ARMY MEDICAL RESEARCH LABORATORY

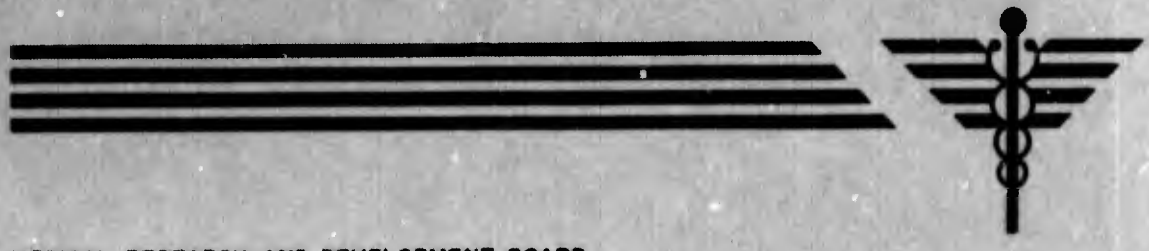
FORT KNOX, KENTUCKY

REPORT NO. 10

Reprinted from
Medical Department Field Research Laboratory
16 September 1947

OBSERVATIONS ON THE RELATION OF HEIGHT OF HEEL AND SUPPORT IN ARCH OF SHOES TO FOOT PHYSIOLOGY IN MARCHING TROOPS[1]

[1]Sub-project under Survey of Foot Measurements and Proper Fit of Army Shoes (MDFRL-53). Approved by CG, ASF, 11 September 1945.



MEDICAL RESEARCH AND DEVELOPMENT BOARD
OFFICE OF THE SURGEON GENERAL
DEPARTMENT OF THE ARMY

REPORT NO. 10

OBSERVATIONS ON THE RELATION OF HEIGHT OF HEEL AND SUPPORT IN ARCH OF SHOES TO FOOT PHYSIOLOGY IN MARCHING TROOPS [1]

by

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from

Medical Department Field Research Laboratory
Fort Knox, Kentucky, 16 September 1947

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Project No. 53-1
MEDEA

16 September 1947

ABSTRACT

OBSERVATIONS ON THE RELATION OF HEIGHT OF HEEL AND SUPPORT IN ARCH OF SHOES TO FOOT PHYSICLOGY IN MARCHING TROOPS

OBJECT

To determine the value to foot health of support in the arch and heel of the feet of marching troops. The control shoes, army service shoe, Type III, and combat boots were compared with experimental shoes with a low heel and with those in which the steel shank support in the longitudinal arch had been removed.

PROCEDURE

Recruits were selected at random on a voluntary basis and observations made during a conditioning period and an experimental period. During both periods the troops were divided into a control and an experimental group and marched up to 13.5 miles a day at 3.2 miles per hour for 5 days each week. For the shankless shoe experiment, the troops wore their own "broken in" army service shoes, Type III, during the conditioning period; during the experimental period half the feet were equipped with standard service shoes, Type III, the other half with the experimental shankless shoe. For the low heel experiment, troops wore their own "broken in" combat boots during the conditioning period; during the experimental period half the feet were equipped with combat boots, the rest with the low heel experimental shoes. Foot lesions were determined twice daily.

RESULTS AND CONCLUSIONS

There was no essential difference between the effect of the control and experimental shoes on the foot health of marching troops as evidenced by the frequency, type, duration, distribution, time of onset, and severity (march time lost due to lesions) of the clinical lesions present.

In the shankless shoe experiment, the superficial lesions constitued 79 per cent of all lesions, the deep lesions 21 per cent; in the low heel experiment, superficial lesions made up 57 per cent of all lesions. The most common lesions were blisters, erythemata, calluses and deep pain. Most lesions were located in the toe, metatarsal, and heel regions.

After the march period, both worn standard service and experimental shankless shoes were somewhat lower in the arch region, with the shankless shoe about 3 per cent lower. The shankless shoe had a considerably greater upward curvature of heel and toe, and a more flexible sole with manual manipulation. This factor gave the shankless shoe a less favorable appearance and possibly had a deleterious effect on the durability of the shoes.

Whether more critical tests will reveal dynamic or static changes in bones and their relationship at the same or greater marching distances remains to be determined.

RECOMMENDATIONS

That further studies in support of the foot by shoes be carried out, testing the other regions of support and their possible combinations.

That these investigations should also include studies of the dynamic foot-shoe relationship using motion picture X-rays.

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OBSERVATIONS ON THE RELATION OF HEIGHT OF HEEL AND SUPPORT IN ARCH OF SHOES TO FOOT PHYSIOLOGY IN MARCHING TROOPS

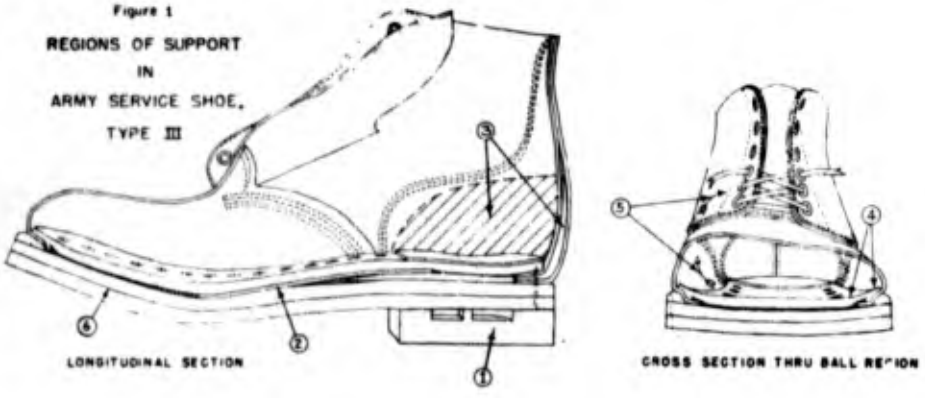
I. INTRODUCTION

Inhabitants of many countries wear some form of foot apparel for supportive and/or protective purposes. However, whether any of the multiple types of footgear favors foot health as compared with a "bare-foot- to-ground" relationship has not been determined.

Different types of shoes vary greatly in the degree of support* given to the foot. In the army standard service shoe for marching and walking purposes (fig. 1), support is usually attained by (1) a heel which raises the posterior part of the foot above the forepart, (2) a shank (leather and/or metal) which elevates the longitudinal arch, (3) a stiff counter which supports the sides of the heel, (4) an upward curvature of the sides of the insole, (5) constriction or "girdling effect" of the lateral and medial aspects of the foot, and (6) sole rigidity.

In World War II, using a shoe of this design, contributions from various agencies indicated that only a small percentage of our soldiers was properly fitted with footgear (7), and it was estimated that possibly 20 per cent of all dispensary visits in the Army were due to foot troubles, many of which were traceable to improperly fitted footgear. Although considerable investigation has concerned itself with the anatomy, physiology, and functional disorders of the feet (1 through 28), little or no specific information is available to determine whether the regional types of support (separately or in combination) indicated above are beneficial to the state of health of the feet of marching troops. Therefore, investigations were undertaken to test the role of support in foot health. The studies were restricted to consideration of the physiological effect of the removal of the shank and of a decrease in heel height of the shoe. These factors were tested by determining their effect on the frequency, type, duration, distribution, and time of onset of clinical foot lesions and on the ability of troops to march.

Figure 1
REGIONS OF SUPPORT IN ARMY SERVICE SHOE, TYPE III



*The term, "support," is here used to indicate any construction characteristic of a shoe which alters the "bare-foot-to-ground" relationship.

II. METHODS AND PROCEDURES

Although the observations on the subjects wearing shankless shoes* and low-heel shoes* were made at different times and on different groups of troops, the methods and procedures were largely similar for both and will be considered together.

Recruits were selected at random on a voluntary basis from Replacement Training Center at Fort Knox, Kentucky, and a medical history and physical examination taken. There were no significant physical disabilities and no past history of disease, injury, or abnormality which might lead to foot troubles. Special note was made of the extent of previous marching or walking, foot complaints and injuries, the clinical foot type (27), presence of fungus infections, and other lesions. All lesions were treated to keep the subjects on the march. Fungus infections were treated with salicylic acid until arrested or cured. Blisters, abrasions, and painful corns were treated with moleskin adhesive plasters, and occasionally blisters were punctured.

Observations were made during a conditioning period and an experimental period. During the conditioning period the subjects were divided into a control and an experimental group and all subjects marched 5 days a week. The daily mileage was gradually increased from 5 to 13.5 miles by 4-day intervals and maintained at the latter distance for the rest of the period. The rate of march was about 3.2 miles per hour (116 thirty-inch steps per minute) with 10-minute rest periods every 50 minutes, and an hour for chow in the field at noon. Foot inspections were made twice daily, immediately preceding the day's march and following a shower and change of shoes at the end of the day's work. Occasional, unannounced inspections were made 5 minutes before or during a march. For each inspection the men were divided alphabetically into three groups which were rotated through three examining medical officers. Careful check was made on foot lesions arising from non-march activities during the evenings and over the week-ends.

The route of march, 13.5 miles in length, was carefully laid as to type of terrain, distance, avoidance of traffic, and facilities for messing in the field. To insure that the men marched under all-weather conditions, three alternate routes were laid out including equal distances of cross-country, hard dirt and gravel, and concrete; all over rolling terrain. The concrete surface was used only twice in each experiment.

For the shankless shoe experiment during the conditioning period, the shoes worn by the troops were their own "broken in" service shoes, Type III, with reversed uppers and composition soles. During this experimental period standard service shoes were worn on both feet by group 1; on the left foot by group 3; on the right foot by group 4; shankless shoes were worn on both feet by group 2; on the right foot by group 3; and on the left foot by group 4.

*Constructed by the Selby Shoe Company, Salem, Massachusetts, under direction of F. M. Gill, Office of the Quartermaster General.

To test the effect of low-heel shoes the troops wore their own "broken in" combat boots during the conditioning period. During the experimental period the new experimental shoe was worn in which the heel height had been lowered by 1/4 inch. To do this it was necessary to construct a special shoe last which corrected for the reduced height of the heel.

