores of the women in these four battalions who used hot weather boots. The analyses in the form of t-tests for large, uncorrelated samples did not reveal statistically significant

Table 22. Lower Extremity Disorders and Number of Men and Women Hospitalized or Discharged from Military Service

Disorder	Graduates		Nongraduates	
	Men	Women	Men	Women
Hospitalization				
Calcaneal stress reaction	0	1	0	0
Lateral ankle sprain	0	1	0	0
Cellulitis	2	2	1	0
Calcaneal stress fracture	0	1	0	0
Medical Discharge				
Calcaneal stress reaction	—	—	0	1
Pes planus	—	—	1	0
Chondromalacia patellae	—	—	2	0
Lateral ankle sprain	—	—	0	1
Tendinitis Achilles	—	—	0	2
Cellulitis	—	—	1	1
Osteochondritis dessicans	—	—	3	0
Legg Perthes disease	—	—	1	0
Degenerative joint disease	—	—	1	0
Arthritis	—	—	0	1
Hallux valgus	—	—	0	1
Osteomyelitis	—	—	0	1
Internal derangement of knee	—	—	0	2

differences in run times ($p>.05$) as a function of boot type among either the men or the women. The men wearing black leather boots had a mean time of 661.54 sec (S D = 59.99) and those with hot weather boots had an almost identical mean score of 662.32 sec (S D = 53.48). The women using leather boots had a mean of 810.57 sec (S D = 75.06) and those using the hot weather boots had a slightly lower mean time of 803.97 sec (S D = 63.28).

The run scores were included in additional analyses in order to examine their relationship to age, sick call attendance, and time spent in a restricted training status. For these analyses, the data of the two footwear groups were combined. To assess the relationship of age to run time, one Pearson product-moment correlation coefficient (r) was computed for the men and a separate one was computed for the women. The correlation coefficient for the women approached zero, $r\ (279) = +.0197$, while that for the men was low, positive, and significant, $r\ (1,018) = +.0766$, $p<.05$.

The run times of the test participants who attended sick call on at least one occasion for a lower extremity problem were contrasted with the scores of those who did not attend sick call for such a complaint. A t-test revealed that the men who had attended sick call took significantly longer to complete the run than those men who had not, $t\ (1,675) = 3.94$, $p<.001$. The mean for the sick call attendees was 674.17 sec (S D = 58.30) and, for those who did not attend sick call, the mean was 658.81 sec (S D = 57.22). The women who had attended sick call also had significantly higher run times than those who had not attended, $t\ (456) = 2.01$, $p<.05$. The mean score for the sick call attendees was 816.56 sec (S D = 80.30) and, for those women who had not attended sick call, the mean was 802.08 sec (S D = 62.07). The relationship between run times and sick call attendance for lower extremity problems was examined further using correlational techniques. The raw data used were an individual's run score and total number of sick call visits. All participants for whom run times were available were included in the analysis, whether or not they had attended sick call. Low, positive, and significant correlations were obtained between number of sick call visits and run times for both the men and the women. The results for the men were $r\ (1,675) = +.1318$, $p<.01$, and those for the women were $r\ (456) = +.1243$, $p<.05$.

The statistical approaches used to examine the relationships between run time and sick call attendance were also applied to run time and training restrictions. The run times of those participants who had received at least one day of restricted duty because of lower extremity disorders were contrasted with the times of those individuals who had not been placed on restricted duty for such disorders. It was found that the men who had spent some time on restricted duty status took significantly longer to complete the run than those men who had not, $t\ (1,575) = 3.84$, $p<.001$. The mean for the former group was 679.95 sec (S D = 54.11) and the mean for the latter was 660.36 sec (S D = 57.86). The women exhibited a similar trend; those who had been placed on restricted duty had a mean time of 820.33 sec (S D = 99.18) and those who had not received a training restriction had a mean time of 805.17 sec (S D = 63.12). The difference between these two means was not significant ($p>.05$). Correlations were performed using as the raw data an individual's run time and total number of days spent on restricted duty status for lower extremity disorders. All participants for whom run times were available were included in the analysis, whether or not they had received restricted training days. A low, positive, and significant correlation was obtained for the men between run times and days of restricted duty, $r\ (1,675) = +.0784$, $p<.05$. The correlation coefficient for the women was low, positive, and nonsignificant, $r\ (456) = +.0917$.

DISCUSSION

Overview of Findings

The incidence of lower extremity problems among the Army trainees in this study substantiates the finding from other research efforts that the basic training environment is a physically stressful one.[5,6] Approximately 23% of the men and 42% of the women who served as test participants reported to sick call at least once seeking medical attention for a lower extremity complaint. The proportion of men attending sick call for foot and leg problems approaches the figure of 26% which was reported by Kowal[29] for men in Army training and by Schnitzer and Hoeffler[5] for men in Navy training. The percentage of women who made a sick call visit is closer to the attendance rate of 37% reported in Bensel's[6] study of male Marine Corps recruits, but less than the rate of 54% reported by Kowal.[29] In previous investigations of lower extremity problems among military recruits, it was found that such problems occur more frequently in the early than in the late stages of training.[3,20] The data of the present study also reflect this pattern. Over 50% of all sick call visits made by the test participants for foot and leg complaints had occurred by the end of the third week of the eight-week training cycle.

In their study of lower extremity disorders occurring among men and women in Army training at Fort Jackson, Reinker and Ozburne[28] found that individuals who incurred these disorders did not differ in age from the mean age of the trainees at the installation. Examination of the ages of the participants in the present investigation also failed to reveal a significant difference between the ages of those who attended sick call with a lower extremity complaint and those who did not. However, a relationship was found between age and duty restrictions. Those men and women placed on restricted duty status because of lower extremity disorders were significantly older than the trainees whose activities were not curtailed. There were also trends in the data indicating that the number of sick call visits and the number of days spent on restricted duty increased with the ages of the trainees.

The results presented here on the frequencies of sick call visits and duty restrictions attributable to lower extremity problems support the findings of other researchers that these problems are responsible for extensive losses of military training time.[10,18] The analyses performed on the results of the physical fitness test revealed that there is also an association between lower extremity disorders and the level of achievement attained in the performance of prescribed training activities. For example, those men and women who attended sick call at least once for a foot or leg problem took significantly longer to complete the 2.4-km run, a portion of the physical fitness test administered at the end of training, than those of the same gender who did not report to sick call for a lower extremity complaint. In addition, the more sick call visits made by the trainees, the longer was the time they required to finish the run. The findings with regard to time spent on restricted duty status because of lower extremity disorders were simile.. Trainees who were placed on restricted duty for at least one day took longer to complete the run than those who were never placed on restricted duty. There was also a tendency for run times to increase as number of days spent on restricted duty increased.

