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CAMP LEJEUNE, NORTH CAROLINA

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PRELIMINARY EVALUATION OF A PROPOSED NEW PHYSICAL READINESS TEST

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Physiology Division
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Bureau of Medicine and Surgery, Navy Department
Work Unit MF022.01.04-8002.5

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SUMMARY PAGE

THE PROBLEM

To determine test scores by age groups for a proposed new Physical Readiness Test.

FINDINGS

Means, standard deviations, and intercorrelations of test events are reported in the paper, as well as observations made during the testing program.

RECOMMENDATIONS

1. That the philosophic basis for the proposed Physical Readiness Test be reconsidered.
2. That the relationship between standard physical performance tests and combat efficiency be investigated.
3. That a single standardized test battery be developed and that the men to be tested be trained in the proper technique in each event.
4. That the test-retest reliability of each item be determined to be satisfactorily high prior to adoption.
5. That sufficient scores be collected to provide satisfactory data in each age group.
6. That the recommendations made in Appendix A be discussed with the Bureau of Medicine and Surgery, U. S. Navy, to determine what recommendations they would consider appropriate.
7. That graduates of the U. S. Marine Corps Physical Fitness Academy be utilized to conduct Physical Readiness Tests and required physical training programs.

ADMINISTRATIVE INFORMATION

Bureau of Medicine and Surgery, Department of the Navy, Work Unit MF022.01.04-8002, report No. 5. Interim report. Approved for publication 2 November 1967.

Published by the Naval Medical Field Research Laboratory, Camp Lejeune, North Carolina 28542.

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This restriction will be removed and the report may be released on 15 December 1967.

ABSTRACT

Approximately 250 Marines, aged 18-45 years, were administered a proposed new Physical Readiness Test, consisting of pull-ups; push-ups; rope climb; bent knee sit-ups in 2 minutes, feet held; leg raises in 2 minutes, elbows held; squat thrusts in 2 minutes; standing broad jump (best of three attempts); jump and reach (best of three attempts); and 3-mile forced march. Means, standard deviations, and intercorrelations of test scores are reported, together with observations and recommendations. Particular attention is drawn to the possibility of cardiac damage to older men subjected to such tests.

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Preliminary Evaluation of a Proposed New Physical Readiness Test

BACKGROUND

Marine Corps Physical Readiness Test

The present Marine Corps Physical Readiness Test[1] prescribes that all male Marines under 40 years of age must meet minimum standards in a battery of five events:

1. Climbing uphill (a step test)
2. Rope climb
3. Evacuation (carrying a "wounded" man)
4. Advance by fire and maneuver
5. Three-mile forced march.

This battery is obviously an attempt to meet the formulations of Bean *et al.*[2] to the effect that there is no abstract measure of fitness – the final standard against which fitness tests must be judged is actual performance. Tests of a particular task must resemble that task. However, in the mind of at least one of the officers responsible for the construction of this test,

> The current test of physical readiness used by the Marine Corps, based on a cursory examination of combat tasks, is not considered a test with a high degree of validity or reliability.[3]

Technically, the battery is open to a number of other serious objections. Among them are:

1. The different events have not been correlated with the combat tasks they are supposed to simulate.

2. The instructions are not standardized, so that the various events may be performed in different ways and the resulting scores may not be comparable.

3. No information is available concerning the intercorrelations between test events, and similar statistical details. In the absence of stand-

ardized methods of conducting the test events, it is impossible to collect the type of data needed for statistical analysis.[4]

4. The scoring is in terms of completion of an event, with minimum times being specified in some of the tests. Since an individual will normally work no harder than he has to, this does not permit an evaluation of differences between individuals or of changes in physical condition from one time to another.

Proposed New Physical Readiness Test

In the spring of 1967 the Coordinator of Physical Training, Headquarters Marine Corps, was charged with the responsibility of developing a new Physical Readiness Test. Three decisions were made by him:

1. To discard the concept of developing a test battery correlated with military performance.

2. To increase the number of test items, in order to provide the examiner with a choice of events.

3. To extend the age of those required to take the test to 45 years.

He proposed a new test, to consist of nine items:

1. Pull-ups (palms out)
2. Push-ups
3. Rope climb
4. Bent knee sit-ups in 2 minutes, feet held
5. Leg raises in 2 minutes, elbows held
6. Squat thrusts in 2 minutes,
7. Standing broad jump (best of three attempts)
8. Jump and reach (best of three attempts)
9. Three-mile forced march.

These are to be done in utilities and boots, but without the helmets, light marching pack, organic weapon, belt, full canteen of water, and bayonet required during the present Physical Readiness Test.[1] Testees are permitted to remove their caps and jackets if they desire. It is planned that in actual field use every man is to be administered the 3-mile forced march, plus four other events of the examiner's choice. Six of the eight events are matched on the assumption that the jump and reach measures the same thing as does the standing broad jump; the sit-up, the same thing as the leg raise; the pull-up, the same thing as the rope climb. The push-up and squat thrusts are not considered to be matched, however, and one or the other will be administered at the examiner's choice. At the same time, the age of men required to take the test is to be increased to 45 years and different standards are to be set for different age groups.

Review of the Literature

Background material on most of these tests is available in the literature. The most pertinent references are summarized below:

1. Pull-ups. A brief study of this event was conducted by the Naval Medical Field Research Laboratory[4] in 1965, using 31 subjects from the 2d Marine Division. On the occasion of the first test, the mean score was 7.8; standard deviation (S.D.), 3.0; on the retest, the mean score was 7.6; S.D., 2.7. The Pearson product moment correlation (r)* between the two was $r = 0.95$, indicating the event has high test-retest reliability.§

Performance of this event with the palms out is not a popular method among testers. It has been discarded by the Airborne Department of the United States Army Infantry School because it is believed that chin-ups (palms in) give a more valid measure† of arm and shoulder strength.[5,6] From the

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*The r is a measure of the relationship between two or more variables. High correlations between separate events indicate that the tests measure the same thing. Low correlations indicate that the tests measure different factors.

§Reliability refers to the ability of a measurement to give consistent results. It is usually reported in terms of a reliability coefficient which expresses the relationship between two measurements of a sample of a population.

†A test is valid if it measures what it purports to measure. This is usually stated as a validity coefficient which expresses the relationship between the predictor and the criterion.

standpoint of test construction, the chin-up is preferable because it gives a greater range of scores and thus a better distribution of the data. This is particularly important at the bottom of the scale, when the ability to do even a single pull-up or chin-up is doubtful.[7,8] Left to themselves, most individuals will choose this method of performing the test.[9] While scores for the chin-up average higher than they do for the pull-up, the correlation between the two events is high[4,8,10,11] and it is probable that determinations that have been made for the chin-ups apply quite closely to pull-ups.

Fleishman considers the chin-up the best measure of Dynamic Strength – the ability to exert muscular force repeatedly or continuously over a period of time.[12] It has a moderate correlation with exercises using the principal antagonistic muscles, such as push-ups ($\underline{r} = 0.58$)[13,14] and dips on parallel bars ($\underline{r} = 0.61$).[14] Fleishman specifically comments that "Push-ups added to pull-ups contributed little new information regarding a subject's Dynamic Strength."[15] Both Cureton and Fleishman found moderate correlations between chin-ups and a 100-yard shuttle run ($\underline{r} = 0.52$)[13] and a 300-yard shuttle run ($\underline{r} = 0.55$).[14] Performance in either pull-ups or chins generally decreases as the body weight of the performer increases.[4,6,14] The reliability coefficient for chin-ups is in the neighborhood of $\underline{r} = 0.89$ to $\underline{r} = 0.96$.[4,14]

2. Push-ups. The push-up is reported to have a reliability coefficient between $\underline{r} = 0.78$ and $\underline{r} = 0.90$ for college students.[16] It has a moderate correlation with the mile run ($\underline{r} = 0.70$)[16] and with chinning. It is a measure of Dynamic Strength (arms) according to the Fleishman classification; Larson[17] considers both the chin-up and the push-up measures of muscular endurance (arms).

3. Rope Climb. There is a paucity of information on the rope climb in the available literature. The knotted rope climb has a moderate (approximately $\underline{r} = 0.50$) correlation with pull-ups and chin-ups and, like them, is adversely affected by body weight.[4] It might be expected that somewhat similar findings would apply to the smooth rope. Climbing a rope has a large factor loading with Dynamic Strength.[17,18]

4. Bent Knee Sit-ups in 2 Minutes, Feet Held. The traditional method of administering the sit-up has been with the knees extended. In some cases the instructions call for the feet to be held down;[19] in others, they do not.[20] In some cases they are performed for a given time, which may vary from test to test; in other cases no time limit is invoked. Physical educators[21-23] and physical therapists[24] have recently attacked this exercise as performed with the knees extended. Their argument is that this increases the

tonus in the iliopsoas muscles and causes an undesirable amount of lordosis to develop, possibly resulting in "sway back." Fleishman considers sit-ups done in this manner a "weak measure" of Dynamic Trunk Strength.[25] Wedemeyer[26] found no significant correlation between the number of sit-ups that could be done by senior high school boys in 2 minutes and strength, weight, or body build. He concluded that the event tested the "general fitness" of the abdominal and thigh flexor muscles. The test-retest coefficient of reliability of the maximal number of straight legged sit-ups with a trunk twist was $r = 0.71$ when aviation cadets served as subjects.[27] The Airborne Department of the U. S. Army Infantry School now performs bent knee sit-ups, feet free, in an effort to place greater stress on the abdominal muscles and less on the iliopsoas group. No time limit is invoked.[28]

The writer has been unable to find any statistical studies of the bent knee sit-up and the extent to which the scores correlate with those for the extended knee sit-up or intercorrelate with those of other events.

5. Leg Raises in 2 Minutes, Elbows Held. Like the sit-up, the leg raise may be performed as a timed or an untimed event, with the arms free or held. This makes for considerable difficulty in determining intercorrelations, reliability coefficients, etc. The writer has found no data in the literature referring to the test conducted for 2 minutes with the elbows held.

Also, like the sit-up, the leg raise is generally considered a measure of the endurance of the trunk muscles.[17, 27] However, the correlation between the maximum number of sit-ups with a trunk twist and the maximum number of leg raises that can be performed is so low (on the order of $r = 0.32$[29] to $r = 0.38$[27]) that the interchangeable use of the two events for testing purposes cannot be justified. The test-retest coefficient of reliability of the maximum number of leg raises was $r = 0.72$ when aviation cadets served as subjects.[27]

6. Squat Thrusts in 2 Minutes. The squat thrust (also known as the Burpee Test) is considered a measure of agility by Larsen,[17] and of the Dynamic Strength of the legs by Fleishman.[25] It is difficult to see any kinesiological justification for the description of the exercise as one designed to strengthen the shoulder girdle and abdominal muscles.[30] It is usually performed as a timed event for such periods as 20 seconds or 30 seconds. Rasch and Hamby[31] used a 1-minute test, but no reports on a 2-minute test were found in the literature. There appears to be no information in the literature regarding the relationship of the squat thrust to the two-block or four-block shuttle run, which are said to measure the individual's ability to change direction. Fleishman comments that "The relation of this factor to agility tests and to running tests needs to be established."[32] Consideration might be given to the fact that

the first movement in the squat thrust is actually a deep knee bend and thus subject to the objections which have been made to this movement.

7. Standing Broad Jump. The standing broad jump is a measure of Explosive Strength; that is, "the ability to expend a maximum of energy in one explosive act."[33] It had a test-retest reliability coefficient of $r = 0.90$ or better when administered to Navy recruits[34] or college men.[33] Fleishman[34] found a mean of 82.94 inches and a standard deviation of 8.73 inches when the test was administered to 201 subjects having an average age of 18 years 3 months at the Great Lakes Naval Training Center. The test is reported[33] to have a correlation with the jump and reach test of $r = 0.71$.

8. Jump and Reach. This is also a measure of explosive power. It had a reliability coefficient of approximately $r = 0.91$ to $r = 0.93$ when administered to Navy recruits[34] or college men.[33] The mean score for the former was 18.4, S.D. = 2.66; for the latter, 21.6, S.D. = 2.81.

This test was originally proposed by D. A. Sargent in 1921 and is sometimes known as the Sargent jump. Sargent found no correlation between the height of the jump and body build, relative length of leg, height, weight, anthropometric measurements, or the amount of knee flexion which preceded the jump.[35] It was restudied by McCloy in 1932, who reported it "does predict the power-type of athletic ability very accurately indeed" and is "one of the best individual test items we have."[36] These opinions were confirmed by Van Dalen a few years later.[37]

As McCloy pointed out, the Sargent jump is primarily a test of the ability of the body to develop power relative to the weight of the individual himself. Since power is the rate of doing work, the event is actually a test of how fast one can work. In terms of physics, the height of the jump is determined by the mass-force ratio. Larson[38] concluded that in this item sheer physical strength was less important than the ability of the individual to utilize strength effectively in a force-time relationship. More recently Smith[39] has reported that the height attained in this jump has little correlation ($r = 0.20$) with the explosive leg strength as measured by a dynamometer or with the strength/mass ration ($r = 0.17$).

9. Three-mile Forced March. This appears to be an event utilized only by the U. S. Marine Corps. Under the present Physical Readiness Test, it is run by men carrying prescribed gear. An earlier small-scale study in this laboratory has shown that $r = 0.89$ when runs with and without this gear are compared.[40] While the number of subjects in that study was very small, the correlation appears reasonable.

This event is, of course, too stressful for recruits or other untrained men. The American Association for Health, Physical Education and Recreation,[41] Fleishman,[42] and other investigators have standardized on a distance of 600 yards. The correlation between these two events is low ($\underline{r} = 0.34$), which is probably due to the fact that the shorter distance depends largely on anaerobic capacity (ability to liberate energy in the absence of oxidation) and the longer distance depends largely on aerobic work capacity.[4] A high capacity for anaerobic work is not necessarily correlated with a high capacity for aerobic work.[43, 44]

PROCEDURE

In the summer of 1967 the Physiology Division, Naval Medical Field Research Laboratory, was requested to administer the foregoing nine-item test to approximately 300 Marines representing various Military Occupational Specialties and ranging in age from 18 to 45 to obtain data to be used in establishing standards of performance.

The battery was administered to Marines drawn from personnel stationed at Camp Lejeune, N. C.* (predominantly 2d Marine Division and Force Troops) and to men from the New River Air Facility (primarily Marine Aircraft Group-26) during the period 28 August to 1 September, inclusive. All subjects over age 35 were required to have an electrocardiogram which showed no suggestion of cardiac disease. Some subjects were halted during the 3-mile forced march when their appearance gave grounds for concern. Other men had individual physical disabilities which made it undesirable for them to participate in certain test items. The medical findings are discussed in detail in Appendix A. They are mentioned here primarily to explain the fact that the number of subjects will be found to differ from test to test. To a lesser extent these numbers were affected by the fact that a few individuals did not appear on both test days.