In case of shoe misfit (28), at the initial examination before the conditioning period, other acceptable "broken in" standard service shoes or combat boots were substituted. The subjects were told that all shoes worn during the experimental period were identical. In addition to shoes, troops wore cushion sole socks (OD 73531824); HBT trousers, jacket and cap; cotton drawers and undershirt; pistol belt and canteen; but no leggings or pack. Socks were changed and foot powder (No. 12040) used before each day's march. The marching regime, foot inspection, shoe fittings, and supervision were identical in both experiments and in all periods.

The state of foot health was estimated by observing the anatomical location, frequency, and clinical types of foot lesions together with the march time lost because of these lesions. The lesions were recorded as (1) subjective (those felt by subject in his feet), (2) objective (those detected by the examination through observation, palpation, or percussion), (3) superficial (those believed confined to the moveable fleshy parts of the foot, i.e., skin, superficial fascia and fat), and (4) deep (those apparently in the muscles, tendons, ligaments, fascia, periosteum, bones and joints). The differentiation into deep and superficial was determined by the physical findings and/or subjective reactions. The superficial lesions included blisters, calluses, corns abrasions, erythemata, contusions, ingrown nails, and plantar warts. The deep lesions included deep pains*, sprains, and tenosynovitides. The types of foot lesions found were limited to these eleven.

The location of the lesions in the foot and leg (see fig. 2) was arbitrarily divided into 7 convenient anatomical regions: (1) toe, including phalanges and all overlying tissue, (2) metatarsal, including metatarsals and all overlying tissue, (3) tarsal, including tarsals and all overlying tissue but not the calcaneus and talus, (4) heel, including calcaneus and all overlying soft tissue, (5) ankle, including ankle articulation, medial and lateral malleoli and their ligaments, the talus and all overlying tissue, (6) lower leg, including tibia, fibula, and all overlying tissue, (7) knee, including knee articulation, ligaments and all overlying tissue. All instances of joint space involvement were listed as being located in the next proximal region.

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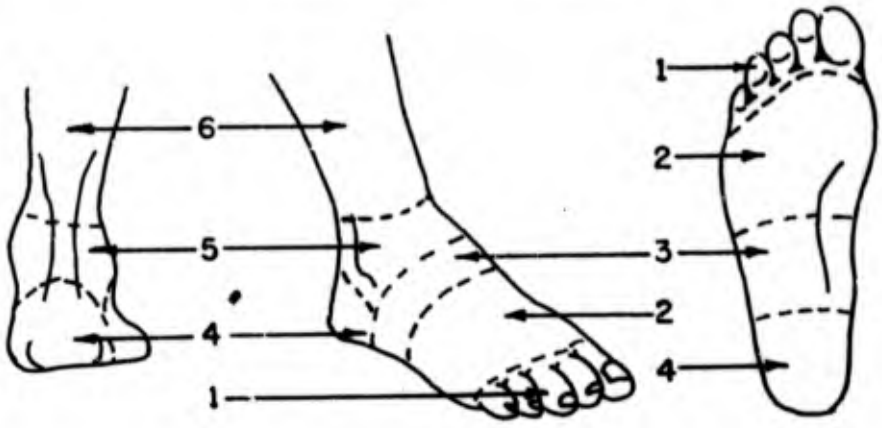
*The term, "deep pain," or "ache," as the investigators use it, refers to an aggregate of lesions consisting of metatarsalgia, digitalgia, talalgia, Morton's syndrome, hypermobility of first metatarsal bone, painful heel (exostoses, osteitis, apophysitis, bursitis, fascitis), hallux rigidus, march fracture, metatarsal arch depression, and prominent scaphoid.

FIG. 2

ANATOMICAL REGIONS



At the end of the experiment in which shankless shoes were used, foot-in-shoe X-rays were taken to determine the relative amount of sag of the foot and shoe in the arch region. To do this, two lines were drawn with 35 per cent barium sulfate in collodion: (1) a skin line along the median plane of the plantar aspect of the foot extending from the heel to the region underlying the head of the third metatarsal, (2) a shoe line following the mid-line of the shoe's inner sole (fig. 3). These two lines, separated only by a cushion sole sock, overlay each other. Measurements (using dividers and an accurate metric scale) were taken of the distance of these lines above the base or ground line. The most posterior point was the notch formed by the front edge of the heel insole. The other three points were selected at 1 cm. intervals in front of this.

X-ray measurements were not considered necessary in the experiment in which low-heel shoes were tested because the difference in heel height was easily demonstrated and measured.

All cases which exhibited symptoms or findings which might have been attributed to march fractures were thoroughly studied, making use of repeated X-rays as well as daily physical examinations. No march fractures were encountered in either experiment.

Throughout the experiments strict military discipline was maintained over the subjects. Except during actual marches neither experimental nor control shoes were worn; low quarter shoes with cotton socks were worn off march. Passes were granted from Friday evening to Sunday evening. A standard army diet of 3500 calories per day was provided; water and salt were taken ad lib. Smoking was permitted at all times except when marching at attention (on concrete roads). A medical officer accompanied each march to insure strict compliance with the conditions of the experiment and to make such medical observations as the experiment required.

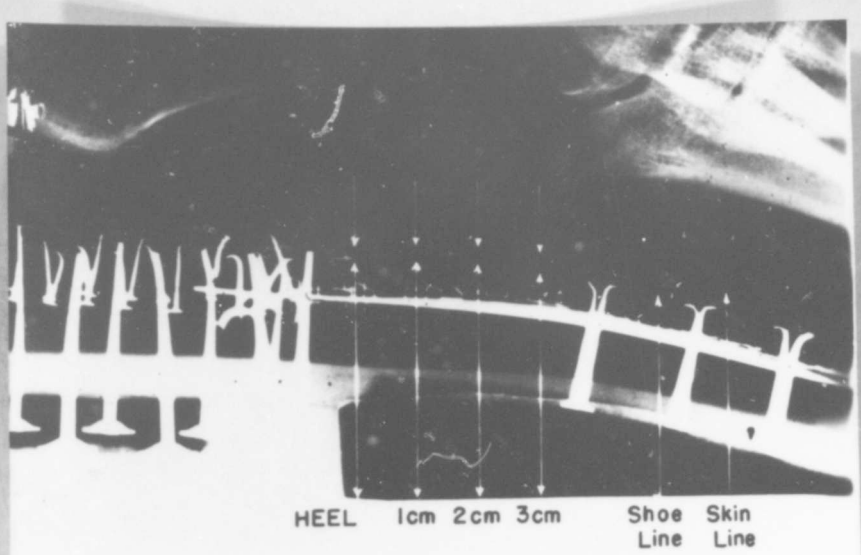


FIG. 3 SAMPLE X RAY STUDY
STANDARD SERVICE SHOE

III. RESULTS

A. Shankless Shoes

The physical data on the troops and the weather encountered are contained in Table 1 and fig. 4. The conditioning period lasted 24 days, the experimental period 34 days. There were 41 feet in the control group, 37 in the experimental group.

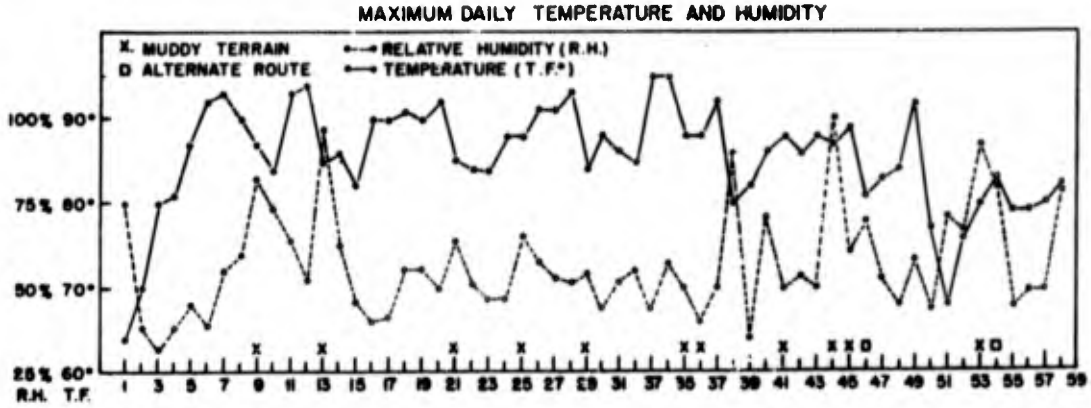
Table 1

Age, Height, and Weight Data

Group	Age (yrs.)		Height (cm.)		Weight (kilo.)	
	Range	Average	Range	Average	Range	Average
1	18-22	18.9	163.7-186.7	175.4	58.4-81.7	68.3
2	18-19	18.1	166.8-177.8	173.1	57.4-82.3	67.6
3	18-19	18.3	161.2-185.2	175.9	57.9-76.2	67.3
4	18-19	18.3	169.1-185.3	176.2	58.5-79.1	65.5
Average	18-22	18.4	161.2-186.7	174.9	57.4-82.3	67.3

FIG. 4

MAXIMUM DAILY TEMPERATURE AND HUMIDITY



1. Initial and final foot inspections. The incidence of the various clinical types of feet is indicated in Table 2. The majority fall in the "normal" group. There were no cases of eversion, inversion, or low arch in either group; i.e., foot types which might need correctional shoes. Initially, clinical and laboratory examination showed epidermophytosis to be present in 87 per cent of the subjects. The initial and final clinical foot inspections revealed relatively few lesions, with blisters, calluses and corns predominant in both groups. Initially, the number of lesions in the control and experimental group was 16 versus 11; finally, 30 versus 28. (For further details see Appendix 1.)

Table 2

Clinical Types of Feet

Type	Control Group	Experimental Group
"Normal"	13	14
Asymmetrical Heel	4	4
Long Toes	2	3
High Arch	-	2
Lean Foot	-	1
Fleshy Foot	-	1

2. New Lesions. Comparison of the two groups in the conditioning and experimental periods is contained in Table 3. In the experimental period as compared to the conditioning period, the new lesions increased in both groups. However, on the basis of new lesions per day and per foot, the relationship of the values for the troops wearing shankless shoes (experimental group) to those for the control group did not differ significantly, either in the individual periods or in the average for both periods. (Further details are in Appendix 1.)