The specific types of disorders incurred by the participants in this study were similar to those identified in other investigations of lower extremity problems among military recruits.[4,6,28] The more prevalent problems diagnosed at sick calls or during the foot examinations included blisters, callouses, and traumatic injuries, such as stress reactions and ankle sprains. Ganglionic cysts and cases of Osgood Schlatter's disease were among the problems having lower incidence rates.

The lower extremity disorders identified in the present sample of Army trainees differed from each other not only in frequency of occurrence, but in impact on the training program. For example, approximately 16% of the men's sick calls were attributable to blisters and 9% of their days of restricted training were for this same problem, whereas ankle sprains accounted for 7% of the men's sick calls and 16% of their restricted training days. The women's data revealed a similar situation. Approximately 13% of their visits and 2% their restricted days were for blisters, while 9% of their visits and 25% of their restricted days were attributable to ankle sprains.

Of the 27 types of lower extremity disorders incurred by three or more test participants, three disorders accounted for over 50% of the men's sick call visits, while 16 other disorders each accounted for less than 3% of their visits. The situation among the women was similar. Over 50% of their visits were attributable to four of the disorders, while 14 disorders each represented less than 3% of their sick call visits. Data such as these indicating that there are substantial differences among lower extremity disorders in their frequencies of occurrence and their impact on training should be considered in the development of strategies for decreasing the incidence of foot and leg problems in the military recruit population. Because of the range of disorders and the differences in their etiologies, plans to reduce the occurrence of them all would be difficult to formulate and, probably, would not be highly successful.

Effects of Boot Type

The relationship between footwear and lower extremity disorders is a subject that should also be explored in support of efforts to reduce the prevalence of foot and leg problems in the recruit population. However, the task of relating the occurrence of a particular disorder to a specific footwear configuration is a difficult one because, as Cavanagh[54] has stated, footwear can have its effect at an "incredibly subtle" level. It was determined that footwear would be included as a variable in the present study since two types of boots were available for use in the test that were made over the same last, the MIL–5, but differed in material, design, and impact characteristics. By obviating effects attributable to the last, an attempt was made in this study to gain information on the potency of other footwear parameters.

The analyses performed to compare the incidences of lower extremity disorders among the trainees who wore hot weather boots with the incidences among those who used black leather boots yielded few statistically significant findings. Two disorders, blisters and lace

[54] P.R. Cavanagh. **The running shoe book.** Mountain View, California: Anderson World, 1980.

lesions, had significantly higher rates of occurrence among the women using the hot weather boot. The men's data revealed only one significant difference in the frequency of a disorder as a function of the type of boot worn and this was also a higher rate of occurrence of lace lesions in the hot weather than in the black leather boot group. As was the case with the women, there was a higher percentage of blisters among the men using hot weather boots than among those using black leather boots, but the men's data did not yield a significant difference between the footwear groups in the occurrence of this disorder.

Analyses of the findings from the first foot examination, which was conducted prior to the issuing of boots and the initiation of training, revealed that the trainees in the two footwear groups were comparable at that time in terms of their physical characteristics and histories of lower extremity disorders. Thus, differences between the footwear groups in the occurrence of specific foot and leg problems would seem to be attributable to differential effects of the boots themselves. Both lace lesions and blisters are associated with pressure and frictional forces on the skin. Lace lesions develop on the ankle and foot area underlying a boot's eyelets and lacing. Since the black leather and the hot weather boots have identical lacing systems comprised of eyelets set in strips of leather, it would appear that differences in the materials used in the uppers and tongues of the two boots may have influenced the formation of lace lesions. The hot weather boot's cotton/duck material is thinner than the leather in the black boot and, thus, its tongue may provide less padding between the laces and eyelets and the skin. The differences noted in the occurrence of blisters may be attributable to any of a number of design features, including the location of seams, and to the materials used in the boots. An understanding of the particular characteristics of the hot weather boot which may have led to the higher frequency of blisters relative to the black leather boot would require data regarding the sites of blister formation and such information was not recorded in this study.

Neither blisters nor lace lesions are generally recognized as being related to impact and energy absorption characteristics of footwear, rather these characteristics are expected to affect the occurrence of traumatic injuries, such as stress reactions. Based upon de Moya's[52] finding that the hot weather boot has impact and energy absorption properties that are inferior to those of the black leather boot, differences between the two types of boots in the rates of occurrence of traumatic disorders would not have been unexpected. However, such differences were not obtained in this study.

The results pertaining to sick call attendance and sick call disposition revealed that the effects of footwear extended beyond the few differences found in the incidences of specific lower extremity disorders. Particularly in the case of the Nongraduates, those recruits who did not complete training with their original battalions, the hot weather boots were associated with a higher proportion of trainees being placed on restricted duty than were the black leather boots. Although statistically significant differences were not obtained, the percentage of individuals receiving medical discharges for lower extremity disorders was also higher in the hot weather than in the black leather boot group. The two footwear groups were similar with regard to the mean number of sick call visits made and the mean number of days spent on restricted duty status for foot and leg problems. If these measures are an indication of the severity of disorders, then the disorders incurred by trainees using hot weather boots were no more severe than those experienced by trainees wearing black leather boots.

To summarize the findings on the relationship between footwear and foot and leg problems, boots made over the same last, but differing in impact properties, materials, and design features, did differentially affect the occurrence of lower extremity disorders. However, few disorders were affected by the type of boot worn. Of the two types of boots included in this study, the black leather appears to be the better boot to use in a recruit training environment since it was associated with lower frequencies of some disorders and lower sick call and restricted duty rates than the hot weather boot was.

Effects of Gender

The data of the men and the women who participated in this study revealed similar trends with regard to footwear effects. On the other hand, the analyses performed to assess the impact of gender on lower extremity disorders yielded extensive differences between the men and the women in frequencies of occurrence of foot and leg problems, utilization rates of medical facilities, and time spent on restricted duty status. The men and the women also differed in the lower extremity characteristics they exhibited before basic training began.

According to the information acquired during the first foot examination of test participants, a significantly higher proportion of men than women had sustained ankle fractures or sprains before entering the military. In addition, cases of tinea pedis were found among the men, but not among the women. The men also had a somewhat higher incidence of ingrown nails, pes planus, and pes cavus than the women did. On the other hand, a significantly higher percentage of women than men had bunions, callouses, and hallux valgus. Subtalar pronation syndrome and corns were also somewhat more common among the women than among the men. These findings are in accord with the American Podiatry Association's report[2,3] that corns, callouses, and bunions occur more frequently in women than in the population at large.