All testing was conducted at Molly Pitcher Field, Camp Lejeune. The forced march course was laid out on ground which is almost level, grassy, and with a soft soil which makes for pleasant running. The course was measured three times with a 100-foot tape to make sure the distance was accurate. The

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*The writers are indebted to Lieutenant Colonel V. D. Bell, USMC, for his assistance in arranging troops for this study and to Major James E. Page, USMC, for his cooperation throughout the test. The photography in Appendix B is by R. F. Rhoads, Jr., Naval Medical Field Research Laboratory. Corporal Henry J. West, USMC, and Lance Corporal Kenneth A. Conklin, USMC, served as subjects.

WBGT index was determined every half hour. The highest index recorded was 35.7, which did not necessitate the suspension of activities but which did appear to result in a decrement of performance. A light sprinkle of rain occurred occasionally during the day and heavy rains were experienced at night. Due to the porous nature of the soil, these did little more than keep the dust down. If they had any material effect on the performance of the runners, they probably reduced the time of the 3-mile forced march by cooling the atmosphere.

Each group of subjects was given an explanation of the reason for the test and requested to make an honest effort in each event so that the resulting scores would be meaningful. With a few exceptions - mostly older men who had not exercised for some time and were afraid of exhausting themselves - the cooperation is considered to have been excellent, and it is believed that the scores represent a reliable sampling of the physical abilities of the men tested. In part, this was no doubt due to the fact that Major General O. R. Simpson, USMC, Commanding General, 2d Marine Division, and Brigadier General J. E. Williams, USMC, Commanding General, Force Troops, FMFLANT, evinced their personal interest in the proceedings by visiting the area during the testing.

The test items are described in detail in Appendix B. In order to prevent fatigue from affecting the scores, the battery was administered over a 2-day period. Where two events had been selected in order to measure a similar factor, only one of them was performed on a given day. All items were administered in random order, with the exception that the 3-mile forced march was always the last event in a day's testing.

RESULTS

The mean scores thus obtained and their standard deviations* are shown in Table 1. In Table 2 they have been broken down by ages in order to give a more meaningful presentation. In some cases the number of subjects was too small to permit computing standard deviations. For greater ease of visualizing the effects of increasing age, the scores have been displayed graphically, test item by test item, in Figures 1 through 9.

*The author is indebted to Lieutenant Colonel C. R. Livingston, USMC, Data Processing Officer, Data Processing Installation No. 2, Marine Corps Base, Camp Lejeune, N. C., and to Captain N. G. Scott, USMCR, Assistant Data Systems Officer, for assistance with the statistical processing of these data.

Table 1. MEAN SCORES OF ALL SUBJECTS ON EACH EVENT

Test Item	N	M	SD	Range
1. Pull-ups	242	5.2	3.4	0-16.5
2. Push-ups	250	28.1	12.7	7-85
3. Rope Climb	181	17.1 sec	7.2 sec	8-48.8 sec
4. Sit-ups in 2 min	246	32.6	15.0	5-82
5. Leg Raises	250	32.1	10.3	5-66
6. Squat Thrust	251	33.8	9.6	11-60
7. Standing Broad Jump	248	6.4 ft	0.7 ft	4.9-9.1 ft
8. Jump and Reach	250	17.0 in	2.9 in	8.5-25.5 in
9. Three-mile Forced March	239	33.5 min	4.9 min	20.0-49.1 min

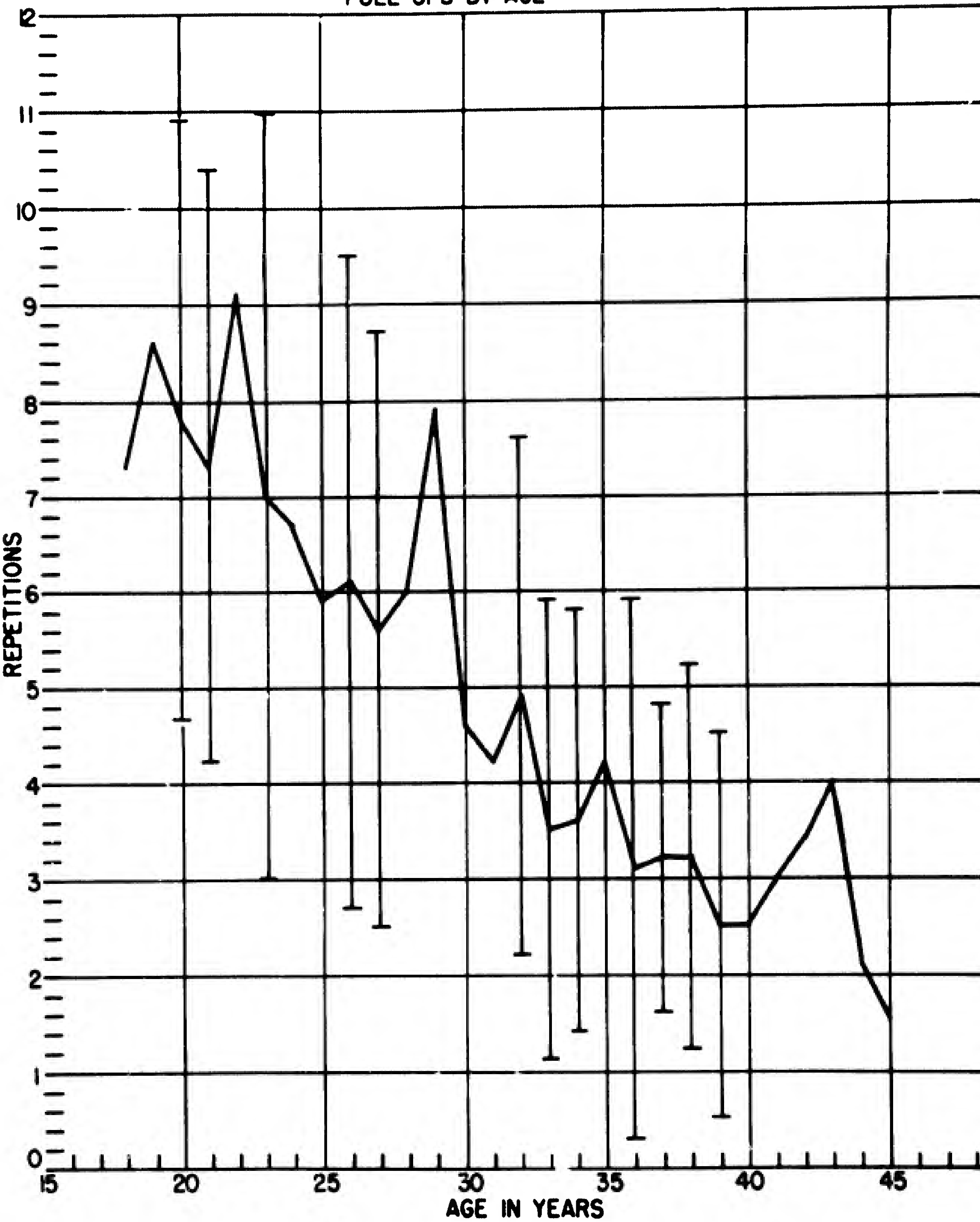
Note: Men who could not do one pull-up were given a zero score in this event; men who failed the timed events (rope climb, 3-mile forced march) were eliminated from the calculations of the means in these events.

Table 2. MEANS AND STANDARD DEVIATIONS OF TEST EVENTS BY AGE

Age Group	Statistical Descriptions																										
	Pull-up			Push-up			Rope Climb (sec)			Sit-up			Leg Raise			Squat Thrust			Standing Broad Jump (ft)			Jump and Reach			3-Mile Forced March		
	N	$\overline{X}$	S.D.	N	$\overline{X}$	S.D.	N	$\overline{X}$	S.D.	N	$\overline{X}$	S.D.	N	$\overline{X}$	S.D.	N	$\overline{X}$	S.D.	N	$\overline{X}$	S.D.	N	$\overline{X}$	S.D.	N	$\overline{X}$	S.D.
18	3	7.3		4	43.2		4	18.6		3	52.3		4	42.5		4	36.8		3	6.6		4	18.2		3	31.0	
19	8	8.6		8	39.5		8	12.2		3	50.5		8	43.5		8	46.5		8	7.1		8	19.9		8	29.3	
20	15	7.8	3.1	15	42.1	18.3	15	15.4	4.7	15	44.9	17.8	15	36.3	7.9	15	41.9	9.5	15	7.0	0.9	15	19.6	2.2	15	30.1	5.2
21	16	7.3	3.1	16	40.2	12.1	16	15.7	7.1	16	45.1	10.3	16	39.5	12.3	16	43.9	6.4	16	6.8	0.4	16	18.2	1.8	15	31.1	5.1
22	7	9.1		7	29.0		7	14.6		7	[illegible]		7	32.4		7	39.6		7	7.3		7	19.9		7	28.3	
23	11	7.0	4.0	11	41.9	10.5	10	14.2	5.1	11	45.1	10.5	11	33.8	7.9	11	41.3	11.8	11	6.7	0.7	11	18.9	1.9	11	30.8	2.7
24	3	6.7		3	45.0		3	12.0		3	39.7		3	38.7		3	40.7		3	7.1		3	18.3		3	31.9	
25	7	[illegible]		7	34.1		7	18.5		7	40.3		7	33.9		7	41.0		7	6.2		7	16.6		7	30.9	
26	16	6.1	3.4	17	28.6	9.1	15	14.7	6.0	17	31.9	14.0	17	39.2	8.5	17	37.3	8.3	18	6.7	0.6	17	18.8	2.3	16	31.6	3.1
27	11	5.6	3.1	11	30.8	7.2	8	12.9		11	38.2	11.9	11	34.4	6.2	11	32.3	8.2	11	6.2	0.8	11	16.6	2.7	10	32.0	3.4
28	5	6.0		5	28.0		3	14.2		5	38.0		5	37.6		5	31.0		5	6.6		5	17.3		4	28.7	
29	6	7.9		6	29.8		6	13.9		6	41.5		6	34.2		6	36.7		6	6.8		6	17.0		6	28.4	
30	7	4.6		7	24.9		5	15.4		7	29.1		7	31.4		7	34.6		7	6.3		7	16.7		7	33.0	
31	8	4.2		9	23.8		5	22.8		9	27.8		9	33.9		9	32.3		9	6.1		9	16.4		9	32.8	
32	21	4.9	2.7	21	36.7	8.0	16	18.4	7.2	21	29.8	14.5	21	30.0	5.8	21	31.0	7.1	21	6.4	0.8	21	17.0	2.3	21	33.6	3.6
33	15	3.5	2.4	15	22.9	6.3	11	20.3	7.8	15	26.4	11.2	15	29.0	5.4	15	28.7	5.1	15	6.4	0.5	15	[illegible]	2.8	15	35.9	3.2
34	10	3.6	2.2	10	22.9	6.8	6	20.8		9	27.7		10	29.7	5.4	10	30.1	6.5	10	6.0	0.7	10	16.5	[illegible]	10	34.4	[illegible]
35	4	4.2		4	36.5		2	14.4		4	32.0		4	34.2		4	41.0		4	6.8		4	17.3		4	33.4	
36	11	3.1	2.8	11	16.4	5.7	5	17.6		11	20.0	[illegible]	11	27.9	8.5	11	28.4	4.4	11	5.9	0.6	11	[illegible]	1.5	10	36.5	4.7
37	12	3.2	1.6	12	20.2	6.4	7	18.9		12	23.1	7.6	12	27.0	6.5	12	28.8	3.4	12	6.4	0.6	12	15.2	2.4	12	36.7	3.0
38	16	3.2	2.0	16	24.2	5.8	10	24.1	9.6	16	27.6	8.5	16	28.9	9.0	16	30.2	6.0	16	6.3	0.6	16	15.7	2.2	15	36.5	2.8
39	12	2.5	2.0	13	16.8	5.8	4	16.6		12	18.6	6.9	12	27.2	10.2	13	27.2	8.0	12	6.4	0.7	13	16.2	2.3	12	38.7	4.8
40	5	2.5		5	23.0		2	17.7		5	22.4		5	29.2		5	25.0		5	6.1		5	12.9		5	37.1	
41	4	3.0		4	16.0		2	19.4		4	23.0		4	29.8		4	24.0		4	5.7		4	16.2		3	39.8	
42	4	3.4		4	20.5		2	17.6		4	24.5		5	26.8		5	25.2		4	5.4		4	[illegible]		4	37.9	
43	2	4.0		3	14.0		1	28.0		2	24.0		3	10.0		3	19.7		2	5.8		3	11.7		2	40.4	
44	4	2.1		4	15.0		2	36.4		4	17.5		4	29.0		4	25.0		4	6.1		4	[illegible]		5	41.4	
45	1	1.5		2	9.0		0			2	11.5		2	15.5		2	22.0		2	5.7		2	13.2		2	38.2	