Table 3

Basic Data

	Conditioning Period		Experimental Period		Both Periods	
	C	E	C	E	C	E
Feet	41	37	41	37	82	74
Days	24	24	34	34	58	58
March Days of Lesions	304	189	446	387	750	576
Week-end Days of Lesions	99	63	113	103	212	166
Total Lesion Days	403	252	559	490	962	742
New Lesions	97	79	125	142	222	221
Per Day*	4	3.3	3.7	4.2	3.8	3.8
Per Foot	2.3	1.9	3.0	3.4	2.7	2.7
Av. Duration Days**	4.1	3.5	4.4	3.8	4.2	3.7
Av. Duration Days Per Foot***	7.6	5.1	10.8	10.4	9.1	7.8
Total Lesions	304	198	446	389	750	585
Per Day*	12.7	9.2	13.1	12.6	12.9	11.2
Type, Superficial	77	55	105	110	182	164
Blister	53	41	72	79	125	120
Erythema	10	3.3	21	17.7	31	21
Callus	6	2.2	5	7.8	11	10
Corn	3	3.3	2	1	5	4.4
Rest	5	5.5	5	4.4	10	10
Type, Deep	20	23.3	20	32	40	55
Pain	18	23.3	19	32	37	55
Rest	2	0	1	0	3	0
Type						
Objective	21	16.6	11	12.2		
Subjective	9	10	2	7.8		
Objective and Subjective	67	52	112	122		
Location						
Toe	44	25.5	54	53	98	79
Metatarsal	34	34.3	50	48	84	82
Heel	8	8.9	14	26.6	22	35.5
Rest	11	10	7	14.4	18	24.4

*Calculated in proportion to number of feet in group.
**Based on total lesion days.
***March lesion days divided by feet in group.

Fig. 5A compares the incidence of new lesions from day to day for both groups and periods. There is no essential difference between the experimental and control group curves in either period as to pattern or frequency of lesions. No correlation exists between the times of increase in mileage and the incidence of lesions. During the conditioning period, as the length of march increases from 4.8 to 13.5 miles per day, the number of new lesions per day increases mildly from 0 and 1 in each group on the first day to maximum values of 10 and 8 during the last half of the period, but the final values for each group

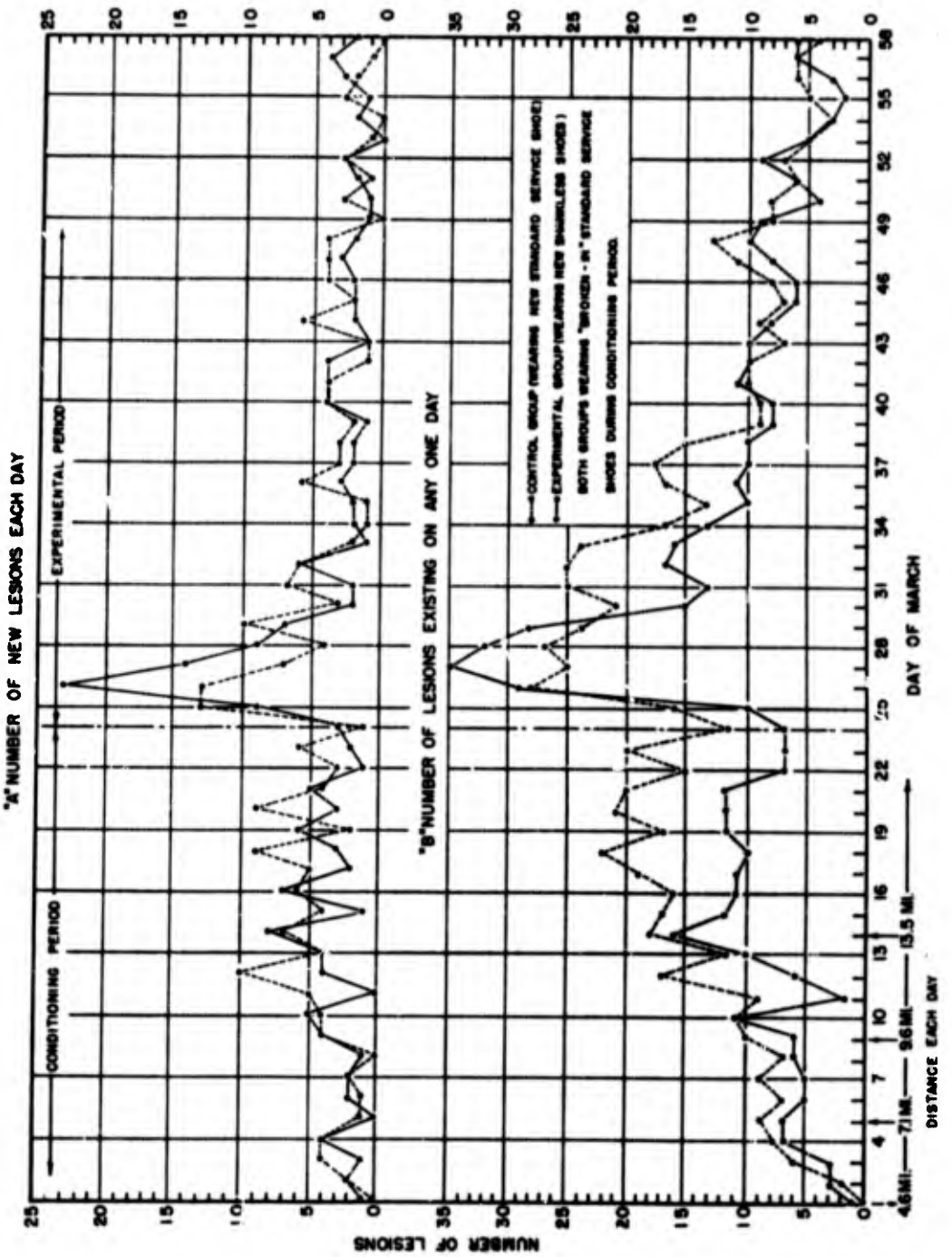

"A" NUMBER OF NEW LESIONS EACH DAY
"B" NUMBER OF LESIONS EXISTING ON ANY ONE DAY
CONDITIONING PERIOD
EXPERIMENTAL PERIOD
NUMBER OF LESIONS
DAY OF MARCH
DISTANCE EACH DAY
4.6 MI.
7.1 MI.
9.6 MI.
13.5 MI.
CONTROL GROUP (WEARING NEW STANDARD SERVICE SHOE)
EXPERIMENTAL GROUP (WEARING NEW SHANKLESS SHOES)
BOTH GROUPS WEARING "BROKEN-IN" STANDARD SERVICE SHOES DURING CONDITIONING PERIOD

FIG. 5

approximate those of the first day. During the experimental period and with a constant mileage per day, the new lesions in each group increase to new high levels with the curve for the experimental group temporarily somewhat higher, but after the fourth experimental day (29th day), the values are well within the range of those obtained during the conditioning period where they remain for the rest of the experimental period. Forty-three per cent of all lesions starting in this 34-day period appeared within the first 5 days.

3. Total Lesions*. Comparison (Table 3) shows that the total lesions and lesions per day in the control group were greater in both periods. However, during the experimental period, the wearing of the shankless shoe increased the number of lesions more than did the use of the new standard service shoe so that the ratio (control/experimental) in this period and the average for both periods decreased mildly as compared to that existing in the conditioning period. (See Appendix 1.)

The curves for the control and experimental groups approximate the same height (except during the last half of the conditioning period), and follow the same general pattern during both periods (Fig. 5 B). Again, there is no correspondence between the changing mileage per day and the number of lesions per day. During the conditioning period the total lesions increase to maximum levels of 10 to 20 at about the 14th day, at which level they are roughly maintained with the group wearing standard service shoes being maintained at the higher level. During the experimental period the lesions in both groups increase to reach a maximum of 25 to 30 per day during the first 5 days, and thereafter fall progressively to values of 5 to 10, approximating the values existing during the early part of the conditioning period.

4. Clinical Types of Lesions. The data on the more frequently occurring types are summarized in Table 4. Superficial lesions predominated in each group during both periods, averaging 79 per cent of all lesions. Blisters and erythema made up 86 per cent (71 and 15, respectively) of all superficial lesions.

Deep lesions made up 21 percent of all lesions. Of these, pain predominated in both groups and periods constituting 97 per cent of the deep lesions.

In the two periods, considered separately or averaged together, the incidence of the more commonly occurring superficial or deep lesions compared favorably in the control versus the experimental group. (See Appendix 1 for details.)

In both groups most of the lesions were a combination of subjective and objective types, and in each period the ratios for the 2 groups were comparable (Table 4).

*These data include all lesions regardless of whether they started in the conditioning or experimental periods.