The differences between men and women in morbidity for some of the disorders identified during the first foot examination were maintained over the course of basic training. During the eight-week cycle, a slightly higher percentage of women than men attended sick call seeking medical attention for corns, callouses, and bunions. The combined foot examination and sick call data also revealed that these problems were more prevalent among the women than the men. According to the combined foot examination and sick call data, tinea pedis and ingrown nails continued to be diagnosed somewhat more frequently in men than women during training. However, approximately equal proportions of men and women made sick call visits for ingrown nails and a somewhat higher proportion of women than men attended sick call for tinea pedis. The findings from the first foot examination that a history of ankle fracture or sprain, pes cavus, and pes planus were more commonly associated with the men than the women were not reflected in their subsequent medical problems insofar as significantly higher proportions of women than men incurred ankle sprains and reported experiencing pes cavus or pes planus pain during training.

A significantly higher percentage of women than men who participated in this study were discharged from military service because of a lower extremity problem. Among those who did not complete training with their original battalions, approximately 4% of the men and double that percentage of women were released because of disorders of the lower extremities.

Also, a significantly higher proportion of women than men attended sick call at least once during basic training for lower extremity complaints. This difference between the men and the women is in accord with health surveys which have found higher rates of utilization of medical facilities by women than by men.[45,46,47] However, the data from the present study reveal that, in addition to the potent effect of gender, the use of medical facilities in this basic training situation was related to training outcome. That is, whether or not individuals completed training with their original battalions.

Among the Graduates, those recruits who did complete training within their original battalions, approximately 21% of the men and 41% of the women made at least one sick call visit for a lower extremity problem. The men Nongraduates, those individuals who were discharged from military service or transferred from their original battalions, had an attendance rate of 42%, approximately equal to that of the women Graduates. The rate for the women Nongraduates was highest; approximately 49% of them attended sick call for foot or leg complaints.

Examination of the data pertaining to duty restrictions for lower extremity disorders revealed similar relationships among the men and women Graduates and Nongraduates. Approximately 9% of the men Graduates and 21% of the women Graduates were placed on restricted duty for such disorders. The figure of 24% for the men Nongraduates again approximated that for the women Graduates. The women Nongraduates had the highest restricted duty rate of 28%.

These data indicate that, although gender has a significant effect on sick call attendance and training restrictions for lower extremity disorders, training outcome is a potent variable as well. From the results of this study, it would appear that men Graduates have the lowest sick call attendance and restricted duty rates for lower extremity problems and women Nongraduates have the highest, with the rates for women Graduates and men Nongraduates being approximately equal to each other and between these two extremes.

The similarities between the women Graduates and the men Nongraduates did not extend to the rates at which they were returned to regular duties, without restriction, after having reported to sick call for a lower extremity complaint. Approximately 18% of the men Nongraduates vs. 26% of the women Graduates were judged, on at least one occasion, to be fit to continue participation in all training activities. The figure for the women Nongraduates was 28%. At 13%, the men Graduates represented the lowest proportion of participants returned to regular duty without restriction. Therefore, regardless of training outcome, women were more likely than men to be found fit for duty after having reported to sick call with a lower extremity complaint.

The number of times the test participants were returned to duty without restrictions was tallied and analyzed in an attempt to have some index of the respective approaches of men and women to medical service utilization. The assumption made is that individuals returned to regular training activities after reporting for sick call had problems of such a minor nature that restricted duty for convalescence was not indicated. The validity of the assumption is

open to debate given the number of variables that could have influenced the actions of the trainees who sought health care and the medical personnel who provided it. However, insofar as returns to unrestricted duty do reflect the trainees' illness behavior, the results of the present study support those of previous investigations which have found that women report more symptoms of illness than men do and make greater use of health services.[45,46,48,49]

Review of the particular types of disorders incurred by the test participants over the course of basic training reveals that there were some differences between the men and the women in the nature of their disorders. Of the 27 disorders that occurred among at least three participants, ganglionic cysts and water retention were diagnosed only among the women and together accounted for approximately 3% of their sick call visits and 2% of their restricted duty time. Instances of osteochondritis dessicans and Osgood Schlatter's disease were limited to the men. Slightly over 3% of the men's sick calls and 10% of their restricted days were attributable to these two disorders combined. Of the four gender-specific disorders mentioned here, only osteochondritis dessicans was associated with medical discharge. Three of the nine men discharged because of lower extremity problems suffered from this disorder.

The other foot and leg problems diagnosed in three or more test participants were experienced by both men and women. However, the frequencies of occurrence of many of these disorders were significantly affected by the gender of the test participants. In each instance in which a statistically significant difference was obtained, the proportion of women diagnosed for the disorder was higher than the proportion of men. This relationship between the men and the women was found for the combined foot examination and sick call data, as well as for the sick call data alone. The lower extremity problems identified more frequently among the women than among the men ranged from callouses, plantar fascial strain, and pes cavus pain, disorders associated with relatively few sick call visits and restricted duty days, to calcaneal stress reactions and ankle sprains, disorders for which test participants were hospitalized or otherwise restricted in their activities for an extensive period of time. Possible reasons that many of the lower extremity disorders were incurred by a significantly higher proportion of the women than the men will be explored below. This entails an examination of the study findings in light of the literature pertaining to the etiologies of the disorders. The etiologies are complex and there is rarely a single cause that can be ascribed to a particular disorder. As a result, there are a number of possible explanations associated with each disorder for the higher morbidity of the women relative to the men.

Analyses of the diagnoses made at sick calls revealed that the rates of occurrence of 12 disorders were significantly higher among the women than among the men. However, for six of these disorders, blisters, callouses, lace lesions, chondromalacia patellae, lateral ankle sprains, and plantar fascial strain, a higher proportion of men than women were put on restricted duty status. To the extent that restricted duty is an index of the severity of a disorder, it can be said that some lower extremity problems that occurred more frequently among women than men were experienced in a milder form by the women than the men.

Blisters, pes planus pain, and chondromalacia patellae were three of the disorders that had significantly higher incidences in women than men. Of all the disorders identified among

the men during sick calls, these three were the most prevalent, occurring at rates of approximately 1.5%. The incidence rates of all other disorders identified among the men in the course of sick calls were less than 1%. Blisters, pes planus pain, and chondromalacia were also among those disorders diagnosed most frequently in women. The sick call data for the women revealed incidence rates of 3% to 5%. Blisters and pes planus pain were associated with relatively low proportions of the men's and the women's restricted days. Blisters accounted for approximately 9% of the men's and 2% of the women's restricted duty, while pes planus pain accounted for 1.5% of the men's and less than 1% of the women's restricted time. However, 28% of the men's and 15% of the women's restricted duty days were attributable to chondromalacia patellae. Thus, of these three, frequently-occurring, lower extremity problems, chondromalacia had the most negative impact in terms of time lost from training.