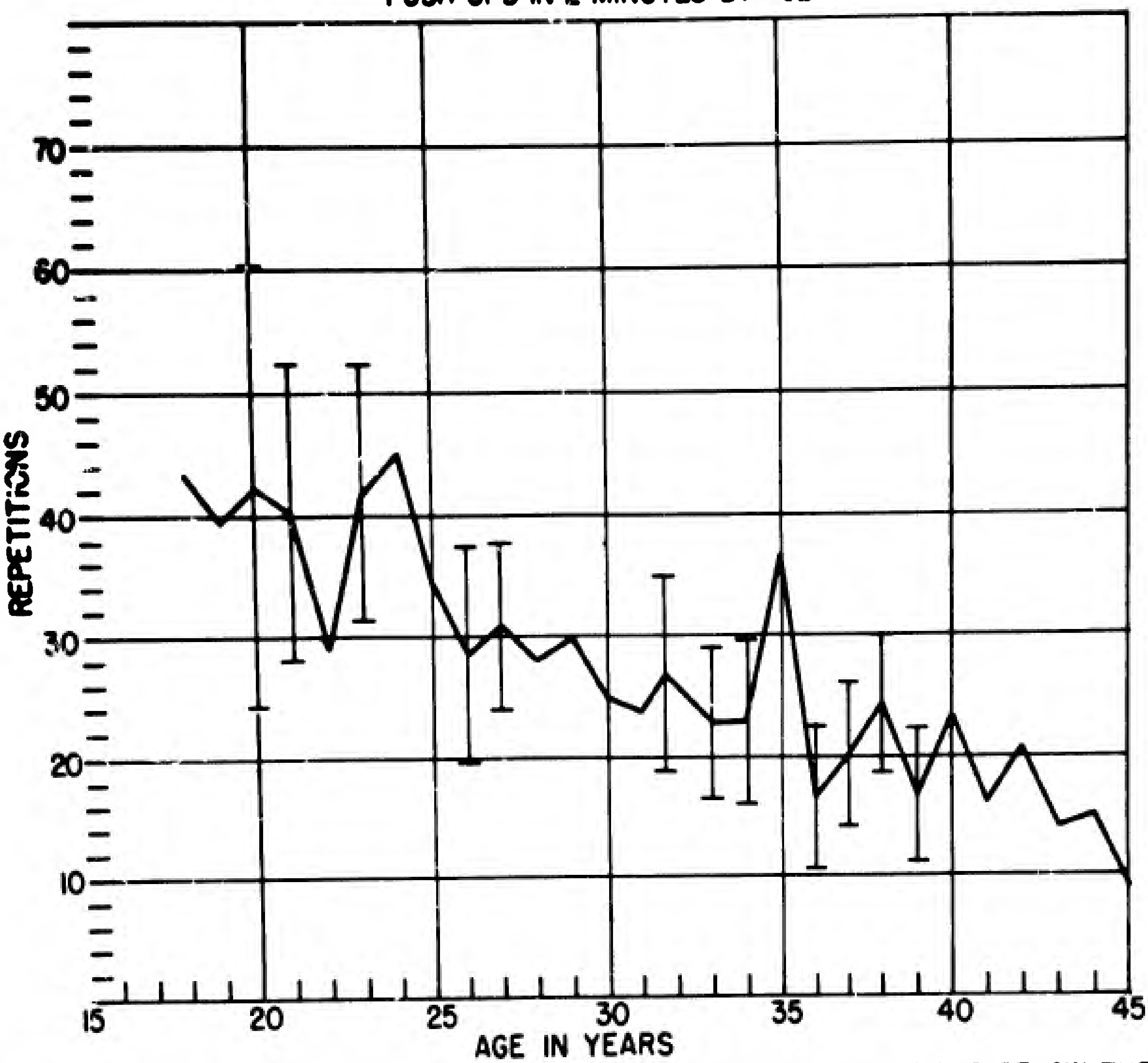
FIGURE I

PULL UPS BY AGE



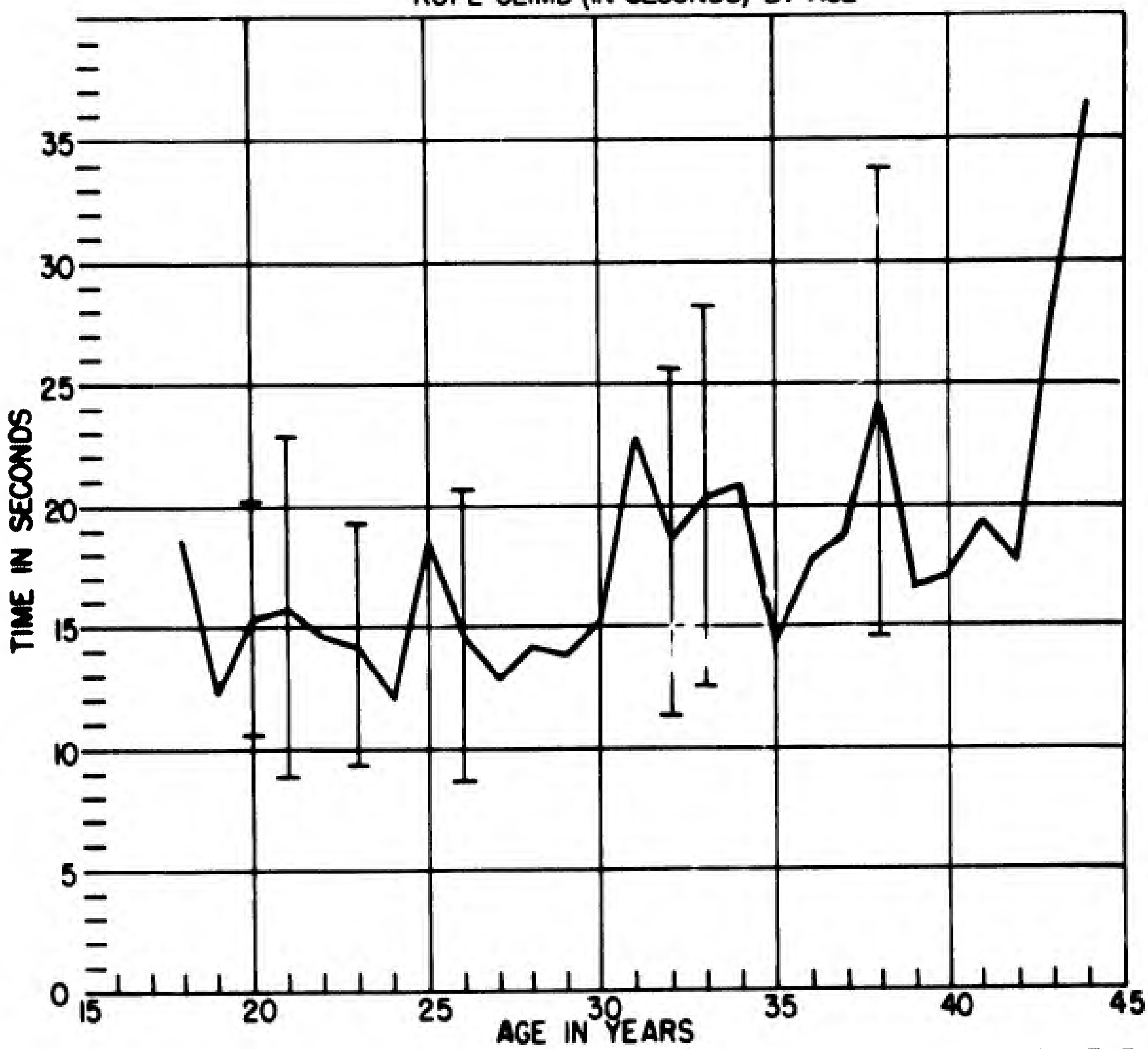
VERTICAL LINES WITH CROSS BARS REPRESENT I SD ABOVE AND BELOW THE MEAN.
THE SD WAS NOT CALCULATED WHEN THE NUMBER OF SUBJECTS <10.

FIGURE 2
PUSH UPS IN 2 MINUTES BY AGE



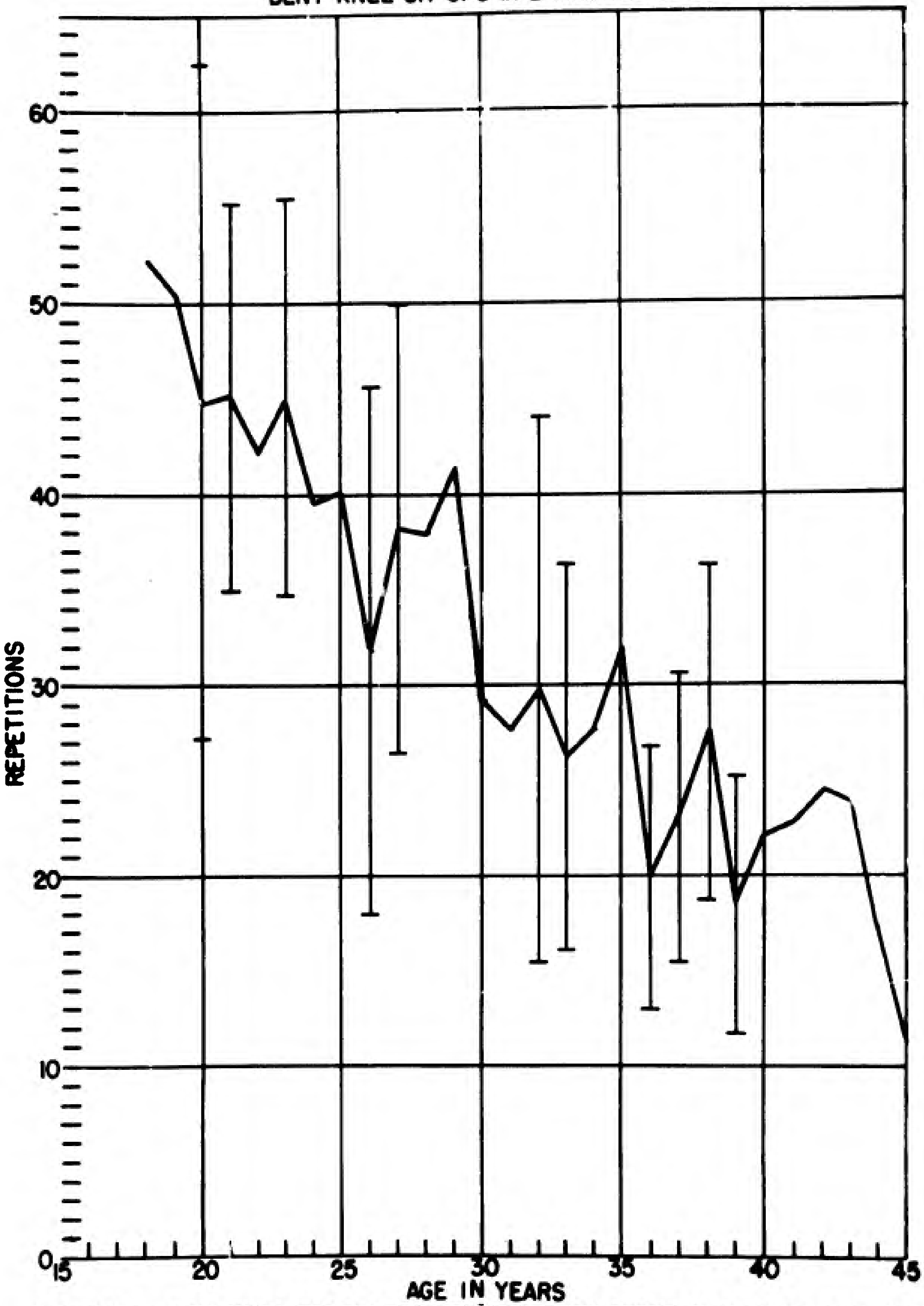
VERTICAL LINES WITH CROSS BARS REPRESENT I SD ABOVE AND BELOW THE MEAN.
THE SD WAS NOT CALCULATED WHEN THE NUMBER OF SUBJECTS < 10

FIGURE 3
ROPE CLIMB (IN SECONDS) BY AGE



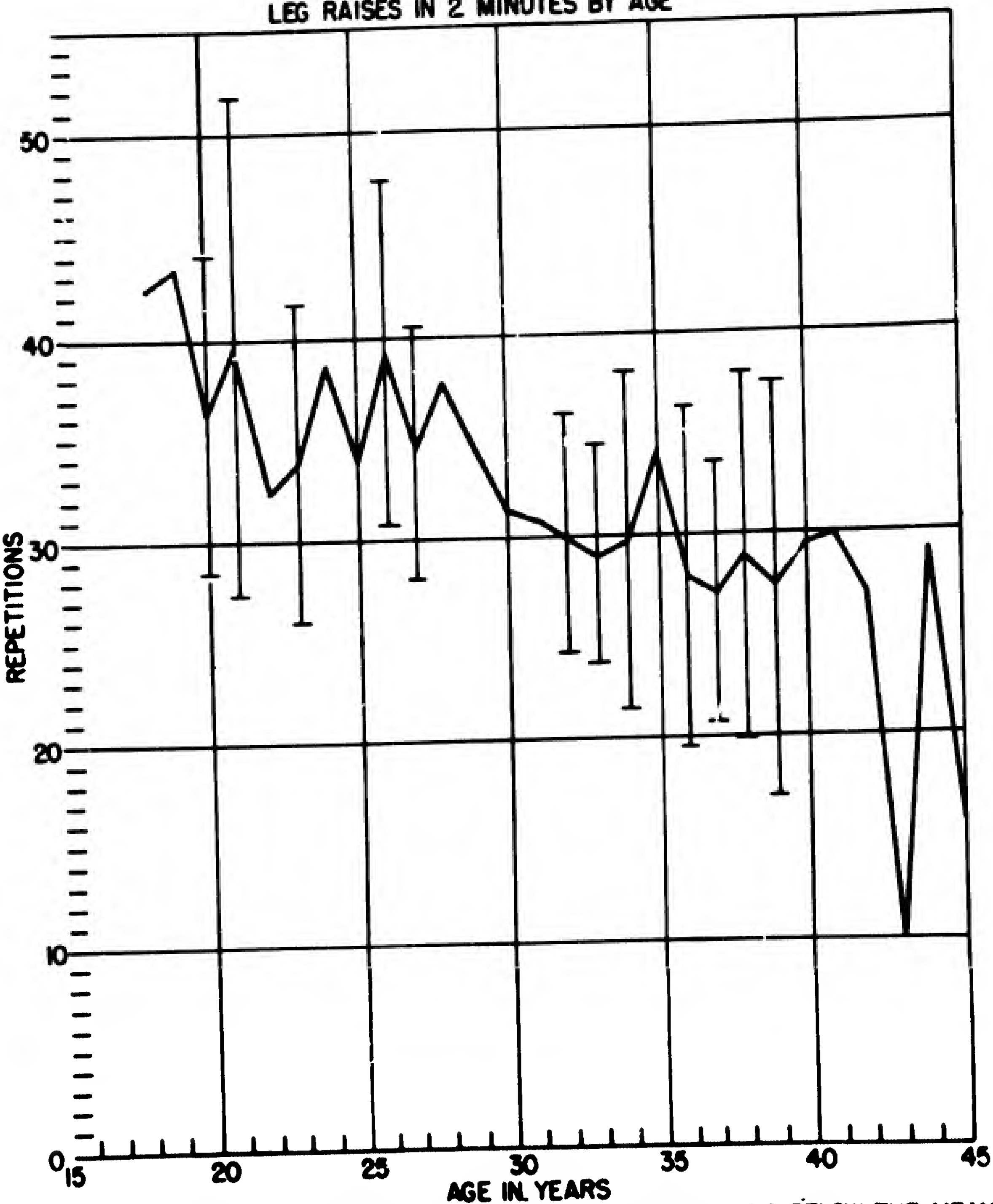
VERTICAL LINES WITH CROSSBARS REPRESENT 1SD ABOVE AND BELOW THE MEAN
THE SD WAS NOT CALCULATED WHEN THE NUMBER OF SUBJECTS < 10.