Table 4

Clinical Nature of Lesions

A. Percentages of Superficial and Deep Lesions

	Conditioning Period				Experimental Period				Both Periods			
	Superficial or Deep Lesions		Total Lesions		Superficial or Deep Lesions		Total Lesions		Superficial or Deep Lesions		Total Lesions	
	C	E	C	E	C	E	C	E	C	E	C	E
Type												
Superficial			79	70			84	77			82	75
Blister	69	74	55	52	68	72	57	55	69	73	56	55
Erythema	13	6	10	4	20	16	17	13	17	13	14	10
Callus	8	4	6	3	5	7	4	5	6	5	5	4
Corn	4	6	3	4	2	1	2	1	3	3	2	3
Rest	6	10	5	7	5	4	4	3	5	6	5	4
Deep			21	30			16	23			18	25
Pain	90	100	19	30	95	100	15	23	92	100	17	25
Rest	10	0	2	0	5	0	1	0	8	0	1	0

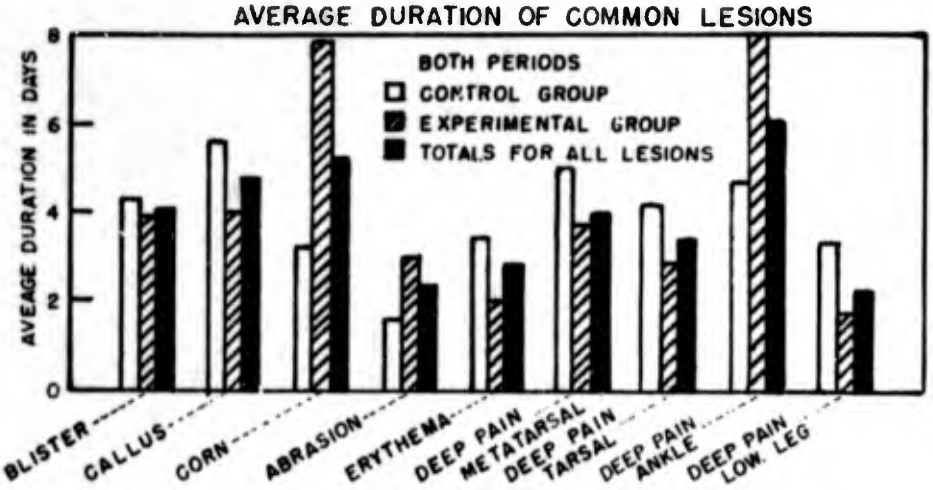
B. Percentages of Objective and Subjective Lesions

	Conditioning Period		Experimental Period	
	C	E	C	E
Type				
Objective	22	21	9	9
Subjective	9	13	2	6
Obj. & Subj.	69	66	89	85

5. Duration of Lesions. The considerable increase during marching of the total number of lesions existing each day is related to the data in Table 3 and fig. 6, showing that the duration of the various lesions was considerable and varied from 2 to 8 days, with the average approximating 4 days. The average duration of lesions in days and the average lesion days per foot increased in both groups during the experimental period, but the ratios of these values were roughly similar in both the conditioning and experimental period. Although, as already indicated, the frequency of the superficial lesions was approximately four times that of the deep lesions, the duration of the deep lesions was in the range of that of the superficial lesions for both periods. Again, for both superficial and deep lesions, there was no essential difference between the values averaged for both periods for the control versus the experimental group.

FIG. 6

AVERAGE DURATION OF COMMON LESIONS



6. Anatomical Location of Lesions. Table 5 gives the distribution of lesions by region and type. Three regions, toe (40%), metatarsal (38%), and heel (13%) contained 91 per cent of all lesions with very little difference in the figures for the different periods and groups considered separately or together. Superficial lesions predominated in all regions; the deep lesions were almost entirely restricted to the metatarsal region. In the toe and heel, 99 and 95 per cent of the lesions were superficial. In the metatarsal region, 72 per cent were superficial; of the deep lesions, 98 per cent were pain. In the above three regions, blisters and erythema made up 87 to 88 per cent of the superficial lesions. (See Appendix 1 for details.)

Table 5

Location of Lesions

	Conditioning Period				Experimental Period				Both Periods			
	Superficial Lesions - %		All Lesions - %		Superficial Lesions - %		All Lesions - %		Superficial Lesions - %		All Lesions - %	
	C	E	C	E	C	E	C	E	C	E	C	E
Toe	100	100	46	32	98	100	43	38	99	100	44	36
Metatarsal	70	58	34	44	72	58	40	34	72	60	38	37
Heel	100	100	8	11	93	92	11	18	95	94	10	16
Rest	9	11	11	13	43	31	6	10	22	23	8	11

7. Time of Appearance of Lesions. Table 6 illustrates the chronological period of the march in which the 3 anatomical regions (containing 90 per cent of all lesions) developed their lesions. During the conditioning period, 57 to 100 per cent of the lesions occurred during the middle third of the period and 70 per cent appeared in the half of the 24-day period, from the 8th-20th day. During the experimental period more lesions appeared earlier, 60 to 80 per cent occurring during the first half of the period and generally more than 50 per cent during the first quarter of the experimental period. In neither period was there evidence that any specific region developed its lesions at a significantly different time than any other region. None of the common superficial or deep lesions developed significantly earlier in one region than another. (See Appendix 2 for details.)

Table 6

Time of Appearance of Lesions

		Conditioning Period (%)			Experimental Period (%)			
Days		1-8	8-16	16-24	1-8	8-16	16-24	24-34
Toe	C	9	73	18	61	20	16	3
	E	22	57	22	50	24	20	6
Metatarsal	C	24	65	12	42	18	26	14
	E	16	71	13	54	9	16	19
Heel	C	0	100	0	43	14	22	21
	E	13	75	12	63	4	12	21
Rest	C	18	46	36	55	0	15	30
	E	22	33	45	61	8	8	23

8. Ability to March. From Table 7 it is apparent that the perecentage loss by march lesions was very small and never exceeded 1.6 per cent. In both periods the loss in the experimental group was somewhat less.

Table 7

Ability to March

	Conditioning Period				Experimental Period			
	Mileage Per Foot*				Mileage Per Foot*			
Group	Planned	Actual	Loss by March Lesions	Loss by Non-March Lesions	Planned	Actual	Loss by March Lesions	Loss by Non-March Lesions
Control	(244) 100	98.6	0.4	1.0	(459) 100	90.5	1.6	7.9
Experimental	(244) 100	98.1	0.03	1.9	(459) 100	89.7	0.4	10.0

*Figures in parentheses indicate distance in miles. All other figures indicate percentage.

9. Effect of Marching on Shoes. Comparison of both types of shoes indicates that the worn shankless had the greater upward curvature of heel and toe.

Table 8 illustrates the effect of marching on the average measurements in the arch region of the shoe (as determined by X-ray). When new, both the standard service type and the shankless shoe approximated 3.3 cm. from shoe line to base (ground) line in the arch region, with the shankless shoe being about 1 mm. lower throughout. The latter can be explained by a relative inadequacy of "leatherboard-heel-seat-filler", and "ground cork filler", used between layers of sole as compensation for thickness of the missing steel shank. After use, both types were depressed in the arch region, but the old shankless shoe dropped somewhat more so that the shoe line in this shoe type was approximately 3 per cent closer to the ground than was that for the standard service shoe. The relationship between shoe and skin line was fairly constant, irrespective of whether the shoe was new, old, standard, or shankless.

Table 8

X-ray Studies

	Base to Sole				Base to Skin				Difference			
Type of Shoe	Heel	1 cm	2 cm	3 cm	Heel	1 cm	2 cm	3 cm	Heel	1 cm	2 cm	3 cm
New Standard	3.57	3.51	3.40	3.21	3.71	3.67	3.56	3.38	0.14	0.16	0.16	0.17
Old Standard	3.37	3.32	3.19	3.01	3.52	3.49	3.37	3.22	0.15	0.17	0.18	0.21
Sag	0.20	0.19	0.21	0.20	0.19	0.18	0.19	0.16	-	-	-	-
New Shankless	3.50	3.44	3.38	3.18	3.66	3.65	3.58	3.43	0.16	0.21	0.20	0.25
Old Shankless	3.21	3.15	3.06	2.90	3.36	3.34	3.29	3.15	0.15	0.19	0.23	0.25
Sag	0.29	0.29	0.32	0.28	0.30	0.31	0.29	0.28	-	-	-	-

III. RESULTS

B. Low Heel Shoes

Forty-one subjects, divided into a control and experimental group, walked for 25 days during a conditioning period followed by a 27-day experimental period at the rates and distances per day indicated in Part A. The recruits had just completed their basic training (8 weeks) at Replacement Training Center, Fort Knox, Kentucky, where they had on occasion walked 11-12 miles per day. The physical data on the men, their feet, and the weather conditions encountered are in Table 9 and fig. 7. The concrete route was used on two days because of the muddy conditions

of the other routes. During the second half of the experiment the temperature averaged considerably less than during the first half.

FIG.7

MAXIMUM DAILY TEMPERATURE AND HUMIDITY

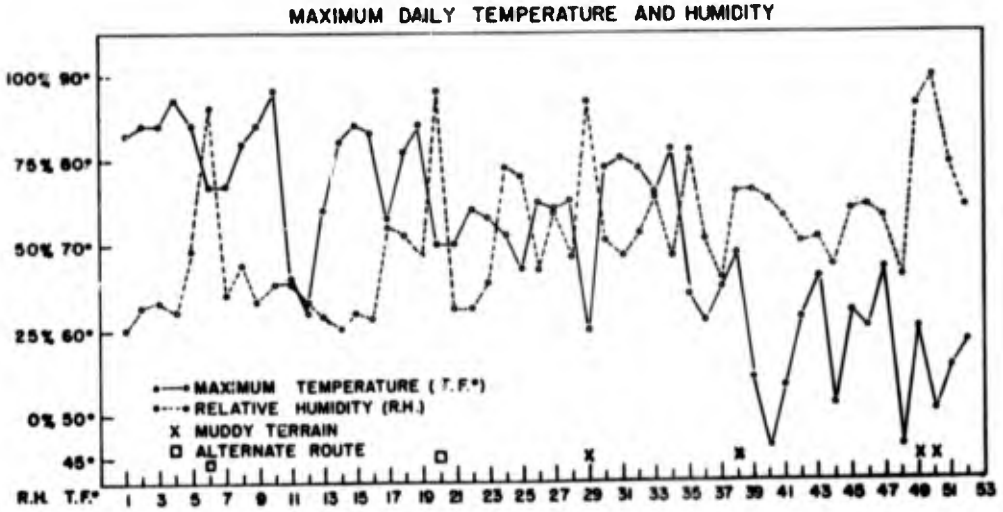


Table 9

Age, Height, and Weight Data

	Age (yrs.)		Height (cm.)		Weight (kilo)	
Group	Range	Average	Range	Average	Range	Average
Control	17-30	19.4	166.5-186.9	171.1	53.9-86.9	70.9
Experi-mental	17-25	20.5	162.1-188.9	176.6	51.2-97.6	70.6

1. Initial and Final Foot Inspection. There were no foot types in need of correctional shoes (Table 10). The initial foot lesions were few and trivial (78 per cent had epidermophytosis). In the final foot inspection there were only 3 lesions in the control group and 4 in the experimental group. All except one (a corn) were deep pains in the metatarsal, heel, and ankle region. (See Appendix 3.)