It has been found that the incidence of chondromalacia patellae among women in the civilian population is twice that among men.[55] In the present study, the proportion of women diagnosed for the disorder was also twice the proportion of men. The etiology of chondromalacia patellae involves a combination of factors, including trauma to the knee, anatomical variations that affect the patellofemoral joint, kneeling and squatting movements, and lack of physical activity.[55] There is no definitive explanation for the higher morbidity of women. However, the finding is in consonance with research reporting lower fitness levels among women than men and anatomical differences between the sexes resulting in poorer running mechanics in women than men.[30,33,34]

According to the work of Jagoda, Madden, and Hinson,[11] physical conditioning also has an influence on the development of blisters, another of the three, frequently-diagnosed disorders. If, as has been reported for women in the population at large,[30,33,34] the women in this study were less fit than the men, it would be expected that the incidence of blisters would be higher among the women than among the men. Footwear is another factor which could be contributing to the difference between the sexes in the rate of occurrence of blisters. The fit of the boots, the fit of the socks, and the type of shoes worn prior to entering the military are all possible elements in the development of blisters. Given the styles of footwear in fashion today, it seems likely that a higher proportion of the men than the women had regularly worn enclosed shoes before beginning training. Thus, it is possible that the men's feet may have been in a better condition to accept the boots. The wearing of socks that are too large and, as a result, bunch up in the toe or heel areas could contribute to frictional forces within the footwear and to the development of blisters. The socks issued to trainees for wear with boots are available in six sizes. Blistering may have resulted if care was not taken to insure that the women with smaller feet received the smaller sizes of socks.

As to blisters and the boots themselves, a bad fit could be due to the issuing of an improper size to an individual or to the incompatibility of the form of the boot last with that of the foot. Since only one last was used in the present study, it is impossible to project the effects

[55] J. Levine. Chondromalacia patellae. **The Physician and Sportsmedicine**, 7, 41–49, 1979.

that lasts of various types may have had on the formation of blisters among the trainees. However, from comparison of the black leather with the hot weather boot, it was determined that the frequency of blisters can vary as a function of boot design and material parameters even when the last is held constant. The proportion of women wearing hot weather boots who attended sick call for blisters was approximately 3% greater than the proportion of women using black leather boots who did. The sick call data also revealed that the rate of occurrence of blisters among the women exceeded that among the men by this same percentage. The possibility that the dimensions of the boot, as determined by the last, influenced blister formation among the women cannot be ruled out on the basis of these data. However, it can be stated that the difference in the incidence rate of blisters between women wearing the leather boot and those wearing the hot weather boot, two types of boots made over the same last, was equal to the difference in the incidence rate of blisters between the men and the women in this study.

It was mentioned that a higher proportion of women than men may have been issued boots in the wrong size and, as a result, blisters may have been more prevalent among the women than the men. The data do not support this inasfar as the percentages of men and women who reported boot-fit problems over the course of training were approximately equal. It could be that the women were more naive than the men in terms of experience with boots or enclosed shoes in general and, thus, were less aware of whether the boots they were wearing were the best size for them.

Pes planus pain, another of the more prevalent disorders among both sexes, has been categorized as an overuse injury.[56] Other disorders of this type that occurred among the test participants are pes cavus pain, plantar fascial strain, and shin splints. All of these disorders were diagnosed significantly more frequently among the women than among the men in this study. According to Eggold,[56] overuse injuries are reactions to stress that result in microtrauma to tissues. With regard to their etiologies, these disorders have been ascribed to a combination of poor physical conditioning, heavy regimens of physical exercise, and abnormal physical characteristics of the feet.[57,58] It also appears from the data of the present study that the overuse injuries experienced by the test participants were not due to the physical characteristics of their feet alone, but rather to a combination of factors. The Exam 1 data indicated that a somewhat higher proportion of the men than the women had a cavus or a planus foot. If arch pain during training was related exclusively to the presence of one or the other of these structural characteristics, the percentage of men diagnosed for pain associated with pes planus or pes cavus would be expected to be equal to or greater than the percentage of women diagnosed for either of these conditions. That this was not the case may be a reflection of the influences that level of physical fitness and severity of exercise regimen had on the

[56] J.F. Eggold. Orthotics in the prevention of runners' overuse injuries. **The Physician and Sportsmedicine, 9,** 125–131, 1981.

[57] D.W. Jackson. Shinsplints: An update. **The Physician and Sportsmedicine, 6,** 51–61, 1978.

[58] S.G. Newell and S.J. Miller. Conservative treatment of plantar fascial strain. **The Physician and Sportsmedicine, 5,** 68–73, 1977.

development of symptoms of overuse. Based upon past research in which the physical conditioning levels of the sexes were compared,[30,33,34] it seems probable that the men in this study were, as a group, more fit than the women. If this were the case, the men should have been better able than the women to undergo the physical training regimen without incurring overuse injuries.

It was mentioned previously that, of all the disorders diagnosed among the men during sick calls, blisters, chondromalacia, and pes planus pain were the only ones with incidence rates of over 1%. These three disorders were also prevalent among the women; the sick call data revealed that the disorders' rates of occurrence were between 3% and 5%. Another problem occurring frequently among the women was a calcaneal stress reaction. Approximately 4% of the women in this study were diagnosed for this disorder at sick call vs. .24% of the men. The difference between the sexes in the rates of occurrence of this disorder was significant. Calcaneal stress reactions were also associated with 28% of the women's restricted duty days and 3% of the men's. This disorder was responsible for the highest proportion of restricted time attributable to any single disorder which the women incurred. The women developed stress reactions of the metatarsals and the tibia as well, but the calcaneus was the most common site. In their study of enlisted personnel undergoing Army training, Reinker and Ozburne[28] also found that women incurred more stress reactions of this bone than of others.

Investigations of lower extremity disorders developed by men in military training revealed that stress injuries of the calcaneus were more prevalent among Marine recruits than among Army or Navy recruits.[15,16] Gilbert and Johnson[16] attributed this to the fact that, unlike the other services, the Marines used a march pattern of "digging in the heels" to effect sharp cadence. The Army's drill is based upon a 30-in. march step. Given that women are, on the average, shorter in stature and leg length than men, and thus have a shorter stride length, it appears that women would be more likely than men to display an emphasized heel strike as they execute the relatively long, 30-in. march step. If this is the case, the expected result would be similar to the Marine Corps finding, a prevalence of calcaneal stress injuries.