FIGURE 4
BENT KNEE SIT UPS IN 2 MINUTES BY AGE



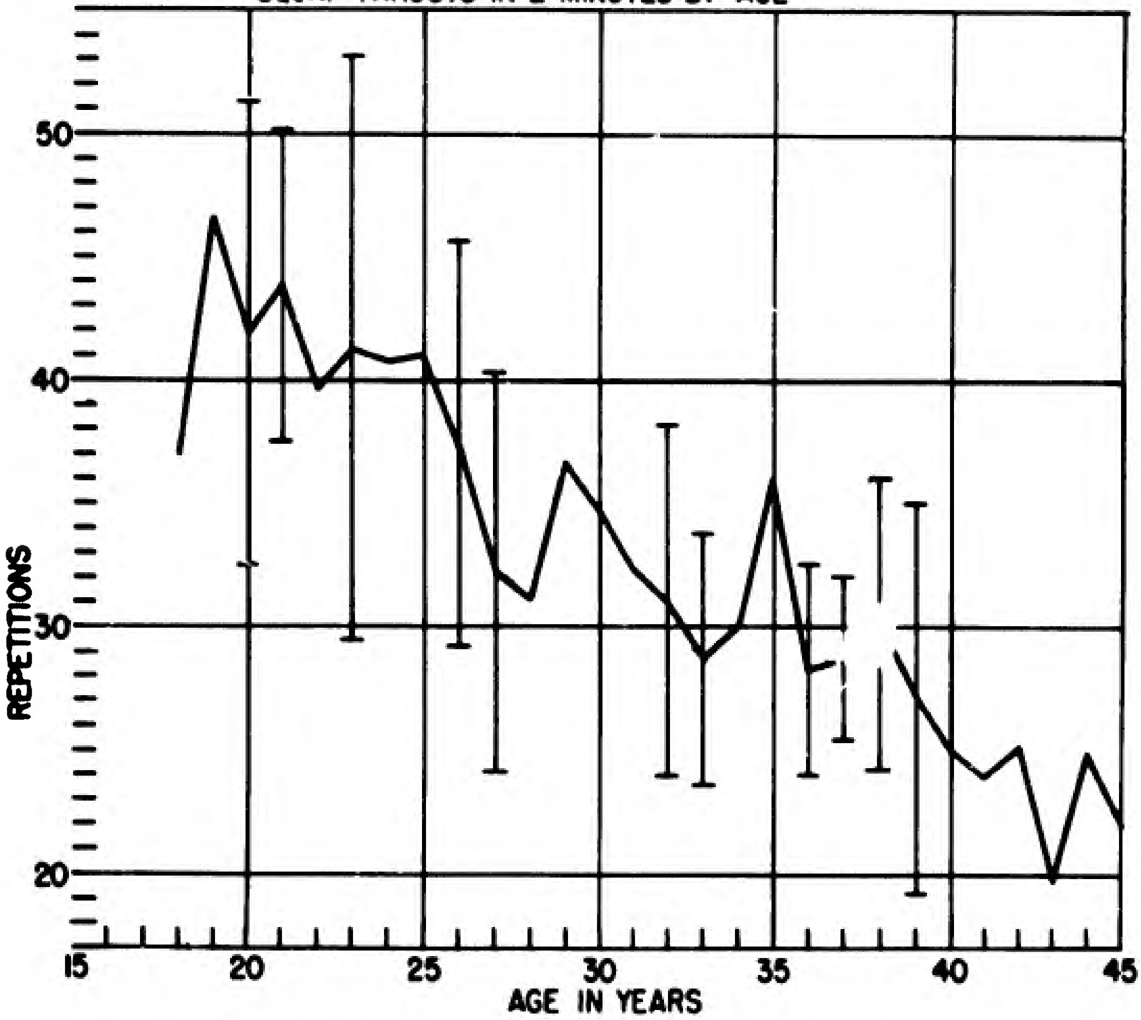
VERTICLE LINES WITH CROSS BARS REPRESENT ISD ABOVE AND BELOW THE MEAN
THE SD WAS NOT CALCULATED WHEN THE NUMBER OF SUBJECTS <10

FIGURE 5
LEG RAISES IN 2 MINUTES BY AGE



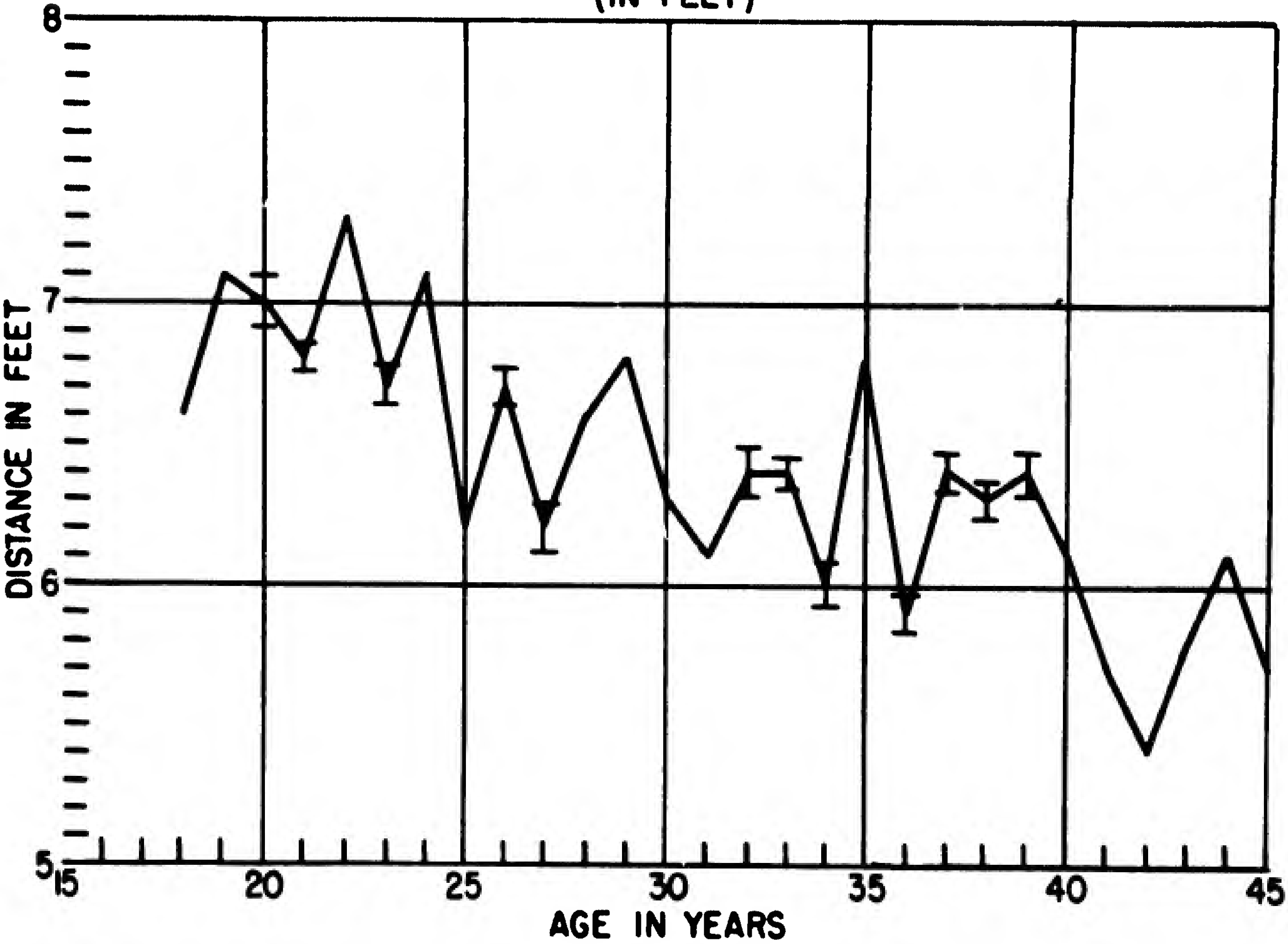
VERTICAL LINES WITH CROSS BARS REPRESENT 1 SD ABOVE AND BELOW THE MEAN.
THE SD WAS NOT CALCULATED WHEN THE NUMBER OF SUBJECTS < 10.

FIGURE 6
SQUAT THRUSTS IN 2 MINUTES BY AGE



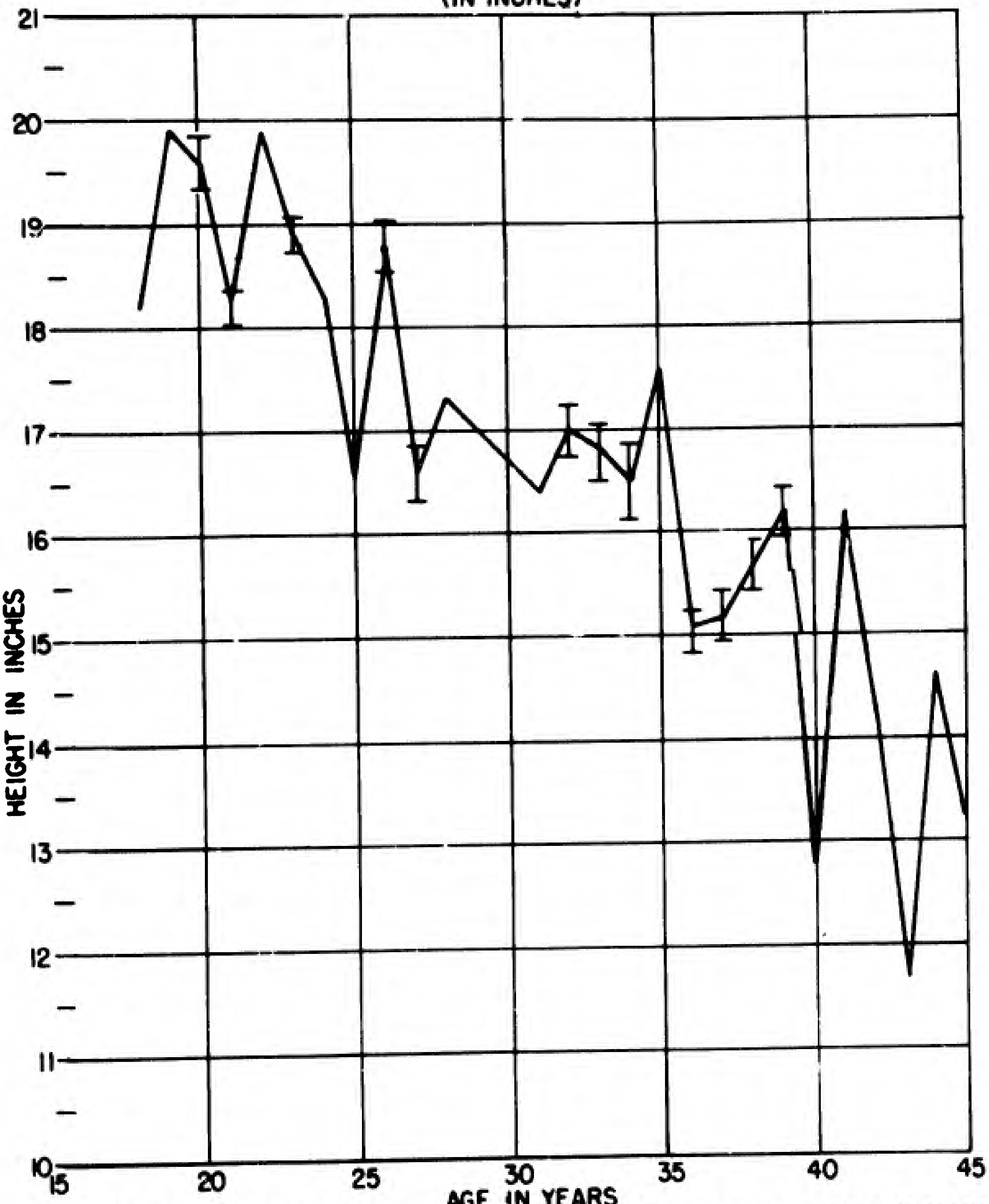
VERTICAL LINES WITH CROSS BARS REPRESENT 1 SD ABOVE AND BELOW THE MEAN. THE SD WAS NOT CALCULATED WHEN THE NUMBER OF SUBJECTS < 10.

FIGURE 7
STANDING BROAD JUMP BY AGE
(IN FEET)



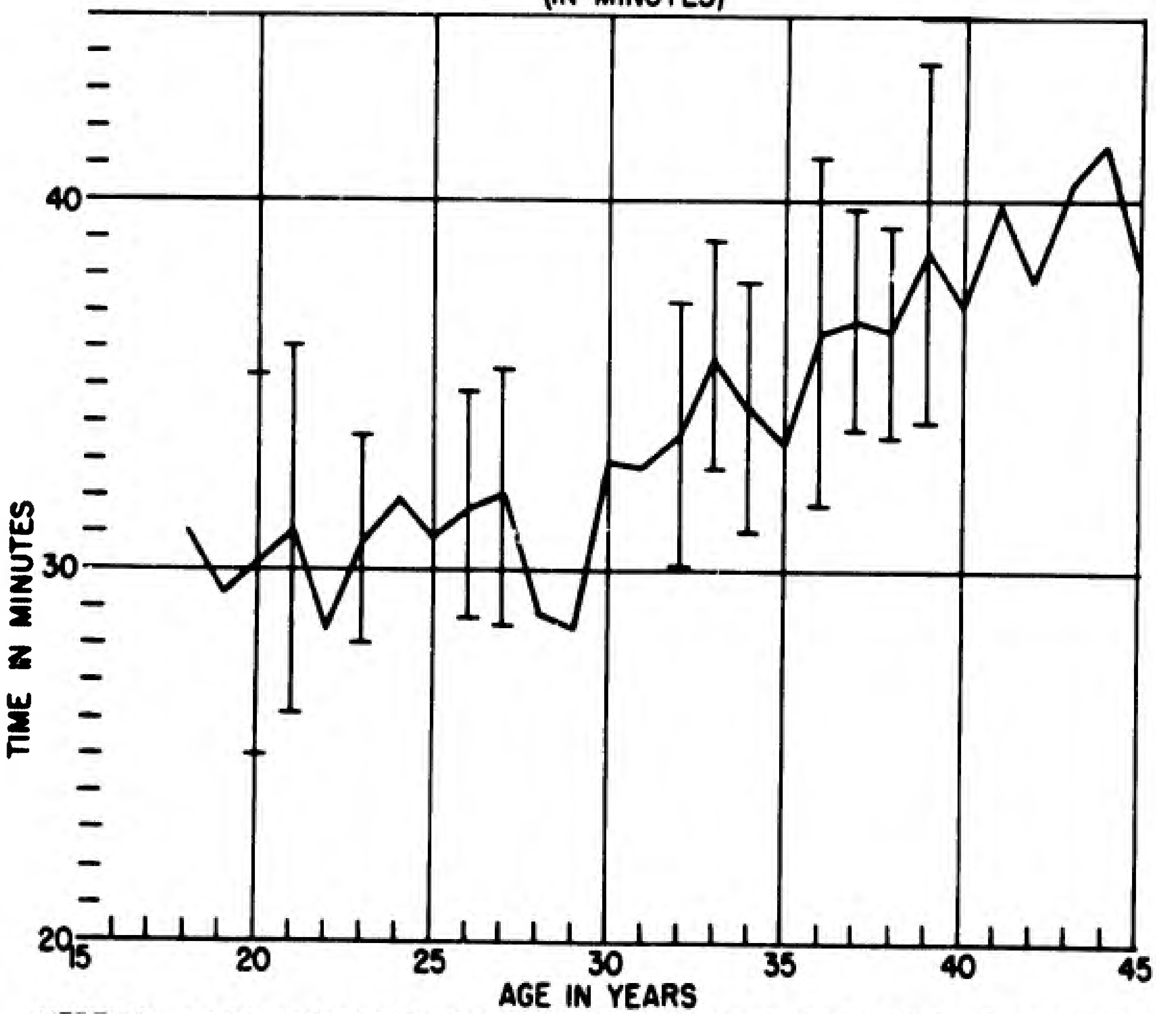
VERTICAL LINES WITH CROSS BARS REPRESENT ISD ABOVE AND BELOW THE MEAN.
THE SD WAS NOT CALCULATED WHEN THE NUMBER OF SUBJECTS < 10.