Table 10

Clinical Types of Feet

Type	Control Grouping	Experimental Grouping
"Normal"	19	17
Low Arch	1	0
Elevation of Toes	0	1
Asymmetrical Heel	0	1
Lean Foot	0	2

2. New Lesions Each Day. During each period the pattern of curves for the control and experimental groups is roughly similar (fig. 8 A). In both groups there are two temporary rises in incidence, a small one on the 10th day when the marching distance was increased to 13.5 miles per day, and a higher peak during the first 3 days of the experimental period (25th-28th day) when the new shoes were first being used. During these 3 days the new lesions averaged 14.3 and 15.6 per day and constituted 51 and 57 per cent, respectively, of all lesions occurring in the experimental period. However, both curves decrease within a few days to approximate the control values.

Table 11

Basic Data

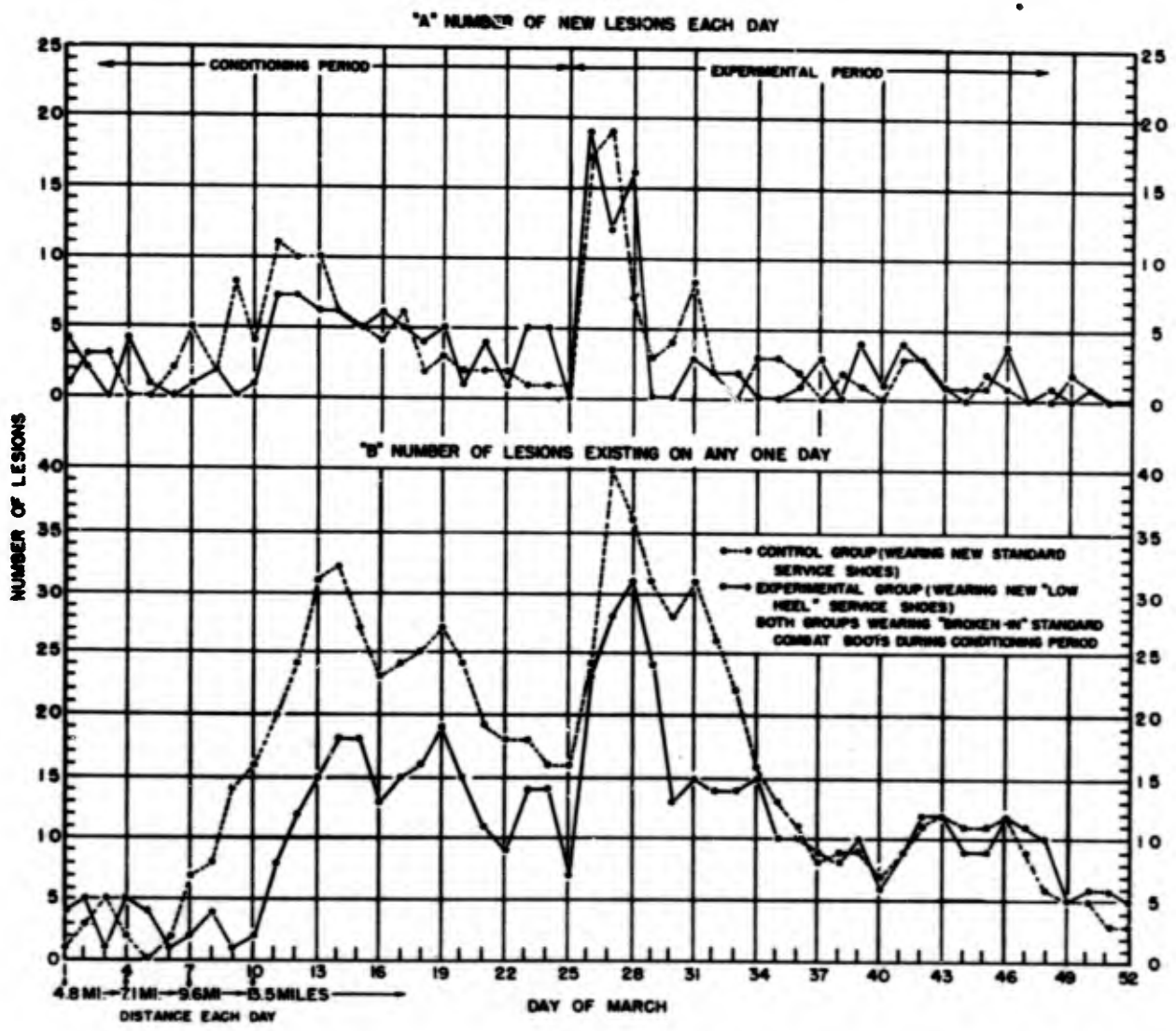
	Conditioning Period		Experimental Period		Both Periods	
	C	E	C	E	C	E
Feet	40	42	40	42	80	84
Days	25	25	27	27	52	52
March Days of Lesions	402	233	409	336	811	569
Week-end Days of Lesions	120	59	106	96	226	155
Total Lesion Days	522	292	515	432	1037	724
New Lesions	94	82	84	82	178	164
Per Day*	3.8	3.1	3.1	2.9	3.4	3.0
Per Foot	2.3	2.0	2.1	2.0	2.2	2.0
Av. Duration Days**	5.5	3.6	6.1	5.3	5.8	4.5
Av. Duration Days Per Foot***	10	5.6	10.2	8.0	10.1	6.8
Total Lesions	402	233	409	336	811	569
Per Day*	16.0	9.3	15.1	11.7	15.6	11.0
Type, Superficial	53	39	50	51	103	90
Blister	38	28	23	12	61	40
Erythema	10	8	17	31	27	39
Callus	1	3	2	5	3	8
Corn	2	0	2	0	4	0
Rest	2	0	6	3	8	3
Type, Deep	41	43	34	31	75	74
Pain	35	37	25	30	60	67
Tenosynovitis	6	6	8	1	14	7
Rest	0	0	1	0	1	0
Type						
Objective	5	2	1	1		
Subjective	3	3	2	6		
Objective and Subjective	74	89	81	75		
Location						
Toe	35	26	23	16	58	42
Metatarsal	39	23	35	28	74	51
Heel	5	12	7	8	12	20
Rest	15	21	19	30	36	51

*Calculated in proportion to number of feet in group.

**Based on total lesion days.

***March lesion days divided by feet in group.

FIG 8


"A" NUMBER OF NEW LESIONS EACH DAY
CONDITIONING PERIOD
EXPERIMENTAL PERIOD
"B" NUMBER OF LESIONS EXISTING ON ANY ONE DAY
NUMBER OF LESIONS
CONTROL GROUP (WEARING NEW STANDARD SERVICE SHOES)
EXPERIMENTAL GROUP (WEARING NEW "LOW HEEL" SERVICE SHOES)
BOTH GROUPS WEARING "BROKEN-IN" STANDARD COMBAT BOOTS DURING CONDITIONING PERIOD
4.8 MI.
7.1 MI.
9.6 MI.
8.5 MILES
DISTANCE EACH DAY
DAY OF MARCH

During each period there was fairly good agreement between the two groups as to new lesions per day or per foot (Table 11).

FIG. 9

AVERAGE DURATION OF COMMON LESIONS

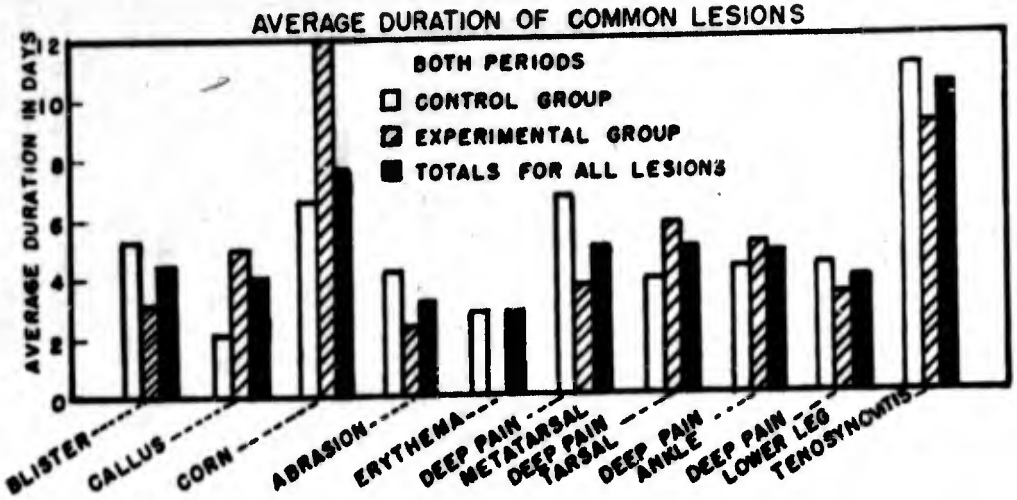


Fig. 9 illustrates that the common superficial and deep lesions lasted from 2 to 12 days with the average approximating 5 days with no great difference between the control and experimental groups. During the conditioning period the lesion days per foot (Table 11) were considerably greater in the control group, but during the experimental period this increased by 43 per cent for the experimental group, as compared to 2 per cent for the control group.

3. Total Number of Lesions Each Day. The curve for the control group (fig. 8 B) is considerably higher (7th-34th day) than that for the experimental group but the patterns of the curves are roughly similar throughout, and elevations of the curves appear at the same times as in Fig. 8 A. There is no definite correspondence between an increase in distance marched per day and the number of lesions per day. Each group had approximately 60 per cent more lesions existing in the first 10 days of the experiment than in the remaining 17 days. During the last 17 days of this period (29 per cent of the total mileage) the experimental group had an average of 8.4 lesions existing per day.

During the conditioning period the lesions per day in the control group were considerably more (16.0 versus 9.3), but this difference decreased considerable during the experimental period (15.1 versus 11.7) largely because of the increase in lesion in the experimental group (Table 11). (See Appendix 3 for details.)

4. Clinical Types of Lesions and Their Frequency. In both groups and periods 57 per cent of the lesions were superficial, 43 per cent were deep (Table 12). The incidence of both the superficial and deep lesions in the control and in the experimental groups compared favorably in both periods.