The rates of occurrence of metatarsal stress reactions were substantially lower than those of the calcaneus. The sick call data revealed that 1.69% of the women and .05% of the men were diagnosed for stress injuries of the metatarsals. This difference between the sexes was significant. The proportions of restricted duty time attributable to stress reactions of the metatarsals were also lower than the proportions associated with stress reactions of the calcaneus. The former accounted for approximately 8% of the women's restricted duty days and none of the men's.

Tibial injury was the only stress reaction for which a significant difference between the sexes was not found. According to the sick call data, tibial stress reactions occurred in .34% of the men and .62% of the women. Stress reactions of the tibia had a relatively greater impact on the men's than on the women's training to the extent that approximately 11% of the men's vs. 4% of the women's restricted duty days were due to this injury.

Although, based upon the sick call data, stress reactions of the tibia, the metatarsals, and the calcaneus combined had an incidence rate of only .63% among the men, approximately

14% of the men's restricted duty days were attributable to stress injuries at these three sites. For the women, the combined incidence rate for stress reactions of the tibia, the metatarsals, and the calcaneus was 6.25% and these stress reactions represented 40% of their restricted duty days. Thus, for both men and women, stress reactions resulted in substantial losses of training time.

In light of the results of other research in which the frequencies of lower extremity disorders developed by men and women in military training have been compared,[27,28] the higher rate of occurrence of stress reactions among the women in this study than among the men is not an unexpected finding. The prevalence of stress reactions among the women could be linked to their body builds or physical conditioning levels. Gilbert and Johnson[16] found that such injuries were more common in individuals who were obese or poorly conditioned and a number of studies have revealed that women, in general, are less fit physically than men and have lower ratios of muscle to adipose tissue.[30,32,33,34] Thus, it appears that women are at greater risk than men to stress injuries.

Although less physically fit and obese individuals may be more susceptible than others to stress injuries, the question arises as to which elements in the military environment actually precipitate the stress reactions. Scully and Besterman[21] linked them to muscle fatigue induced by the recruits' extreme physical activity and to limitations on joint mobility imposed by the wearing of boots. Undoubtedly, the test participants were exposed to a training regimen which of itself was physically stressful. Also, in accordance with standard Army basic training procedures, they wore boots for all events, including physical readiness training in which running was emphasized. Therefore, the test participants could very well have experienced the muscle fatigue and limited joint mobility which Scully and Besterman[21] associated with stress reactions.

An investigation by de Moya[52] of the physical properties of Army boots yielded some specific information on the contribution that boots may make to muscle fatigue and the effects of the limitations boots place on joint mobility. de Moya found that Army boots do not provide the levels of shock absorption and impact protection found in commercially-available running shoes. In addition, the lack of elasticity of the boot's sole material relative to those in running shoes results in a greater energy loss during impact of a runner's foot on the ground. The greater the energy loss, the more internal energy runners must use to make up the deficiency, and this accelerates muscle fatigue. de Moya also compared the flexibility of the boot soles with that of running shoe soles and found the latter to be significantly more flexible. He hypothesized that the boot's inflexibility may cause the foot to strike the ground in a manner which alters the pattern of forces on the foot relative to that experienced when running shoes are worn.

The fact that stress reactions occurring among male recruits account for a substantial portion of their time lost from training has been documented in this study as well as in earlier studies.[16,18,19] In recent research on lower extremity disorders evidenced during military training, it has been found that women are more likely than men to incur stress reactions.[27,28] The present study substantiated this and also revealed that the proportion of time the women spent on restricted duty for stress reactions was three times greater than that spent by the

men. All of this leads to the conclusion that measures should be taken to lower the morbidity of both men and women for stress reactions of the lower extremities. One approach to accomplish this end is suggested by de Moya's[52] work. That is the use of running shoes, instead of boots, during physical fitness runs. A further decrease in the incidence of stress reactions might well be achieved by improving the cushioning and shock-absorbing properties of the boots and thereby diminishing the magnitude of the forces to which the feet and legs are subjected during drilling and marching. This could be done by adding a midsole to the boot which is made of a material chosen for its energy absorbing characteristics, such as foam. In addition, the ventilating insoles could be replaced by insoles of a material selected for its cushioning, as well as its sweat-absorbing and frictional, properties.

As was the case with stress reactions of the bones of the foot and lower leg, relatively high proportions of both the men's and the women's restricted duty days were associated with lateral ankle sprains. Approximately 16% of the men's and 25% of the women's training restrictions were attributable to this disorder. A significantly higher proportion of the women than the men were diagnosed for lateral ankle sprains, a finding in consonance with those of other studies of lower extremity disorders among men and women in military training.[26,28]

An ankle sprain is one of the more common injuries associated with sports participation and has been linked to ground surface characteristics, footwear characteristics, and muscle flexibility.[59] If an individual walks or runs on rough, uneven ground, an ankle sprain could very well result. However, it does not appear that ground surface characteristics alone could account for the finding that a higher proportion of women than men in this study were diagnosed for sprained ankles since the men and the women trained together in the same areas.

The footwear characteristics cited by Walsh and Blackburn[59] as affecting the incidence of ankle sprains are those that control lateral movement of the rear of the foot. The characteristics include the stiffness of the heel counter, the width of the heel base of the footwear, the compressibility of the materials comprising the rear portion of the footwear, and the fit of the footwear in the heel and ankle areas. Each of these elements can affect the stability of the foot and, thus, the joint motion at the tibiotalar surface. Since the men and the women in this study wore the same boots, it would appear that the footwear characteristics that could have resulted in a higher incidence of ankle sprains among the women than among the men would be limited to differences in the fit of the boots in the heel and ankle areas.

Regression equations derived from anthropometric surveys of large samples of Army men and women reveal that, given equal foot lengths, foot breadths, or heel breadths, the heel-ankle circumferences of men are predicted to be, on the average, at least 1 cm greater than those

[59]W.M. Walsh and T. Blackburn. Prevention of ankle sprains. American Journal of Sportsmedicine, 5, 243–245, 1977.

of women.[42,43,44] These predicted relationships indicate that women could be fitted in boots properly accommodating the various length and breadth dimensions of the feet, but not the girth. The result could be a looser fit for the women in the heel-ankle area than would be found among men with similar foot length and breadth dimensions.