FIGURE 8
JUMP AND REACH BY AGE
(IN INCHES)



VERTICAL LINES WITH CROSS BARS REPRESENT 1 SD ABOVE AND BELOW THE MEAN.
THE SD WAS NOT CALCULATED WHEN THE NUMBER OF SUBJECTS < 10.

FIGURE 9
3 MILE FORCE MARCH BY AGE
(IN MINUTES)



VERTICAL LINES WITH CROSS BARS REPRESENT ISD ABOVE AND BELOW THE MEAN.
THE SD WAS NOT CALCULATED WHEN THE NUMBER OF SUBJECTS <10.

The Pearson product moment correlation between the various events is displayed in Table 3. The purpose of a correlation is to show the extent to which two variables are related. As with any statistical treatment, its interpretation is affected to some extent by the circumstances of its use. Probably most statisticians would be willing to accept the following interpretations as a rule of thumb:

Less than 0.20	Negligible relationship
0.20-0.40	Little relationship
0.40-0.70	Substantial relationship
0.70-0.90	Marked relationship
0.90-1.00	Very high relationship

The square of the coefficient of correlation (r^2) is known as the coefficient of determination (d). When multiplied by 100, this gives the percentage of the variance of one event that is associated with the variance in another, provided that a causal relationship between the two can be assumed. The ds are shown in Table 4.

DISCUSSION

The Naval Medical Field Research Laboratory was consulted regarding the proper performance of some of the events used in this proposed new test but not with regard to the underlying philosophy or the selection of the individual items. There is a serious question as to the advisability of abandoning the concept that the test battery should be correlated with military performance. It is difficult not to agree with Bean,[2] Balke and Ware,[45] and others that performance capacity is the only satisfactory criterion of physical fitness. Since the primary performance capacity in which the Marine Corps is interested is combat efficiency, it would appear that until it has been demonstrated that these tests have a high correlation with some aspect of combat efficiency, there is no way of knowing whether these measures have anything more than face validity. It would further seem that the approach being used by Nichols,[46] Gruber et al.,[47-49] and others, in which they are attempting to determine the tasks required of the combat infantryman and then devise tests to measure their capacities in these tasks, is inherently more promising.

The British Army Physical Efficiency Tests require a man carrying battle order and weapon to

1. Cover 10 miles in 2 hours 10 minutes

2. Surmount a 6-foot wall

Table 3. INTERCORRELATIONS (r) OF TEST EVENTS

Test Item	N	Push-ups	N	Rope Climb	N	Sit-ups	N	Leg Raises	N	Squat Thrust	N	Standing Broad Jump	N	Jump and Reach	N	3-mi Forced March
1. Pull-ups	242	0.54	178	0.44	241	0.54	242	0.47	242	0.55	242	0.46	242	0.47	233	0.55
2. Push-ups in 2 Min			181	0.28	246	0.68	249	0.55	250	0.68	247	0.33	250	0.38	238	0.54
3. Rope Climb					180	0.30	181	0.33	181	0.39	180	0.27	181	0.30	174	0.38
4. Sit-ups in 2 Min							246	0.51	246	0.62	246	0.40	246	0.42	237	0.58
5. Leg Raises in 2 Min									250	0.48	247	0.33	249	0.36	238	0.44
6. Squat Thrust											247	0.39	250	0.40	238	0.54
7. Standing Broad Jump													247	0.64	239	0.35
8. Jump and Reach															238	0.39

3. Jump a 9-foot-wide ditch

4. Carry a man of own weight 200 yards

5. On completion of 2, 3 and 4, fire five rounds at each of two targets at 25 yards and score five hits overall.

Twenty minutes are allowed for the wall, ditch, carrying, and firing.

They consider these tests "highly relevant to a soldier's battle capability."[50]

The normal procedure in constructing a test of physical performance is to select a test criterion (in this case, military efficiency), choose an experimental test, and then correlate the test against the criterion. A tentative

Table 4. COEFFICIENTS OF DETERMINATION (d) OF TEST EVENTS ($d = r^2$)

Test Item	Push-ups	Rope Climb	Sit-ups	Leg Raises	Squat Thrust	Standing Broad Jump	Jump and Reach	3-mi Forced March
1. Pull-ups	29	19	29	22	30	21	22	30
2. Push-ups		7	46	30	46	11	14	29
3. Rope Climb			9	11	15	7	9	14
4. Sit-ups				26	38	16	18	34
5. Leg Raises					23	11	13	19
6. Squat Thrusts						15	16	29
7. Standing Broad Jump							41	12
8. Jump and Reach								15

approach toward a test of this type was reported in a paper by Rasch and Hamby.[31] They believed that tests such as the standardized "Advance by Fire and Maneuver" described in that study possess promise for the testing of combat infantrymen.

Assuming that a causal relationship exists between physical performance test items, it would appear from Table 4 that there is relatively little to be gained by including push-ups and sit-ups, push-ups and squat thrusts, or standing broad jumps and jump and reach in the same battery. On the other hand, sit-ups and leg raises and pull-ups and rope climbs have so little associated variance that they cannot be considered alternate forms of the same test.

The test-retest coefficient of reliability of the proposed test items has not been established. While such coefficients are in some cases available for high school boys or other groups, the reliability of a set of measurements applies to a certain population under certain conditions. Reliability depends upon the population measured as well as upon the measuring instrument.[51] From the standpoint of acceptable test construction, it is necessary to establish the reliability of each set of measurements on a population consisting of U. S. Marines. Much of the necessary data could be obtained while Marine units were taking their routine Physical Readiness Tests, provided they were authorized to use the proposed new test instead of the present one.

In any event, a decision to adopt a test in which the items might vary from one time to another would involve serious drawbacks. Most importantly, it would not allow comparisons to determine whether an individual or a unit's fitness had changed from that observed in a previous test, nor could different units' fitness be compared. Under such a testing program, it would become almost impossible to make a meaningful statement about the physical readiness of the Marine Corps.

It is obvious, of course, that in some age categories the number of individuals tested was too small to permit the drawing of any conclusions. Work of this type should be continued until there is a satisfactory number of subjects recorded for each age. Good sampling technique would indicate that future data be collected on the West Coast, at Guantanamo, at Vieques, and elsewhere in order to obtain a true cross-sample of Marine Corps personnel.

In discussing the conduct of the Physical Readiness Test with the participants, it became evident that in many cases field units are paying little attention to the proper performance of each event. One informant, for example, stated that in his unit they sent a tall man and a short man out to pace off the distance for the 3-mile run and then split the difference between their results. In most cases the distance for the 3-mile run is measured by use of an automobile, with no attempt to check the accuracy of the speedometer. A test run with a pickup truck available to the Naval Medical Field Research Laboratory showed the odometer recorded almost .1 mile short of a full mile as measured with a steel tape.

It is clear that test scores obtained under such conditions as these are practically meaningless for comparative purposes. It is suggested that standard distances, etc. be laid out at each base and that the quarterly tests be conducted under the supervision of a graduate of the United States Marine Corps Physical Fitness Academy whenever such men are available. These men have been trained in the proper procedure in the administration of these tests and would serve as reliable and impartial judges. Under such conditions, the data collected would be reliable and would provide a far more accurate picture of the state of physical fitness in the Marine Corps than it is possible to obtain under present conditions.

The $1\frac{1}{2}$-inch line prescribed for the rope climb proved extremely difficult to obtain. It was finally located at a boat building and repair company in a city about 40 miles from Camp Lejeune. It has the advantage that this size is the one used in gymnastic competition, but in view of its weight (1.67 pounds per foot) and the difficulty experienced in its procurement, there would appear to be some doubt as to its availability in the field. Obviously a smaller line would be more difficult to climb, but a lighter and more readily available size would have definite advantages. It is recommended that further study of this matter should be undertaken before the size of the line is standardized.

A second difficulty was observed in that several different styles of rope climbing were employed. If intra and inter comparisons of individuals are to be meaningful, it is necessary that a standardized method be developed and taught to those who are to be required to participate in the Physical Readiness Test.

From the standpoint of test construction, it would be preferable to require the performance of chin-ups (palms in) rather than pull-ups (palms out). While these two are highly correlated and the relative position of an individual in a group would probably not be much affected by this change, a better distribution of the data would be achieved.

The findings of this study have raised a serious question concerning the dangers inherent in administering physical fitness tests to older men, especially those who have not been following a regular exercise program. Because of the rigid physical requirements imposed upon aviators, it was thought that a brief report on the standards required of aviators on hazardous duty would be pertinent. Accordingly, a summary of their fitness requirements is furnished in Appendix C.

Perhaps the most important paragraph in this paper is the one in the medical annex concerning the necessity of an enforced, continuous program of physical training. The finest testing program ever devised will do nothing to keep men physically fit. Experience indicates rather clearly that left to themselves most men will not keep up the vigorous and sustained exercise necessary to preserve a state of physical readiness for combat. This situation affords an excellent opportunity to evaluate the abilities of graduates from the new United States Marine Corps Physical Fitness Academy, Quantico, to produce good physical condition in men under their charge as compared with subjects left to their own devices, and to study the role of physical exercise in the prevention of cardiac impairment.

It is recognized that the solution of the technical points which have been presented in the foregoing discussion will necessitate a long range research program, whereas the Corps is confronted with an immediate requirement for a method of evaluating the physical fitness of its troops. In spite of certain problems standard measures of all around physical fitness such as are incorporated in the present test will at least provide useful objective measurements until such time as more complete data are available.

RECOMMENDATIONS

On the basis of this study, the following recommendations are made:

1. That the philosophic basis for the proposed Physical Readiness Test be reconsidered.
2. That the relationship between standard physical performance tests and combat efficiency be investigated.
3. That a single standardized test battery be developed and that the men to be tested be trained in the proper technique in each event.
4. That the test-retest reliability of each item be determined to be satisfactorily high prior to adoption.
5. That sufficient scores be collected to provide satisfactory data in each age group.
6. That the recommendations made in Appendix A be discussed with the Bureau of Medicine and Surgery, U. S. Navy, to determine what recommendations they would consider appropriate.
7. That graduates of the U. S. Marine Corps Physical Fitness Academy be utilized to conduct Physical Readiness Tests and required physical training programs.
8. That pertinent research such as is being carried on by Nichols, Gruber, and others be monitored for information of interest to the Marine Corps.

REFERENCES

1. Marine Corps Order 6100.3D, 18 March 1965.

2. Bean, W. B., et al. A Critique of Physical Fitness Tests. Report No. 3. Fort Knox, Kentucky: Armored Medical Research Laboratory, 19 February 1947.

3. Whalen, Robert P. Physical Fitness Testing of Members of the United States Marines. Amphibious Warfare School, Student Staff Study FY64, p. 5.

4. Rasch, Philip J. and Brown, Mark. A Critical Analysis of Three Physical Fitness Tests. NMFRL Report 15:#21, July 1965.

5. Berry, Fred C. Why the Pull-up Went. Infantry, 55:22, November-December 1965.

6. Townsend, James M. to Rasch, Philip J. Personal Communication, 2 February 1966.

7. Fleishman, Edwin A. The Dimensions of Physical Fitness - The Nationwide Normative and Developmental Study of Basic Tests. New Haven: Yale University, August 1962, p. 22.

8. DeWitt, R. T. A Comparative Study of Three Types of Chinning Tests. Res. Quart. 15:249-251, October 1944.

9. Hamlin, H. E. and Waterman, F. A. The Energy Cost of Chinning the Bar and Push-up Exercises. Res. Quart. 7:75-80, October 1936.

10. Phillips, B. E. The JCR Test. Res. Quart. 18:12-29, March 1947.

11. McGaw, Lynn W. Effect of Variation of Forearm Position in Elbow Flexion. Res. Quart. 35:504-510, December 1964.

12. Fleishman, Edwin A. The Structure and Measurement of Physical Fitness. Englewood Cliffs: Prentice-Hall, Inc., 1964, p. 130.

13. Ibid., pp. 60-61.

14. Cureton, Thomas Kirk, et al. Endurance of Young Men. Washington, D. C.: Society for Research in Child Development, 1945, pp. 1-14.

15. Fleishman, p. 72.

16. Cureton, op. cit., pp. 33-36.

17. Larson, Leonard A. Some Findings Resulting from the Army Air Forces Physical Training Program. Res. Quart. 17: 144-164, May 1946.

18. Fleishman, op. cit., p. 64.

19. AAHPER Youth Fitness Manual, Revised Edition. Washington, D. C.: American Association for Health, Physical Education, and Recreation 1965, p. 18.

20. Cureton, op. cit., pp. 69-71.

21. Flint, M. Marilyn. Selecting Exercises. J. Amer. Ass. Health Phys. Educ. 35:19 et seq., February 1964.

22. Nelson, Dale O. Focus on Two Fitness Exercises. J. Amer. Ass. Health Phys. Educ. 35:22-23, May 1964.

23. Soderberg, Gary L. Exercises for the Abdominal Muscles. J. Amer. Ass. Health Phys. Educ. 37:67-70, September 1966.

24. Kendall, Florence P. A Criticism of Current Tests and Exercises for Physical Fitness. J. Amer. Phys. Ther. Ass. 45:187-197, March 1965.

25. Fleishman, op. cit., p. 156.

26. Wedemeyer, Ross. A Differential Analysis of Sit-ups for Strength and Muscular Endurance. Res. Quart. 17:40-47, March 1946.

27. Karpovich, Peter V., Weiss, Raymond A., and Elbel, Edwin A. Relation between Leg-Lift and Sit-up. Res. Quart. 17:21-23, March 1946.

28. Berry, Fred C., Jr. The New Airborne Sit-up. Sport International, 34/E: 31-32, 1967.

29. Cureton, op. cit., pp. 54-57.

30. Physical Conditioning. TM 21-200. Headquarters, Department of the Army, December 1957, p. 82.

31. Rasch, Philip J. and Hamby, Jefferson, W. Physical Fitness Scores of Combat Marines. NMFRL Report 17:#24, October 1966.