Of the superficial lesions, blisters (29%), erythema (19%), and the deep lesion, pain (37%), predominated in both periods and groups, and made up 85 per cent of all lesions. Blisters and erythema made up 86 per cent (52 and 34) of all superficial lesions, and deep pain constituted 86 per cent of the deep lesions. (See Appendix 3 for details.)

Table 12

Clinical Nature of Lesions

A. Percentages of Superficial and Deep Lesions

	Conditioning Period				Experimental Period				Both Periods			
	Superficial or Deep Lesions		Total Lesions		Superficial or Deep Lesions		Total Lesions		Superficial or Deep Lesions		Total Lesions	
	C	E	C	E	C	E	C	E	C	E	C	E
Type												
Superficial			56	48			59	62			58	55
Blister	71	72	40	34	46	24	28	15	59	44	35	24
Erythema	19	20	11	10	34	60	20	37	26	44	15	24
Callus	2	8	1	4	4	10	2	6	3	9	2	5
Corn	4	0	2	0	4	0	2	0	4	0	2	0
Rest	4	0	2	0	12	6	7	4	8	3	4	2
Deep			44	52			40	38			42	45
Pain	85	86	37	45	73	97	30	37	80	90	34	41
Tenosynovitis	15	14	7	7	24	3	9	1	19	10	8	4
Rest	0	0	0	0	3	0	1	0	1	0	0	0

B. Percentages of Objective and Subjective Lesions

	Conditioning Period		Experimental Period	
	C	E	C	E
Type				
Objective	6	2	1	1
Subjective	4	3	2	7
Obj. & Subj.	90	95	96	92

5. Anatomical Location of Lesions. The toe (29%), metatarsal (37%), and heel (9%) regions contained 75 per cent of all lesions. For these regions the relative values for the control versus the experimental groups remained fairly constant in both periods (Table 13). Almost all lesions in the toe region were superficial, the values for the periods and groups varying only from 94 to 100 per cent. In the metatarsal and heel regions 54 and 51 per cent, respectively, of the lesions were superficial. During the experimental period the percentage increased for the control group in both regions, while for the experimental group the percentage increased in the heel region and decreased in the metatarsal region. (Further details are in Appendix 3.)

Table 13

Location of Lesions

	Conditioning Period				Experimental Period				Both Periods			
	Superficial Lesions - %		All Lesions -%		Superficial Lesions - %		All Lesions-%		Superficial Lesions - %		All Lesions-%	
	C	E	C	E	C	E	C	E	C	E	C	E
Toe	94	96	37	32	96	100	28	20	95	98	33	26
Metatarsal	51	35	42	28	66	61	42	34	58	47	42	31
Heel	0	42	5	15	29	75	8	10	17	55	6	12
Ankle	0	13	3	10	17	55	14	24	12	43	9	17
Rest	0	0	13	15	15	10	8	12	5	4	10	14

6. Time of Appearance of Lesions by Region and Type. Most of the lesions appeared during the middle half of the conditioning period in both groups, averaging 80 per cent for the control group and 68 per cent for the experimental group (Table 14). During the experimental period 70 per cent and 63 per cent of the lesions in the control and experimental groups, respectively, appeared during the first 7 days. There was no indication that any specific region developed its lesions at a different time from any other region, or that there was a preferential region for early development of the common superficial or deep lesions. (See Appendix 4.)

Table 14

Time of Appearance of Lesions

Days		Conditioning Period (%)			Experimental Period (%)		
		1-5	6-19	19-25	1-7	7-20	20-27
Toe	C	6	89	6	74	26	0
	E	19	46	35	63	32	6
Metatarsal	C	18	72	10	66	29	6
	E	13	74	13	72	18	11
Heel	C	0	100	0	70	15	15
	E	8	75	17	63	25	12
Ankle	C	0	100	0	67	25	8
	E	12	75	13	70	25	5
Rest	C	0	89	13	79	16	5
	E	10	72	18	57	40	3

7. Ability to March. As in the experiment in which shankless shoes were worn, the mileage lost by march lesions was quite small in both groups and periods, the average for control and experimental groups being 1.4 per cent versus 1.0 per cent (Table 15).

Table 15

Ability to March

	Conditioning Period				Experimental Period			
	Mileage Per Foot*				Mileage Per Foot*			
Group	Planned	Actual	Loss by March Lesions	Loss by Non-March Lesions	Planned	Actual	Loss by March Lesions	Loss by Non-March Lesions
Control	(280)100	95.9	1.6	2.5	(364.5)100	95.8	1.0	3.2
Experimental	(280)100	97.5	0.8	1.7	(364.5)100	95.2	1.4	3.4

*Figures in parentheses indicate distance in miles. All other figures indicate percentage.

8. Effect of Marching on Shoes. Visual inspection and manipulation of the two shoe types revealed very little difference as to general condition, degree of curvature of heel and toe, and flexibility of shoe.

IV. DISCUSSION

The incidence of tenosynovitis in both groups of the experiment with low-heel shoes deserves explanation. During the conditioning period, each group had 6 cases of traumatic tenosynovitis distributed in the metatarsal, ankle, and lower leg regions. During the experimental period, 8 cases of tenosynovitis occurred in the control group as compared to 1 in the experimental group. These lesions are believed to be caused by the "broken in" combat boots worn during the conditioning period, since (1) the preceding experiment had only one such case, (2) removal of a pressure point from the cuff of the boot caused symptomatic improvement, and (3) most of the lesions in the experimental period represented reactivation of old lesions.

Except for minor differences, the results obtained using shankless shoes and low-heel shoes are similar and will be considered together.

It is believed that the initial period achieved adequate conditioning of the subjects and established their comparability. In this period, the control and experimental groups showed comparable susceptibility to the development of new lesions, and the nature and location of the lesions produced failed to indicate significant differences in the reaction patterns for the two groups. During the last few days of the conditioning period, the declining incidence of specific lesions, together with the daily observation that the subjects no longer showed evidence of

muscular fatigue or soreness either generally or in the legs and feet after marches, indicated that for practical purposes conditioning had been achieved. Therefore, any actual further statistically significant divergence in lesions in the two groups in the experimental period should be attributed to the different principles of support embodied in the two shoes.

The number of new lesions per day and the total lesions existing each day increased considerably in both groups during the first few days of the experimental period. The increments were statistically significant. However, this can be attributed to the "breaking in" process of the stiff new shoes, since each group wearing different shoe types showed this same response and no significant difference existed between the group wearing standard service shoes and those with shankless shoes or with low heels. For the remainder of the experimental period the incidence of lesions in the two groups was roughly similar, the values approximated or were less than those in the latter stages of the conditioning period, and the types and locations of the lesions were essentially the same for the two groups. Finally, there was no significant difference between the effect of the two experimental shoe types on the foot health of the marching troops as evidenced by the type, number, duration, location, and severity of the lesions and the ability of the troops to march.

Therefore, under the conditions of these experiments, the absence of a steel shank in a shoe or the reduction in height of the heel is not deterimental to the health of the feet of marching troops. However, it remains to be determined by how much the shank removal actually affected the support of the feet and whether the tests used for both types of experimental shoes were adequate to determine the state of foot health. As shown by X-ray, although both standard and shankless shoes were somewhat lower in the arch region after the march period, the latter were only about 3 per cent lower than the standard shoe, certainly not a large difference. On the other hand, comparison of both types of shoes indicated the worn shankless type to have a greater upward curvature of the heel and toe, and manual flexing showed that the worn shankless type was appreciably more flexible in the sole and probable less capable of support. However, accurate gauging of this factor is impossible by manual means, and the X-ray measurements are based on a "static shoe" when the subject was standing and cannot be taken as evidence of what takes place in a "shoe in action".

No tests were made to determine what dynamic or static changes, if any, took place in the bones and their relationship in the feet. It is obvious that such changes might well exist and contribute to the pathology of the feet. Therefore, the possibility must be entertained that more critical tests might well reveal significant alterations in the feet at the mileage walked in these experiments, or that considerable prolongation of the mileage per foot might bring to light correlated changes in foot physiology and in the shoes worn as revealed by present or additional tests.

V. CONCLUSIONS

Tests were made of the value to foot health of support in the arch and heel of the feet of marching troops. The control shoes, army service shoe, Type III, and combat boots were compared with experimental shoes with a low heel, and with those in which steel shank support in the longitudinal arch had been removed.

During the first few days of the experimental period, when the shoes were new, the highest incidence rates of lesions were reached for both control and experimental groups.

There was no essential difference between the effect of the control and experimental shoes on the foot health of marching troops as evidenced by the frequency, type, duration, distribution, time of onset, and severity (march time lost due to lesions) of the clinical lesions present.

In the shankless shoe experiment, the superficial lesions constituted 79 per cent of all lesions, the deep lesions 21 per cent; in the low-heel experiment, superficial lesions made up 57 per cent of all lesions. The most common lesions were blisters, erythema, callus, and deep pain. Most lesions were located in the toe, metatarsal, and heel regions.

After the march period, both worn standard service and experimental shankless shoes were somewhat lower in the arch region, with the shankless shoe about 3 per cent lower. The shankless shoe had a considerably greater upward curvature of heel and toe, and a more flexible sole with manual manipulation. This factor gave the shankless shoe a less favorable appearance and possibly had a deleterious effect on the durability of the shoe.

What more critical tests involving dynamic or static changes in bones and their relationship at the same or greater marching distances will reveal, remains to be determined.

VI. RECOMMENDATIONS

That further studies in support be carried out, testing the other regions of support and their possible combinations.

That these investigations should also include studies of the dynamic foot-shoe relationship, using motion picture X-rays.