It is possible that such differences in the fit of the boots on the men and the women did exist and did influence the rates of occurrence of ankle sprains. However, findings related to the incidence of lateral ankle sprains as a function of the type of boot worn by the women indicate that footwear fit, insofar as it is determined by the last, may not be the potent variable affecting the occurrence of this disorder. According to the sick call data, the proportion of women wearing black leather boots who experienced lateral ankle sprains was 1.4% greater than the proportion of women using hot weather boots who were diagnosed for ankle sprains. Again according to the sick call data, the percentage of all women in this study who incurred ankle sprains was 1.5% greater than the percentage of men. Thus, the difference in the incidence rate of ankle sprains between women wearing the leather boot and those wearing the hot weather boot, boots made over the same last, but differing in other characteristics, approached the difference in the incidence rate between the man and the women.

The third factor which Walsh and Blackburn[59] implicated in the etiology of ankle sprains was muscle flexibility, specifically tightness of the heel cord. They hypothesized that tight heel cords cause abnormal movement at the ankle joint when the foot is not bearing weight and this leads to instability as the foot strikes or pushes off the ground. A related finding reported by Glick, Gordon, and Nashimoto[60] is that sprains are more likely to occur in individuals having significant talar tilt than in those with a normal relationship between the bones at the ankle. These reports indicate that the level of physical conditioning and the presence or absence of subtalar pronation syndrome may influence the probability of occurrence of ankle sprains. Regarding the data acquired in the present study, the findings from the first foot examination revealed that a somewhat, but not significantly, higher proportion of women than of men evidenced subtalar pronation syndrome. Although no firm conclusions can be made on the basis of these data, it is possible that the presence of this physical characteristic alone or in combination with a lower level of physical conditioning may account for the higher rate of occurrence of ankle sprains in the women than in the men.

The etiology of tendinitis Achilles is not unlike that of lateral ankle sprains insofar as ground surface and footwear characteristics, along with muscle flexibility, have been associated with the occurrence of this disorder.[61] As was also the case with ankle sprains, the proportion of women in this study diagnosed for tendinitis Achilles was significantly higher than the proportion of men.

[60] J.M. Glick, R.B. Gordon, and D. Nashimoto. The prevention and treatment of ankle injuries. **Sports Medicine, 4,** 136–141, 1976.

[61] G.W. Smart, J.E. Taunton and D.B. Clement. Tendon disorders in runners -- A review. **Medicine and Science in Sports and Exercise, 12,** 231–243, 1980.

Because the Achilles tendon connects the gastrocnemius and the soleus muscles to the calcaneus, the flexibility of this musculotendinous unit is a consideration in the etiology of tendinitis. It has been found that sudden increases in physical activity levels or participation in physical activities by relatively sedentary individuals can irritate the Achilles tendon because it and its associated muscles lack flexibility.[61] Results of other research comparing the fitness levels of men and women[30,33,34] would indicate that the women in this study were in poorer physical condition than the men and, therefore, more prone to tendinitis Achilles when exposed to the physically demanding basic training regimen.

A factor which has been implicated in the onset of tendinitis Achilles is not related to the characteristics of a given item of footwear, but rather to differences in the types of footwear an individual may wear. It has been reported that switching among shoes of differing heel heights increases the strain on the Achilles tendon and promotes trauma.[54,61] Given the fashion trends in footwear, it seems likely that at least some women in this study were accustomed to shoes with high heel raises relative to Army boots and that the heels of the shoes commonly worn by the men were lower and closer to the height of the boot heels. Thus, the women to a greater extent than the men may have been at risk for tendinitis Achilles.

The particular footwear characteristics which have been linked with tendinitis Achilles are those that may result in irritation of the sheath of the tendon and subsequent inflammation and degeneration. These include soft heel counters, narrow heel bases, poor fit in the heel and ankle areas, and inflexible soles.[61] In high-topped footwear, like the black leather and hot weather boots, the potential for irritation of the tendon due to the boot's backstay must also be recognized. As was the case with lateral ankle sprains, it appears that footwear characteristics that could be responsible for the higher proportion of cases of Achilles tendinitis among the women in this study than among the men are those associated with the fit of the footwear. A looser fit of the boot on the women than the men in the heel-ankle area could have resulted in less rearfoot stability and a greater likelihood of tendinitis occurring among the women. Consideration of the incidence of tendinitis Achilles as a function of the type of boot worn by the women indicates that footwear fit may not be the prime factor affecting the occurrence of this disorder. According to the sick call data, the proportion of women wearing hot weather boots who were diagnosed for tendinitis Achilles was 1.2% greater than the proportion of women using black leather boots who were diagnosed for this problem. The sick call data also reveal that the percentage of all women in the study who had tendinitis was 1.4% greater than the percentage of men. Thus, the difference in the incidence rate between women wearing the two types of boots approached the difference in the incidence rate between the men and the women.

Some Considerations Related to Decreasing the Occurrence of Lower Extremity Disorders

These discussions of specific lower extremity disorders have been concerned principally with possible causes for the higher rates of occurrence of the disorders among the women relative to the men with whom they underwent Army basic training. This focus on gender-related differences should not belie the fact that the foot and lower leg problems incurred by the men were very costly in terms of time lost from training and utilization of medical

personnel and facilities. Approximately 23% of the men in this study attended sick call seeking medical attention for foot or leg complaints and approximately 11% of all the men lost some time from regular training activities while convalescing from lower extremity disorders. Also, the men who sought treatment of these disorders made, on the average, 1.7 visits to medical facilities and those men whose activities were curtailed spent, on the average, 4.2 days on restricted duty. These figures, coupled with the fact that over 90% of Army personnel are men, emphasize the expense associated with lower extremity disorders that occur among men in Army training. Researchers who have studied foot and leg problems experienced by military men have proposed measures for lowering the incidence of such problems including thorough pre-enlistment screenings, instruction of recruits in foot hygiene, early identification and treatment of disorders, and modification of recruit training programs.[3,5]

These preventive actions should benefit military women as well. However, it is unlikely that their implementation would lower the women's injury rate to the extent that it approximates the men's. This negative projection is based upon consideration of the etiologies of the lower extremity disorders diagnosed in this study. In the course of this discussion, it has been mentioned that these disorders are among those incurred by individuals participating in athletic activities and that, for reasons that appear to be associated with differences in anatomical structure or physical fitness level, women's morbidity is higher than men's.[30,33,35]

Footwear characteristics were among those variables implicated in the etiologies of the lower extremity problems and their role in the relative incidence of these problems in men and women has also been discussed. Both types of boots worn by the participants in this study were manufactured over a last developed from measurements made on men's feet. However, there are findings from the study which suggest that, with regard to the differences between the sexes in rates of occurrence of lower extremity problems, the effects of the fit of the footwear were limited. One of these findings is related to the incidence of lower extremity disorders as a function of use of the hot weather vs. the black leather boot. Although these boots are made over the same last, there were disorders for which the difference in rate of occurrence between the women in the two boot groups approximated the difference in rate of occurrence between the sexes. This suggests that the incidence of at least some lower extremity disorders may be more closely associated with footwear design and material parameters than with differences between men and women in the fit of the footwear. Another finding from this study bearing on the effects of footwear is that the women had a higher incidence than the men of most of the lower extremity disorders diagnosed, including those whose etiologies do not implicate footwear fit.