32. Fleishman, op. cit., p. 33.

33. Glencross, D. J. The Nature of the Vertical Jump Test and the Standing Broad Jump. Res. Quart. 37:353-359, October 1966.

34. Fleishman, op. cit., p. 59.

35. Sargent, D. A. The Physical Test of a Man. Amer. Phys. Educ. Review, 26:188-194, April 1921.

36. McCloy, C. H. Recent Studies in the Sargent Jump. Res. Quart. 3:235-242, May 1932.

37. Van Dalen, Deobold. New Studies in the Sargent Jump. Res. Quart. 11: 112-115, May 1940.

38. Larson, Leonard A. A Factor and Validity Analysis of Strength Variables and Tests with a Test Combination of Chinning, Dipping, and Vertical Jump. Res. Quart. 11:82-96, December 1940.

39. Smith, Leon E. Relationship between Explosive Leg Strength and Performance in the Vertical Jump. Res. Quart. 32:405-408, October 1961.

40. Rasch, Philip J. and Wilson, I. Dodd. The Correlation of Selected Laboratory Tests of Physical Fitness with Military Endurance. Milit. Med. 129:256-258, March 1964.

41. AAHPER Youth Fitness Test Manual, Revised Edition. Washington, D. C.: American Association for Health, Physical Education, and Recreation, 1965, p. 23.

42. Fleishman, op. cit., pp. 171-172.

43. Wyndham, C. H., et al., cited in Haisman, M. F. A Review of Physical Fitness Tests with Particular Reference to the Maximal Oxygen Intake. Army Personnel Research Establishment Research Memorandum P/3, February 1967, p. 23.

44. Ahlborg, B., et al. Capacity for Brief Exercise in Relation to Capacity for Prolonged Exercise in Man. Acta Medica Scand. Supplementum, 472: 182-193, 1967.

45. Balke, Bruno and Ware, Ray W. The Present Status of Physical Fitness in the Air Force. Report 59-67. Randolph Air Force Base, Texas: School of Aviation Medicine, USAF, May 1959.

46. Nichols, T. F., et al. Critical Combat Skills, Knowledges, and Performances Required of the 1962 Light Weapons Infantryman (MOS 111.0). Fort Benning, Georgia: U. S. Army Infantry Human Research Unit, January 1961.

47. Gruber, Alin, et al. Development of a Methodology for Measuring Infantry Performance in Marching and Moving. Fort Lee, Virginia: U. S. Army General Equipment Test Activity, June 1965.

48. Gruber, Alin, et al. Development of a Methodology for Measuring Infantry Performance in Maneuverability. Fort Lee, Virginia: U. S. Army General Equipment Test Activity, June 1965.

49. Gruber, Alin, et al. Development of a Methodology for Measuring Infantry Performance in Digging Hasty Fighting Positions. Fort Lee, Virginia: U. S. Army General Equipment Test Activity, June 1965.

50. Haisman, M. F., op. cit., p. 4.

51. Guilford, J. P. Fundamental Statistics in Psychology and Education. Fourth Edition. New York: McGraw-Hill Book Company, 1965, p. 439.

52. Henry, Franklin. The Practice and Fatigue Effects in the Sargent Test. Res. Quart. 13:16-29, March 1942.

53. Whitley, J. D. and Smith, L. E. Larger Correlations Obtained by Using Average Rather Than "Best" Strength Scores. Res. Quart. 34:248-249, May 1963.

54. Henry, Franklin M. "Best" Versus "Average" Individual Scores. Res. Quart. 38:317-320, May 1967.

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APPENDIX A

MEDICAL ANNEX ON THE ADMINISTRATION OF THE PROPOSED PHYSICAL READINESS TEST (PRT)

by
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LCDR L. H. Cronau, Jr., MC, USNR

BACKGROUND

The following are the general impressions of the medical observers at the PRT field trials. These comments apply only to the medical aspects of the testing and to some of the implications of these observations.

SUBJECTS DISQUALIFIED FOR NON-CARDIAC REASONS

Detailed information was not recorded on these subjects but the general findings were as follows: This group contained from 12 to 15 persons who were excused from particular phases of the trials for one or more orthopedic reasons. One individual related that he had suffered from chronic "back trouble." Two persons were noted to have difficulties with their wrists; one had a recent fracture and the second had a history suggestive of arthritic changes. One individual was under treatment for an infected bite to the shoulder. A third was under treatment for tendonitis. The remaining subjects complained of various muscle strains and sprains involving the ankle, knee, etc. These Marines were disqualified from various activities because there were serious doubts whether valid measurements could be made, even if the complaint did not represent a real impairment.

HEAT CASUALTIES

Subjects were considered to be "heat casualties" when they exhibited paleness, vomiting, or staggering, or if they complained of headache, vertigo, faintness, or nausea or any combination of these signs and symptoms during any test event. There were six persons who were classified as heat casualties, five of whom developed difficulties while participating in the 3-mile run, and one while engaged in the squat thrust. There did not appear to be any particular predilection for any age group. This may reflect the relatively small number of older troops tested.

EXCLUSICN AS POSSIBLE CARDIAC RISKS

A total of 100 men, in the age group 35 years and over, was screened by ECG before being allowed to enter the PRT. Of these, only 76 were permitted to take the PRT, the greatest concern being the stress of the 3-mile run, although the other exercises could produce sufficient stress to be potentially dangerous as well. These men were screened out in the following manner:

1. Frankly abnormal ECG's (which were small in number and were limited to age group 40 years and over).

2. ECG tracings which were of questionable nature in conjunction with a change from previous ECG and/or basis of history which was suggestive of cardiac impairment.

3. History which was sufficiently suggestive of cardiac impairment that it appeared to be imprudent to subject the person to the vigorous exercise required by the PRT.

In addition, one 28-year-old individual was rejected for the 3-mile run because of a history of heart "flutter." From his description, it appeared that this was an auricular tachycardia or flutter which had been confirmed by ECG. Because he had occasionally experienced dyspnea and "pain" in his chest associated with marked exertion, it was felt that he should not be subjected to the stress of the 3-mile run.

Despite the above precautions, there were two individuals who were stopped during the PRT because of signs of cardiopulmonary embarrassment. One of these subjects was stopped after running about ¼ mile and showed frank cyanosis, appeared dyspenic, and complained of a "tightness" in the chest. His complaints were relieved by administering oxygen for about 3 minutes, but he was admitted to the hospital for evaluation. He was found to have significantly impaired pulmonary function. The second subject will be evaluated by his medical officer and probably has some degree of impaired pulmonary function. Both of these Marines were in the over-40-years age group.

FOLLOW-UP OF INDIVIDUALS EXCLUDED BECAUSE OF ABNORMAL ECG

It should be restated here that an ECG diagnosis of abnormality was made on most conservative criteria, because the purpose of the test was not to measure any individual's endurance but to define limits for presumably healthy men of the various age groups.

The criteria of abnormality used were:

1. Left axis deviates of more than -30°.

2. Any rhythm disturbances other than sinus arrhythmia (although no cases of sinus arrhythmia were observed).

3. A "Q" wave in a standard lead which was either one-fourth the height of the R wave or 0.04 second in duration.

4. Failure of R wave progression in the anterior precordium as well as actual loss of voltage.

5. ST elevation greater than 1 mm in standard leads and greater than 2 mm in precordial leads.

6. Any low or discordant "T" waves.

The 24 men who were rejected for the PRT as possible cardiac risks were evaluated by their respective medical officers in a manner which seemed appropriate to the examining physician. The manner of evaluation varied, as would be expected, and was based on repeat ECG or reinterpretation of the same and/or clinical impressions based on physical examination and/or history. Of the 24 persons, two were lost for follow-up b. ause of transfer to new duty stations.

The results of these evaluations are outlined as follows:

1. On the basis of ECG:

a. Reinterpretation of the ECG tracing on which exclusion from the PRT was based

(1) Interpretation as normal	1
(2) Non-specific and/or non-changing abnormalities	3
(3) Abnormal ECG	6
(4) Read or interpreted as "normal in view of history and/or physical examination"	7

b. Repeat ECG

(1) Normal	2
(2) Others	0

2. On the basis of clinical findings:

a. Normal	10
b. Individual restricted from further PRT but no diagnosis given	1
c. Minimal or borderline cardiomegaly	1
d. Hypertension	4

Thus, it appeared that there was definite organic disease which could account for the abnormalities noted in the screening of ECG's in four cases and probably so in two additional cases for a total of six. In summary, then, the findings of screening ECG's showed abnormalities of sufficient magnitude to warrant investigation in search of possible cardiovascular disease in about one-quarter of the men tested in the age group 35 to 45 years. Of these, about one-quarter had definite organic disease, or sufficient indications of, to warrant restriction of physical activity.

CONCLUSIONS

The number of subjects rejected for certain phases of the study because of injuries and limitations other than cardiopulmonary did not appear striking considering the number exposed to potential job strain and injury. Although the WGBT index did not exceed 85.7 and was generally 81 or below, there were seven individuals who showed varying degrees of stress and were classified as "heat casualties," although this classification could be argued. The observations do suggest, however, that there are probably a large number of personnel who are in relatively poor physical condition, by the usual Marine Corps standards, and/or poorly acclimatized.

The number of persons rejected as possible cardiac risks, however, is rather remarkable, even when it is taken into account that conservative criteria were used as a basis for the exclusion of subjects.

RECOMMENDATIONS

Based on the above findings, the following recommendations are made for consideration and possible study:

1. Routine annual electrocardiograms should be extended to age 35.

2. Any person 35 years of age or older should have a routine ECG before any PRT is given.

3. Consideration should be given to administering pulmonary function studies to men over 35 years of age to determine the presence of impaired function among Marines.

4. No individual who is over 35, or who exceeds the maximum weight for his height, should be allowed to take the PRT in any circumstance, without the approval of his medical officer.

5. Finally, because it is medically prudent and would probably help reduce the number of non-cardiac casualties, it would be advisable to have an enforced, continuous program of physical training rather than subject "out of shape" individuals to the stress of a quarterly PRT without any prior conditioning.

APPENDIX B

DESCRIPTION OF TEST EVENTS

1. Pull-up:

Subject grasps an overhead bar with both hands, palms out, and comes to a full hang (Fig. B-1). He flexes his elbows until he can place his chin over the bar (Fig. B-2). One point is counted each time he gets his chin over the bar. A final half point is counted if he gets his elbows parallel with the ground, (This is largely a motivational device to obtain an all-out effort from the subject.) No kicking or bicycling is permitted.

2. Push-up:

Subject starts in the front leaning rest position. The body is kept straight from head to heels. A partner places his fist under the subject's chest (Fig. B-3). The subject bends his elbows, keeping the body straight until his chest touches the partner's fist (Fig. B-4). He then straightens his arms and returns to the starting position, keeping the body straight throughout the movement. As many repetitions as possible are made.

3. Rope Climb:

A rope 20 feet long and $1\frac{1}{2}$ inches in diameter is suspended from an overhead beam. Subject stands on the ground and grasps the rope in any desired manner (Fig. B-5). On the command "Go" a stop-watch is started and he begins to climb as rapidly as possible (Fig. B-6). The time is recorded when he touches the overhead beam (Fig. B-7).

4. Bent Knee Sit-ups in 2 Minutes:

Subject lies supine, with his hands behind his head and his knees flexed at about a 65-degree angle. His ankles are held down by a partner (Fig. B-8). He sits up as many times as possible in 2 minutes (Fig. B-9), each time touching his chest to his thighs. One repetition is counted each time his chest touches his thigh. No body twist is required.

5. Leg Raises in 2 Minutes:

Subject lies supine, his hands behind his head and his elbows held down by a partner (Fig. B-10). He raises his legs to a 90-degree angle and then returns to the deck as many times as possible in 2 minutes (Fig. B-11). One repetition is counted each time his legs are raised to the vertical.

6. Squat Thrusts in 2 Minutes:

Subject starts from the position of attention (Fig. B-12). He bends his knees, places his palms on the ground (Fig. B-13), thrusts his legs to the rear (Fig. B-14) in the front leaning rest position (Fig. B-15), recovers to the squatting position and returns to the starting position. He goes through this cycle as many times as possible in 2 minutes. One repetition is counted each time he returns to the position of attention.

7. Standing Broad Jump:

Subject toes a line (Fig. B-16) and jumps as far forward as possible (Fig. B-17). He repeats this three times. A marker is placed at the point where the back of his heels hit the ground (Fig. B-18). If the man falls backwards, he is given another attempt. For convenience in measuring, one chalk line was laid 5 feet from the starting line. Five more lines were then laid down 5 feet apart, so that distances jumped could be easily measured by an ordinary desk ruler. The longest jump is recorded.

8. Jump and Reach:

A blackened $\frac{1}{4}$-inch plywood board, 5 feet long and 1 foot wide, marked off in half inches, is mounted on a post. Subject dips his index finger in powdered chalk and reaches as high as possible with heels kept on the floor, marking the board with the chalked finger (Fig. B-19). He swings the arms down and backward, pausing momentarily in a crouched position (Fig. B-20). He jumps upward as high as possible, swinging the arms vigorously forward and upward to the vertical, marking the board at the peak of the jump (Fig. B-21). This is repeated three times. The distance between the reach mark and the highest jump is recorded to the nearest half inch.

9. Three-mile Forced March:

Subject covers a 3-mile course over reasonably level ground in the shortest time possible, but at his own pace (Fig. B-22).

Uniform for Each Event: Utilities with boots. Subject may remove blouse and cap if he desires.

Statistical Comment:

The writer is aware of the fact that studies of physical performance tests have indicated that the average of several available trials gives a better correlation with the criterion than does the single best score.[52-54] However, the differences are relatively small. In a testing situation, such as prevails in a military organization, the increased accuracy theoretically possible by use of the average does not appear to be great enough to justify the increased time and calculations that would be required.