VII APPENDIX

APPENDIX 1

A. DAILY INCIDENCE AND TYPE OF CLINICAL LESIONS

	Conditioning Period—Control Group	Experimental Period—Control Group	Total
Day of Study	[illegible]	[illegible]	[illegible]
Miles Per Day	[illegible]	[illegible]	[illegible]
Type of Socks	[illegible]	[illegible]	[illegible]
Superficial			
Blister	[illegible]	[illegible]	[illegible]
Erythema	[illegible]	[illegible]	[illegible]
Callus (painful)*	[illegible]	[illegible]	[illegible]
Corn (painful)*	[illegible]	[illegible]	[illegible]
Abrasion	[illegible]	[illegible]	[illegible]
Contusion	[illegible]	[illegible]	[illegible]
Ingrown Nail*	[illegible]	[illegible]	[illegible]
Plantar Wart*	[illegible]	[illegible]	[illegible]
Total	[illegible]	[illegible]	[illegible]
Deep			
Deep Pain	[illegible]	[illegible]	[illegible]
Sprain	[illegible]	[illegible]	[illegible]
Tenosynovitis	[illegible]	[illegible]	[illegible]
Total	[illegible]	[illegible]	[illegible]
Group Total	[illegible]	[illegible]	[illegible]
Total Lesions Per Day	[illegible]	[illegible]	[illegible]

	Conditioning Period—Experimental Group	Experimental Period—Experimental Group	Total
Superficial			
Blister	[illegible]	[illegible]	[illegible]
Erythema	[illegible]	[illegible]	[illegible]
Callus (painful)*	[illegible]	[illegible]	[illegible]
Corn (painful)*	[illegible]	[illegible]	[illegible]
Abrasion	[illegible]	[illegible]	[illegible]
Contusion	[illegible]	[illegible]	[illegible]
Ingrown Nail*	[illegible]	[illegible]	[illegible]
Plantar Wart*	[illegible]	[illegible]	[illegible]
Total	[illegible]	[illegible]	[illegible]
Deep			
Deep Pain	[illegible]	[illegible]	[illegible]
Sprain	[illegible]	[illegible]	[illegible]
Tenosynovitis	[illegible]	[illegible]	[illegible]
Total	[illegible]	[illegible]	[illegible]
Group Total	[illegible]	[illegible]	[illegible]
Total Lesions Per Day	[illegible]	[illegible]	[illegible]

B. INCIDENCE AND LOCATION OF CLINICAL LESIONS

Conditioning Period

Location		Blister C	Blister E	Erythema C	Erythema E	Callus C	Callus E	Corn C	Corn E	Abrasion C	Abrasion E	Contusion C	Contusion E	Ingrown Nail C	Ingrown Nail E	Plantar Wart C	Plantar Wart E	Deep Pain C	Deep Pain E	Sprain C	Sprain E	Tenosynovitis C	Tenosynovitis E	Totals C	Totals E	Totals C&E
Toe I		6	3	1	.	1	.	.	.	2	.	.	.	.	1	.	.	.	.	.	.	.	.	10	6	16
Toe II		16	6	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17	6	23
Toe III		3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	2	5
Toe IV		1	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	3	4
Toe V		8	2	1	.	.	.	3	3	1	1	.	.	.	.	.	.	.	.	.	.	.	.	13	6	19
M.T.I	DH	10	5	4	3	2	.	.	.	.	.	.	.	.	.	1	.	6	6	.	.	.	.	21	14	35
	MS	.	1	.	.	.	.	.	.	.	2	.	.	.	.	.	.	4	2	.	.	.	.	4	5	9
M.T.II	DH	2	5	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	5	9
	MS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0
M.T.III	DH	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	0	2	2
	MS	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	2	.	.	.	.	1	2	3
M.T.IV	DH	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	0	1
	MS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0
M.T.V	DH	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	1	2
	MS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0
2 or more	DH	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	1	2	3
2 or more	MS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	0	1
Tarsal		.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	5	.	.	.	.	4	6	10
Heel		6	5	1	.	1	2	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	8	8	16
Ankle		.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	3	0	3
Lower Leg		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	3	.	.	.	.	3	3	6
Knee		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	0	1
Totals		53	37	10	3	4	2	3	3	4	3	0	1	0	1	1	0	18	21	2	0	0	0	97	71	168

Experimental Period

Location		Blister C	Blister E	Erythema C	Erythema E	Callus C	Callus E	Corn C	Corn E	Abrasion C	Abrasion E	Contusion C	Contusion E	Ingrown Nail C	Ingrown Nail E	Plantar Wart C	Plantar Wart E	Deep Pain C	Deep Pain E	Sprain C	Sprain E	Tenosynovitis C	Tenosynovitis E	Totals C	Totals E	Totals C&E
Toe I		6	3	2	.	2	2	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	11	7	18
Toe II		17	22	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	19	23	42
Toe III		3	1	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	3	8
Toe IV		3	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	4	7
Toe V		13	7	.	2	.	2	1	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	16	11	27
M.T.I	DH	14	9	1	2	1	.	.	.	1	1	.	.	.	.	.	.	3	7	.	.	.	.	24	19	43
	MS	.	.	1	.	.	.	.	.	.	2	.	.	.	.	.	.	2	1	.	.	.	.	3	3	6
M.T.II	DH	4	4	2	.	1	1	.	.	.	.	.	.	.	.	2	.	1	.	.	.	.	.	10	5	15
	MS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	0	1
M.T.III	DH	1	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	0	3
	MS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0
M.T.IV	DH	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	2	2	.	.	.	.	2	4	6
	MS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0
M.T.V	DH	.	1	1	.	.	.	1	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	2	3	5
	MS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	2	0	2
2 or more	DH	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	3	7	.	.	.	.	3	9	12
2 or more	MS	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0	0	0
Tarsal		1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	1	4	.	.	.	.	3	5	8
Heel		10	16	2	4	1	1	.	.	.	1	.	.	.	.	.	.	1	2	.	.	.	.	14	24	38
Ankle		.	1	1	2	.	.	.	.	.	.	.	.	.	.	.	.	1	2	.	.	.	.	2	5	7
Lower Leg		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	3	.	.	.	.	1	3	4
Knee		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	0	1
Totals		70	71	31	16	7	7	2	1	3	4	0	0	0	0	2	0	19	29	0	0	1	0	125	128	253

*Recorded only when symptomatic.

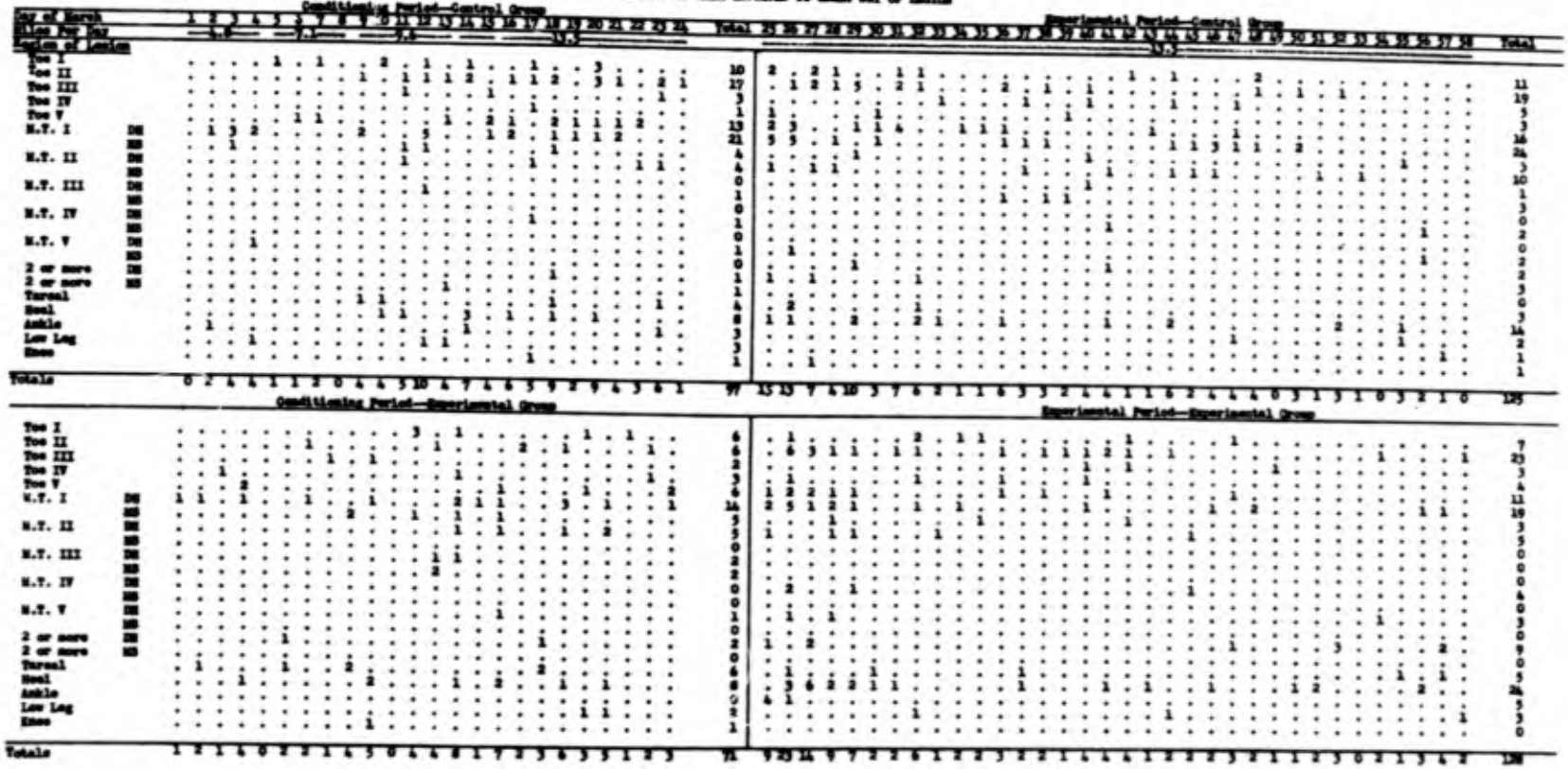
**In addition to the initial (first) lesions indicated here, there were 4 cases of hyperhidrosis and 2 old scars. At the final inspection there were an additional 2 cases of hyperhidrosis and 1 old scar.