Although the effects of the fit of the footwear, as determined by the last, cannot be cited as the potent factor underlying the differences between the men and the women in rates of occurrence of lower extremity disorders, the fact remains that the women in this study wore boots made over a last developed for men. This raises the question of whether or not use of a last designed around the dimensions of women's feet would lower the injury rate, number of sick calls, and restricted duty time of women in Army training. The definitive answer to this question would come from a study in which disorders incurred by women wearing boots made over the MIL-5 last are compared to those incurred by women wearing an identical boot made over a last developed to women's foot dimensions. If it is to incorporate data

comparable to that used to establish the MIL–5 system, the development of a women's last would be a costly, long-term effort requiring, as the first step, the acquisition of extensive data on the foot dimensions of a large sample of Army women. The measurements would then have to be converted into a three-dimensional model of the foot and, subsequently, into a series of lasts the dimensions of which vary to reflect relationships among the foot dimensions.

One of the questions that arises in the face of such a large undertaking is whether or not, if the MIL–5 last is retained, changes could be made to the boot which would result in a reduction of lower extremity disorders, sick calls, and duty restrictions among the women. The definitive answer to this question as well would come from further research. However, consideration of the disorders diagnosed in this study and their etiologies indicates that the incidence of stress reactions might well be decreased through the addition to the boot of an energy-absorbing midsole and, possibly, an insole with good cushioning properties. In the present study, 40% of the women's restricted duty days were attributable to stress reactions of the calcaneus, the metatarsals, and the tibia. Therefore, modifications to the boot which would lower the incidence of stress reactions would substantially reduce the loss of training time. A program directed toward making such changes to the boot and assessing their effectiveness in reducing the rate of occurrence of stress reactions offers advantages over an effort to develop a last for women since the former can be accomplished more quickly and should also benefit the male segment of the Army population.

Several findings from this study should be considered in the development of any plans to implement a last for women or to make other changes in the boots. With few exceptions, the types of lower extremity disorders diagnosed among the men in this study were identical to those diagnosed among the women and, although the boots were made over a last developed for men, some 23% of the men in this study attended sick call for foot and leg problems. Thus, a last for women should not be viewed as a panacea. In addition, a range of disorders with differing etiologies was identified among the trainees in this study. No single change in the boots or the last can be expected to reduce the incidence of all of them. Plans to modify the footwear should be directed toward reducing the incidence of disorders which are associated with high frequencies of occurrence and high proportions of time lost from training.

CONCLUSIONS

1. **Sick Call Visits and Disposition.** Approximately 23% of the 2,074 men and 42% of the 767 women who participated in this study attended sick call at least once during their time in basic training seeking medical attention for a lower extremity problem. The regular training activities of approximately 11% of the men and 22% of the women were curtailed for one or more days because of lower extremity disorders. Of the men in this study, .43% received medical discharges because of foot or lower leg problems. The comparable figure for the women is 1.30%. Statistical analyses indicated that significantly higher percentages of the women than the men attended sick call, were restricted in their training activities, and received medical discharges for lower extremity problems.

2. **Previous Disorders.** Examination of the feet and lower legs of the test participants prior to the beginning of basic training revealed that the women had significantly higher incidences of hallux valgus, callouses, and bunions than the men did, while a significantly higher proportion of men than women had previously sustained ankle fractures or sprains.

3. **Disorders Exclusive to Each Sex.** Of 27 types of lower extremity disorders diagnosed over the course of this study, ganglionic cysts and water retention were identified only among the women; osteochondritis dessicans and Osgood Schlatter's disease were identified only among the men. The remaining disorders were experienced by both men and women.

4. **Disorders by Gender.** The highest percentages of the men's sick call visits were made for treatment of blisters, chondromalacia patellae, and pes planus pain. Blisters, chondromalacia patellae, and stress reactions of the calcaneus accounted for the highest proportions of the women's sick call visits. Among the men, the highest proportions of days spent on restricted duty were due to chondromalacia patellae, lateral ankle sprains, and medial tibial flare stress reactions. The highest percentages of the women's restricted duty days were for chondromalacia patellae, lateral ankle sprains, and stress reactions of the calcaneus.

A significantly higher proportion of women than men were diagnosed for blisters, stress reactions of the calcaneus, callouses, lace lesions, metatarsal stress reactions, pes planus pain, chondromalacia patellae, lateral ankle sprains, tendinitis Achilles, shin splints, plantar fascial strain, and pes cavus pain. The largest differences between the sexes were in the rates of occurrence of blisters and stress reactions of the calcaneus. No lower extremity disorders diagnosed in members of both sexes were incurred by a significantly higher proportion of men than women.

5. **Factors in Morbidity by Gender.** Examination of the literature pertaining to the etiologies of the lower extremity disorders diagnosed among the test participants revealed that there are a number of factors which could be associated with the higher morbidity of the women relative to the men. Among these are anatomical structure, physical fitness level, and fit of the footwear.

6. **Disorders by Boot Type.** Comparison of the effects of two types of combat boots on lower extremity disorders revealed higher rates of occurrence of blisters and lace lesions among the men and the women who wore hot weather boots than among those who wore black leather boots. The hot weather boots were also associated with higher sick call and restricted duty rates than were the black leather boots.

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APPENDIX

Descriptions of Lower Extremity Disorders

Cited in Study

ARTHRITIS. Inflammation of the joints.[62] In this study, the term refers to inflammation of the joints of the lower extremities.

BLISTER. A localized collection of fluid between the layers of the skin. A blister may develop from friction on the skin that induces shearing forces between the skin's superficial layer and deeper layers.[7]

BUNION. A localized swelling at the medial or dorsal aspect of the first metatarsal phalangeal joint. A bunion may be associated with hallux valgus, angulation of the great toe toward the other toes.[62]

CALCANEAL STRESS REACTION. See STRESS REACTION and STRESS FRACTURE.