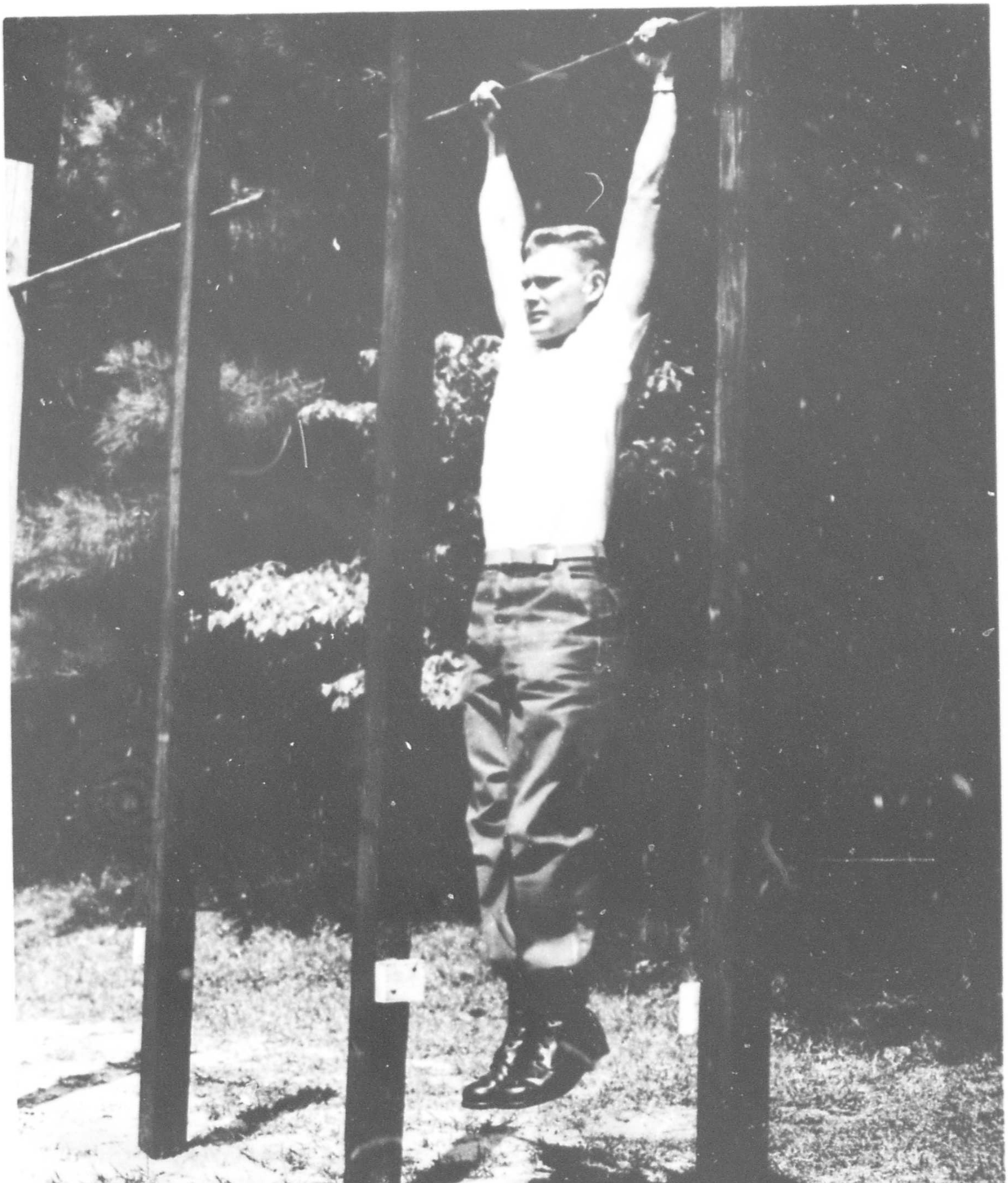

Fig. B-1

Fig. B-2

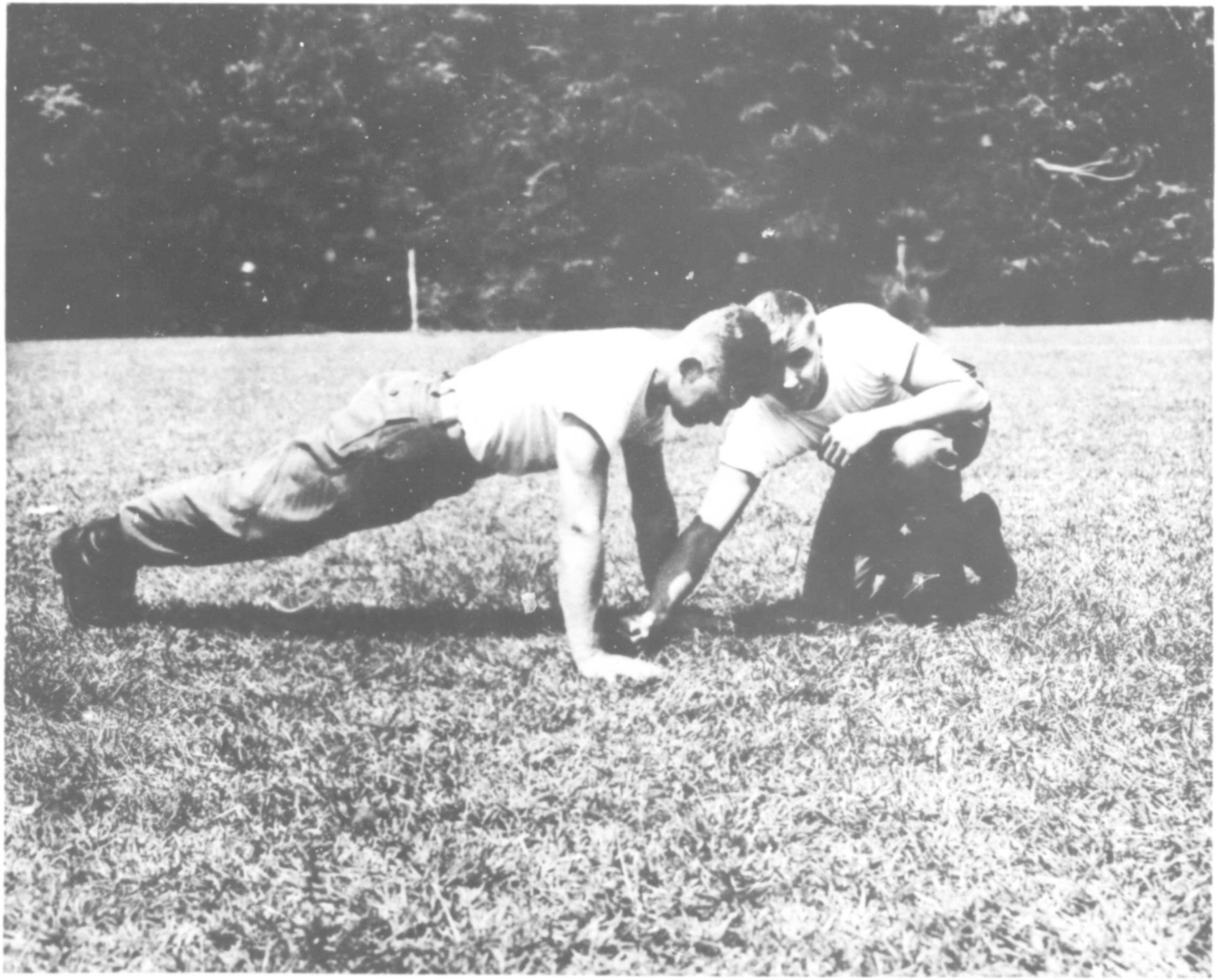

Fig. B-3

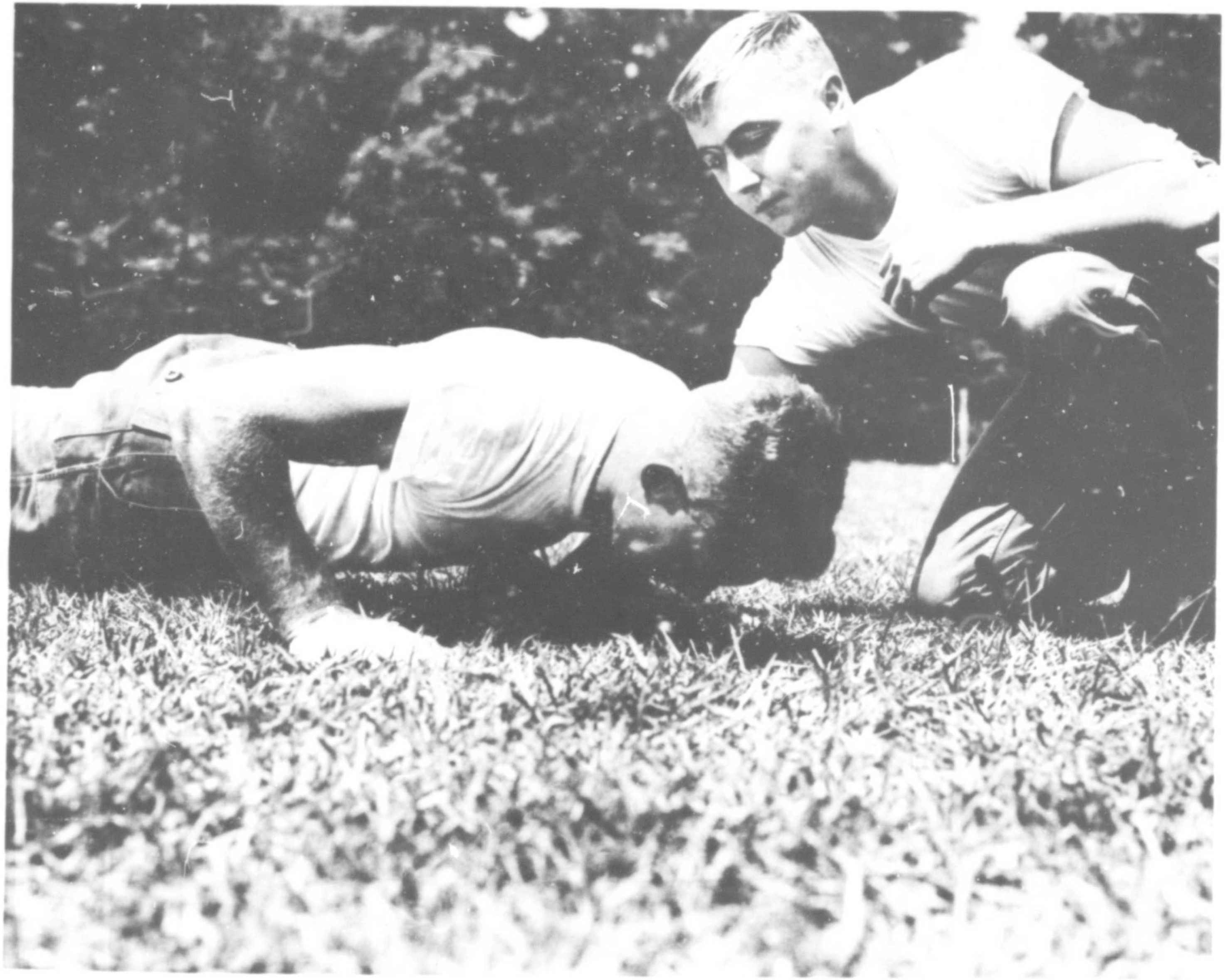

Fig. B-4

Fig. B-5

Fig. B-6

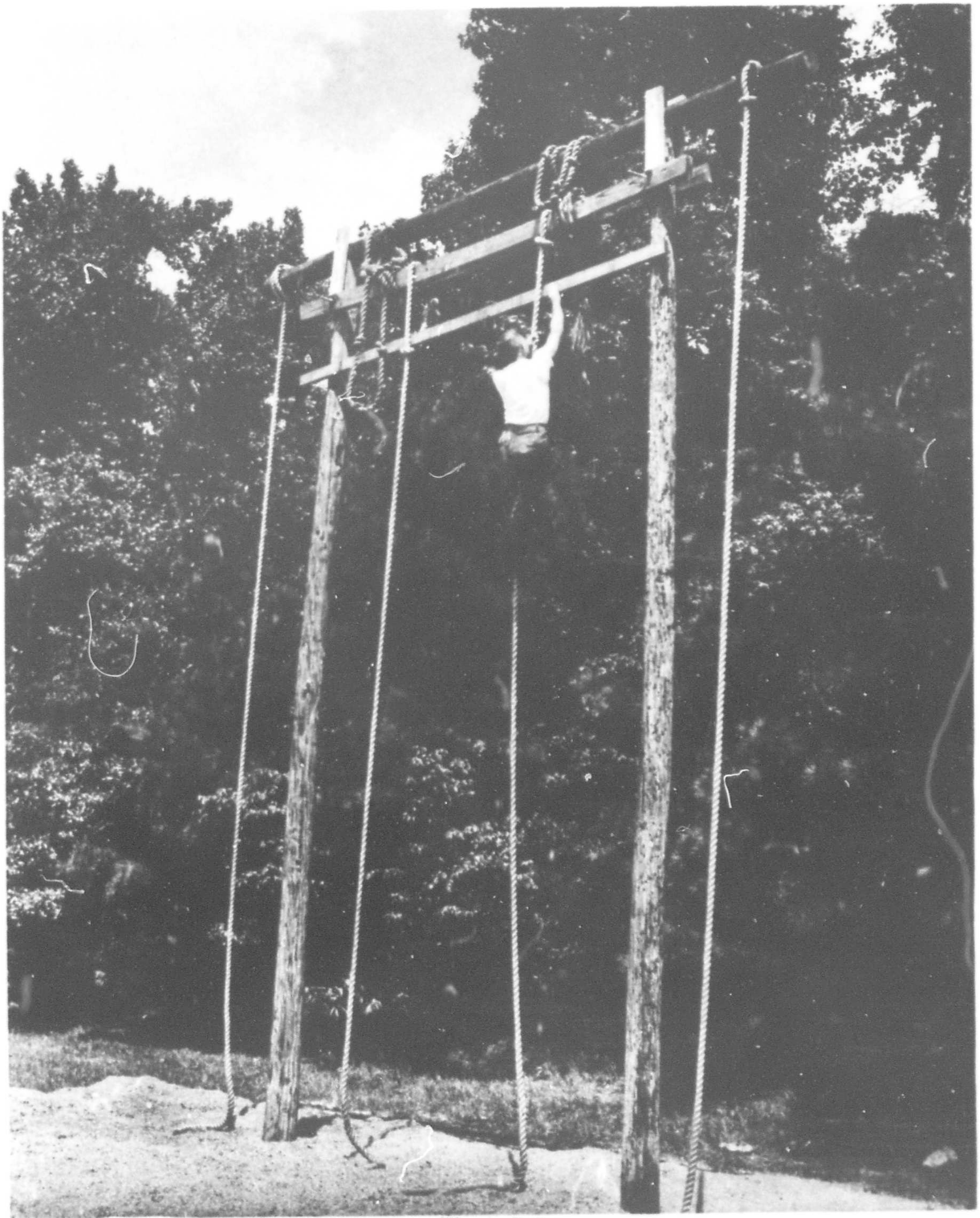