DH—Distal Head
MS—Mid-shaft
M.T.—Metatarsal

C—Control Group
E—Experimental Group

APPENDIX 2

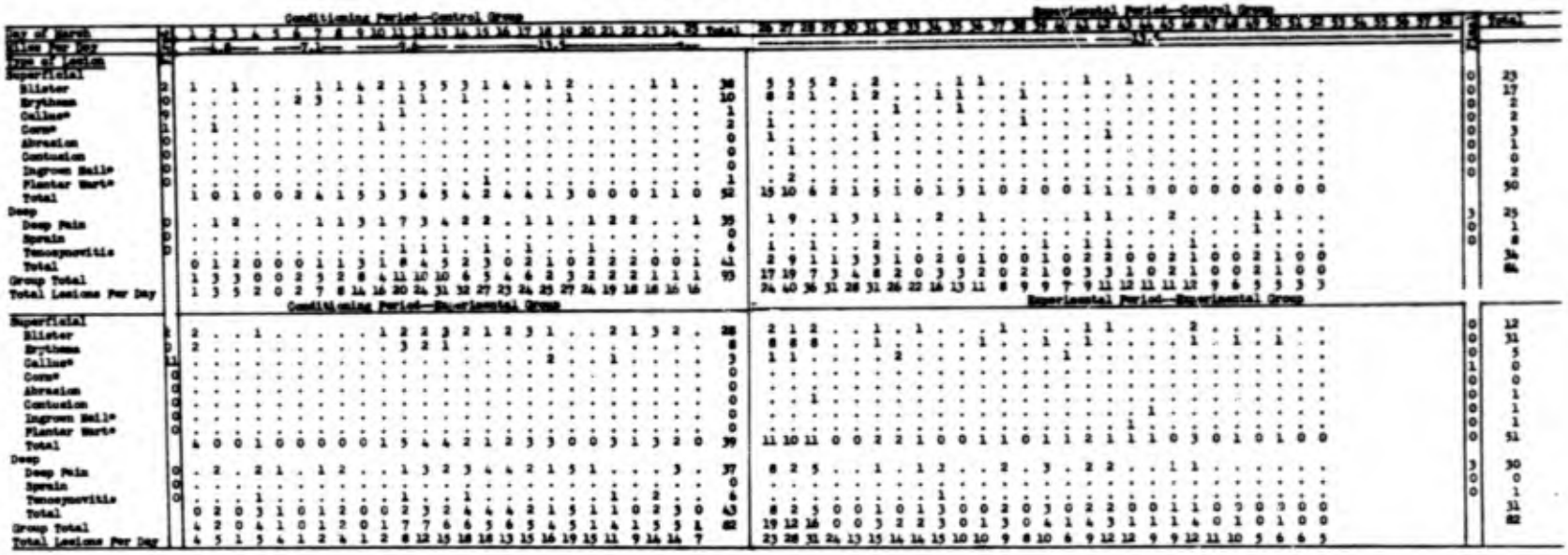
RELATION OF AREA INVOLVED TO ONSET DAY OF LESION



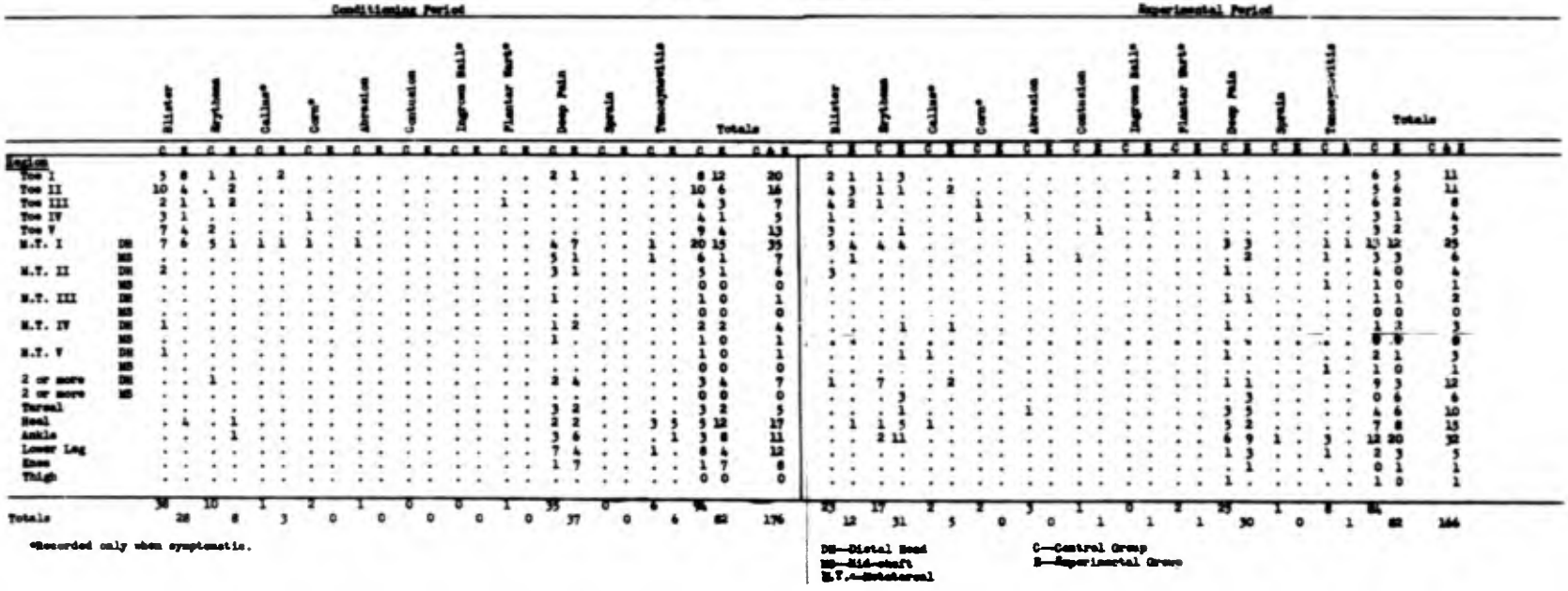
DH—Distal Head
MH—Mid-shaft
M.T.—Metatarsal

APPENDIX 3

A. DAILY INCIDENCE AND TYPE OF CLINICAL LESIONS



B. INCIDENCE AND LOCATION OF CLINICAL LESIONS



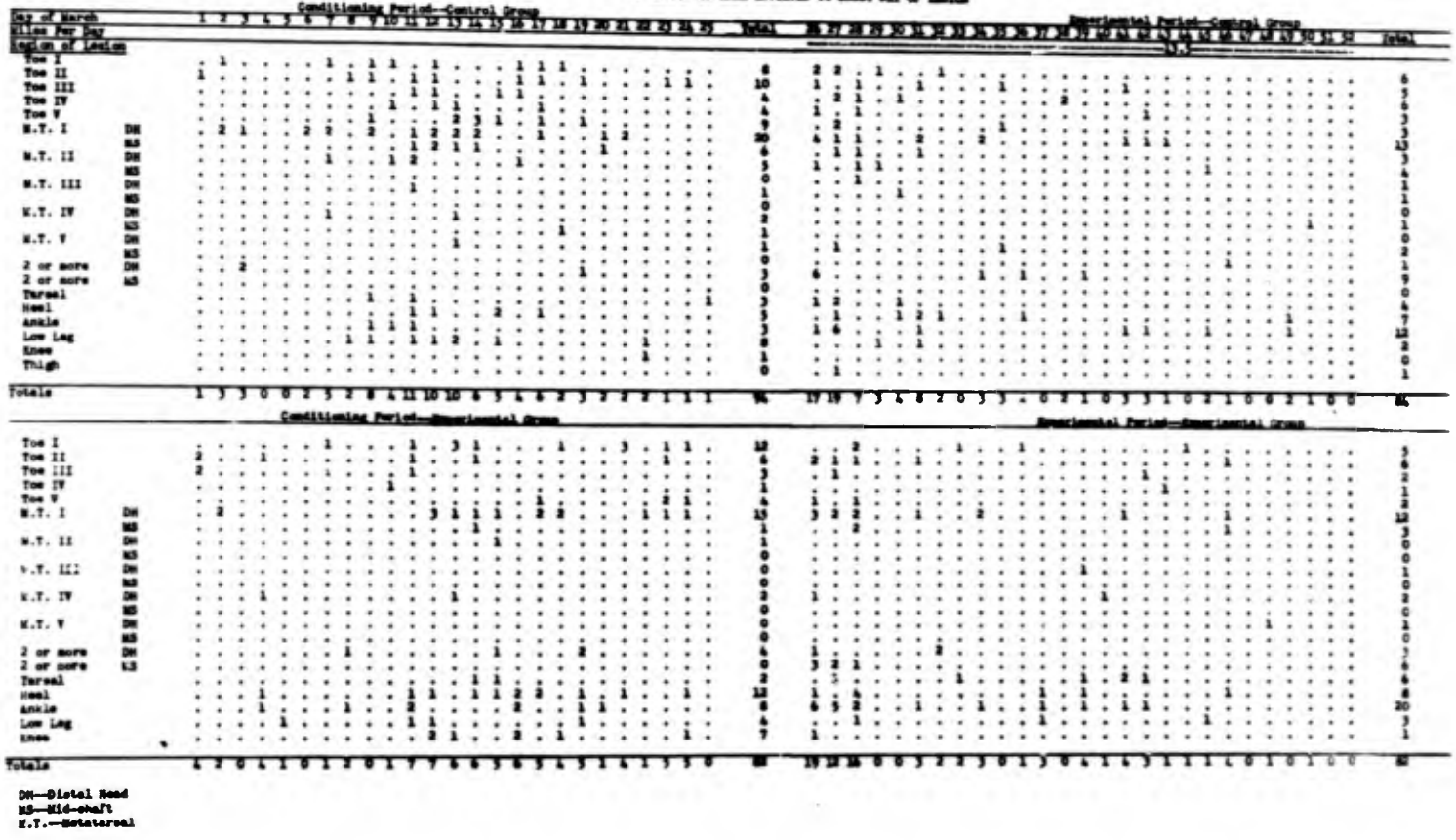
*Recorded only when symptomatic.

DS—Distal Head
MS—Mid-shaft
M.T.—Metatarsal

C—Control Group
E—Experimental Group

APPENDIX 4

RELATION OF AREA INVOLVED TO ONSET DAY OF LESION



DH—Distal Head
MS—Mid-shaft
M.T.—Metatarsal

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