CALLOUS. An area of hardened, thickened skin on the plantar aspect of the foot. A callous is formed through prolonged, recurrent friction and pressure.[63]

CELLULITIS. An acute inflammation which extends along connective tissue planes and across intercellular spaces. There is widespread swelling and redness, without definite localization and with little or no pus formation. Cellulitis is a secondary infection associated with blisters and the presence of staphylococcus aureus. The zone of infection is fiery red, hot, swollen, painful, and extremely tender.[8,64]

CHONDROMALACIA PATELLAE. Softening and degeneration of the cartilage of the knee resulting in rough gliding motion between the surfaces of the patella and the femur. Symptoms include knee pain, swelling, weakness, and locking or buckling of the knee.[65]

CORN. Thickened skin which forms a conical mass extending into the derma. Corns are usually located over the small joints of the toes or between the toes and are caused by external pressure.[66,67]

[62] **Stedman's medical dictionary (23rd Edition).** Baltimore: Williams & Wilkins, 1976.

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DEGENERATIVE JOINT DISEASE. A form of arthritis in which there is degeneration of cartilage.[62] In this study, the term refers to cases in which the lower extremities are involved.

GANGLIONIC CYST. A sac containing fluid which is within fibrous tissue and attached to a tendon sheath in the foot.[62]

HALLUX VALGUS. Angulation of the great toe (hallux) away from the midline of the body, or toward the other toes.[63]

HAMMERTOES. A condition of the toe in which the proximal phalanx (i.e., toe bone closest to the body of the foot) is extremely extended while the distal phalanges are flexed.[63]

INGROWN NAIL. A condition in which adjacent tissue overlaps the nail such that the nail appears to be growing into the flesh. Ingrown nails appear most often on the great toe (hallux). They can be caused by improper cutting of the nails or by footwear that constricts the toes.[68]

INTERNAL DERANGEMENT OF KNEE. Dislocation of cartilages of the knee.[62]

LACE LESION. A friction or pressure lesion on the skin, particularly the anterior ankle area, due to footwear lace or eyelet pressure.[68]

LATERAL ANKLE SPRAIN. A tear in the anterior talofibular ligament of the ankle due to forces associated with plantar flexion and inversion. Symptoms include pain and swelling.[67,69]

LEGG PERTHES DISEASE. A disease involving degeneration of cells at the upper end of the femur and their subsequent formation into coarse, granular material. There is no infection associated with Legg Perthes disease, but rather inadequate circulation.[62]

METATARSALGIA. A term used to indicate a complaint of burning or soreness across the plantar aspects of some or all of the five metatarsal phalangeal joints.[63]

MEDIAL TIBIAL FLARE STRESS REACTION. See STRESS REACTION and STRESS FRACTURE.

METATARSAL STRESS REACTION. See STRESS REACTION and STRESS FRACTURE.

NUMB FEET/TOES. Morbid or abnormal sensation in the feet or toes which is also referred to as paresthesia.[63]

[68] E.H. Roberts. **On your feet.** Emmaus, Pennsylvania: Rodale Press, 1980.

[69] J.S. Cox and R.L. Brand. Evaluation and treatment of lateral ankle sprains. **The Physician and Sportsmedicine, 5,** 51–55, 1977.

OSGOOD SCHLATTER'S DISEASE. A disease involving one or more of the ossification centers of the tibia in the area of the knee joint. There is degeneration of the tibial tuberosity followed by calcification. The disease is accompanied by pain, swelling, and tenderness over the tibial tuberosity.[70]

OSTEOCHONDRITIS DESSICANS. Inflammation of both bone and cartilage resulting in the splitting of pieces of cartilage into the knee joint.[66]

OSTEOMYELITIS. Inflammation of bone marrow and adjacent bone.[62]

PES CAVUS PAIN. Pain in the arch area associated with exaggerated height of the foot's longitudinal arch.[66]

PES PLANUS PAIN. Pain in the arch area associated with depression of the foot's longitudinal arch.[63]

PLANTAR FASCIAL STRAIN. Inflammation and minute tearing of the dense connective tissues on the bottom of the foot which run longitudinally from heel to toes. The tissues are exposed to stretching and to strain when there is excessive pronation in the area of the foot's longitudinal arch. Plantar fascial strain is associated with heel pain and point tenderness in the arch.[58,67]

SESAMOIDITIS. Inflammation of the sesamoid bones, two small, round bones anchored in the tendons upon the plantar surface of the first metatarsal.[62]

SHIN SPLINTS. A general term used to describe pain and discomfort around the anterior portion of the tibia.[62]

STRESS FRACTURE. A partial or complete fracture of the bone. As used in this study, the term indicates cases in which radiological findings are positive. Stress fractures are attributed to rhythmically-repeated, subthreshold, mechanical insult to a bony structure until it weakens and bone destruction occurs. Radiographs may not show destruction until one to four weeks after symptoms first arise. The clinical picture usually includes a history of using a part strenuously for many days, with swelling and point tenderness directly over the bony part involved. The term stress reaction is used in this study to indicate cases in which the clinical symptoms of a stress fracture are present, but positive radiological findings are lacking.[12,16,17]

STRESS REACTION. A suspected stress fracture of a bone. As used in this study, the term indicates situations in which the clinical symptoms of a stress fracture are present, but positive radiological findings are lacking. The sites of the stress reactions diagnosed in this study were the heel (calcaneus), the metatarsals, and the upper portion of the tibia (medial tibial flare).[17]

[70]M.A. Mital and R.A. Matza. Osgood Schlatter's disease: The painful puzzler. **The Physician and Sportsmedicine**, 5, 60–73, 1977.

SUBTALAR PRONATION SYNDROME. Excessive inward movement at the joint between the talus and the calcaneus. This movement forces the leg to rotate inward.[71]

TENDINITIS ACHILLES. The Achilles tendon, in the back of the heel area, connects the gastrocnemius and the soleus muscles of the lower leg to the calcaneus. Traumatic or mechanical irritation of the Achilles tendon or its sheath gives rise to a locally painful, noninfectious inflammation of this area.[61]

TINEA PEDIS. Also referred to as "athlete's foot," this is a superficial fungus infection commonly seen between the toes and on the soles of the feet. It is marked by maceration, cracking, and scaling of the skin, and is accompanied by intense itching.[66]

WATER RETENTION. Swelling of the feet which may be associated with stress fractures.[16]

[71] J. Sammarco. Biomechanics of the ankle. Surface velocity and instant center of rotation in the saggital plane. **American Journal of Sports Medicine**, 5, 231–234, 1977.