Figure B-7

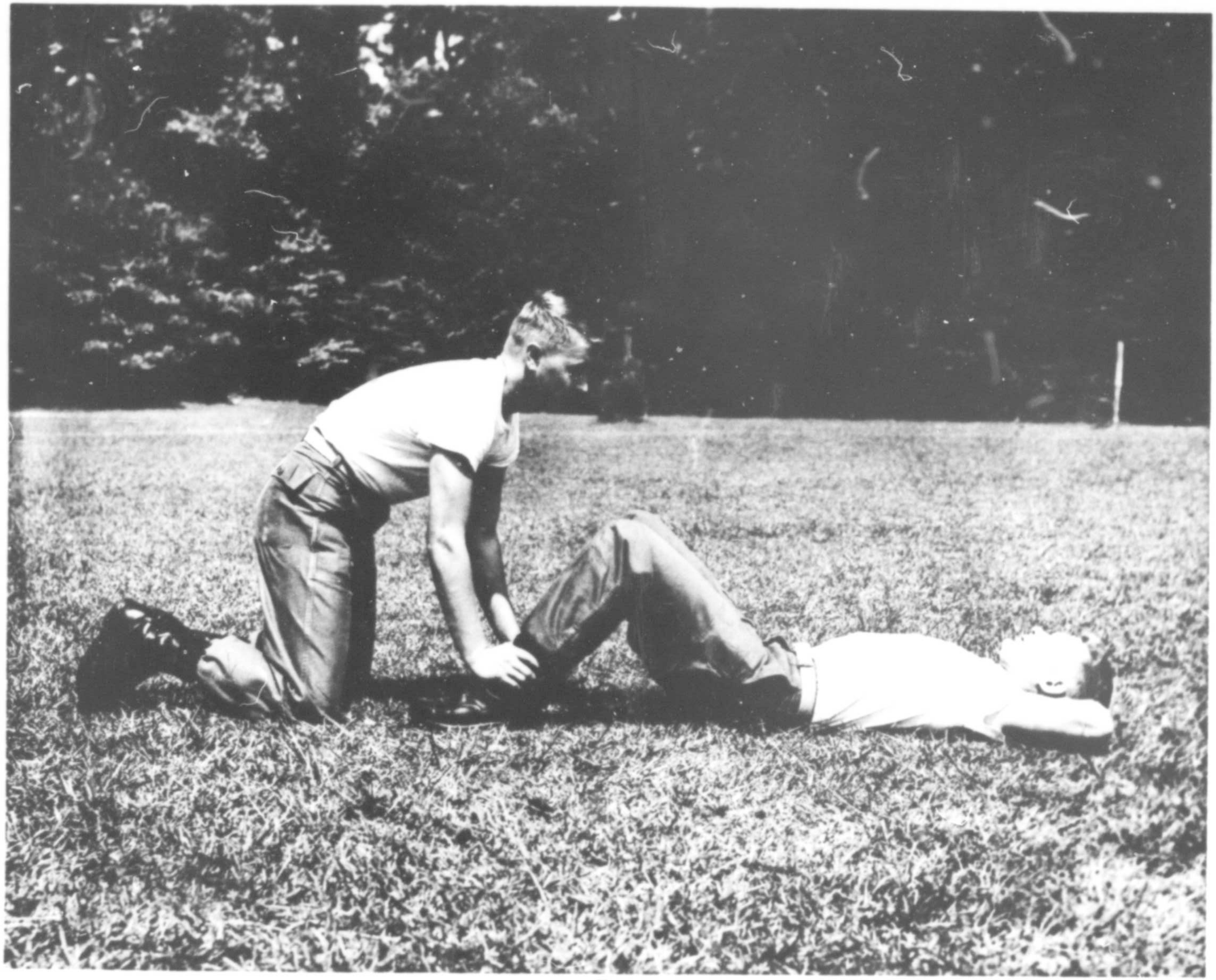

Fig. B-8

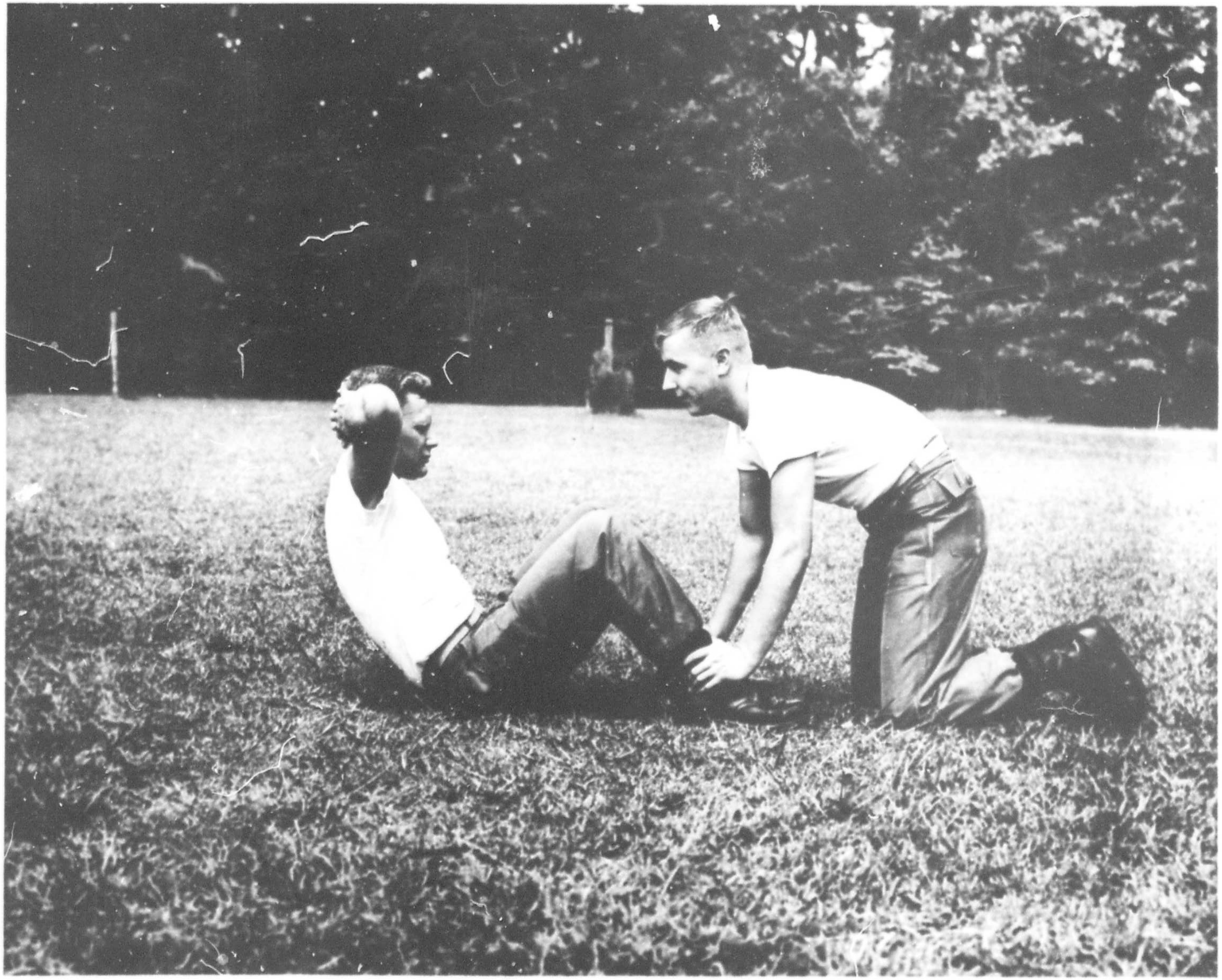

Fig. B-9

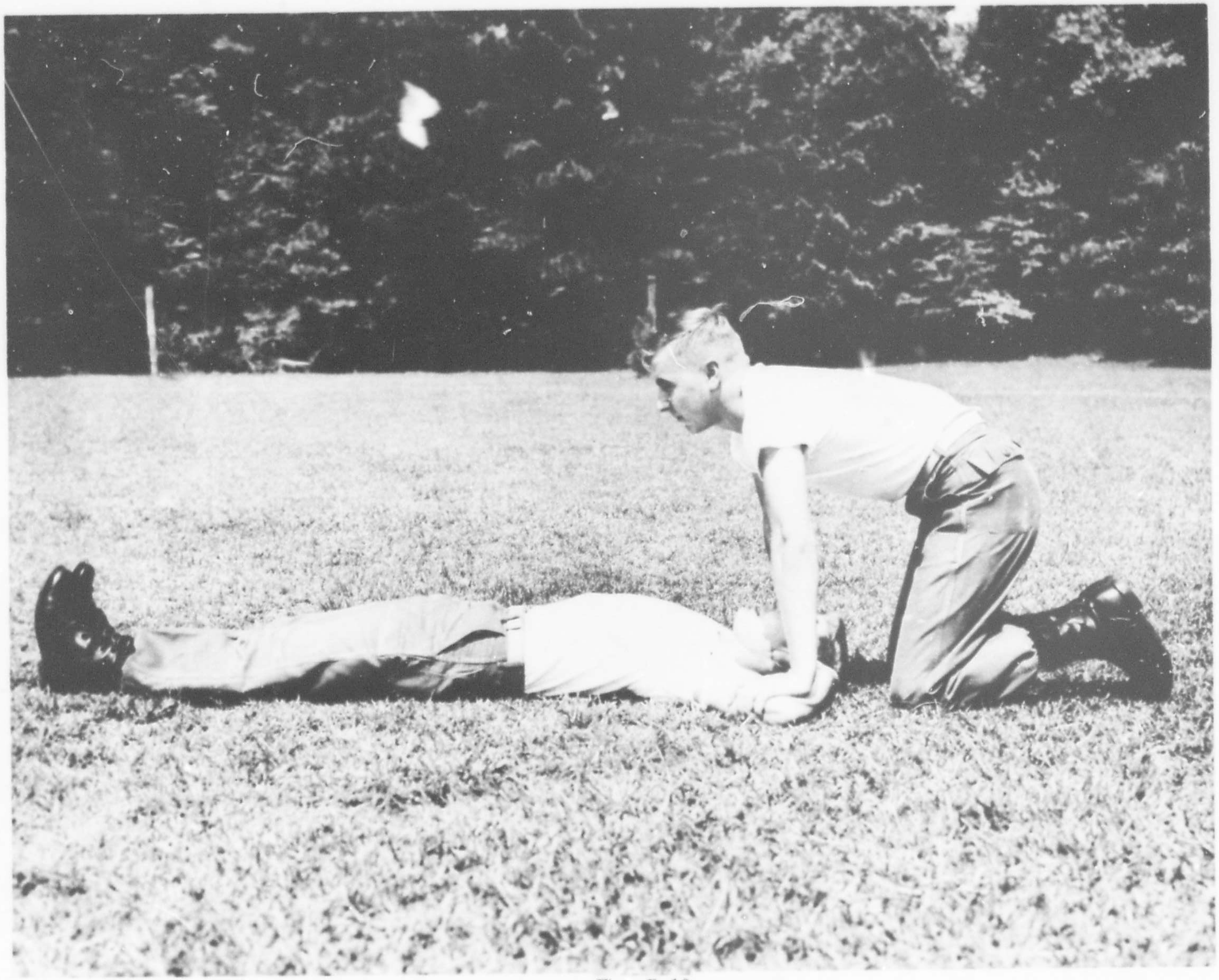

Fig. B-10

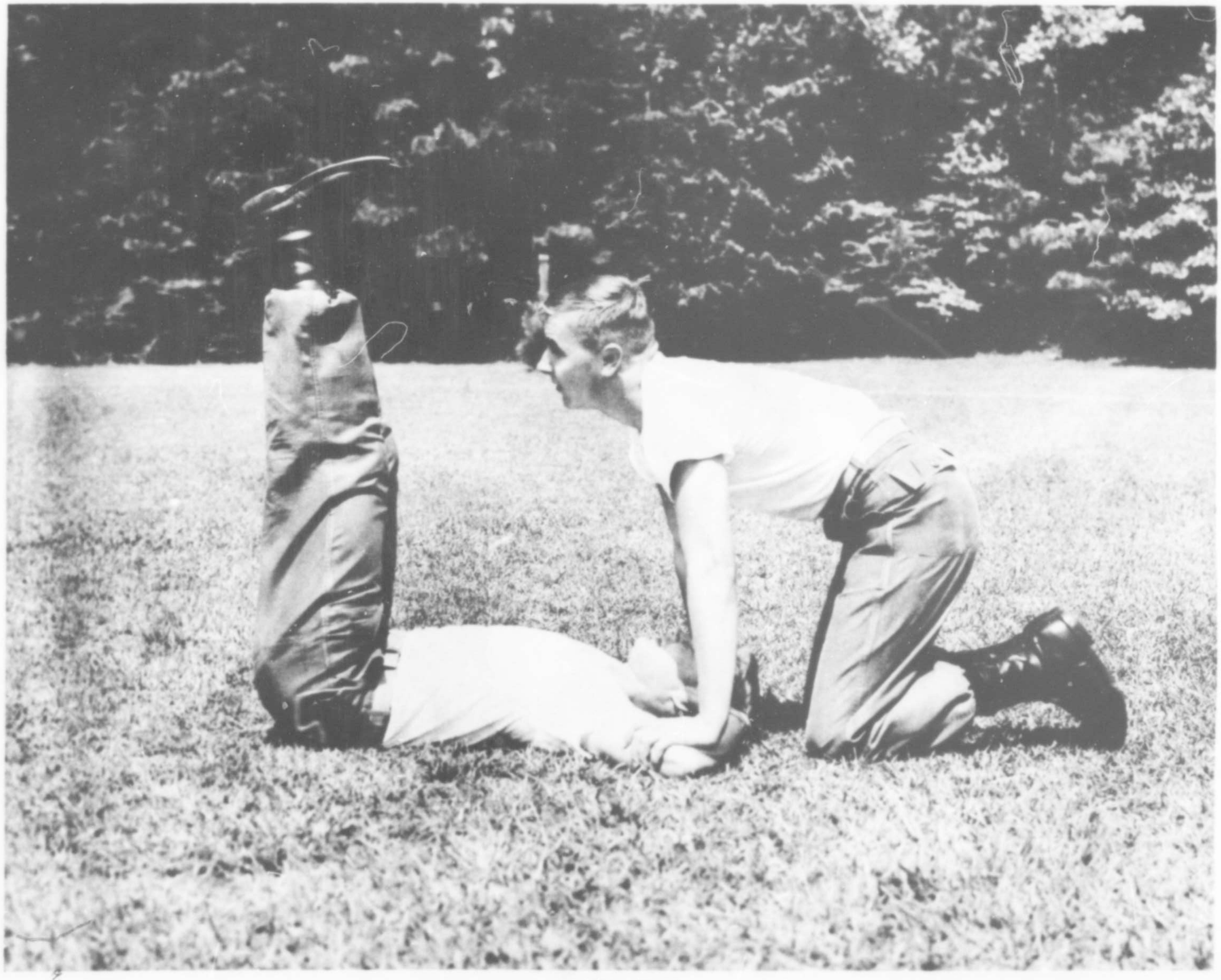

Fig. B-11

Fig. B-12

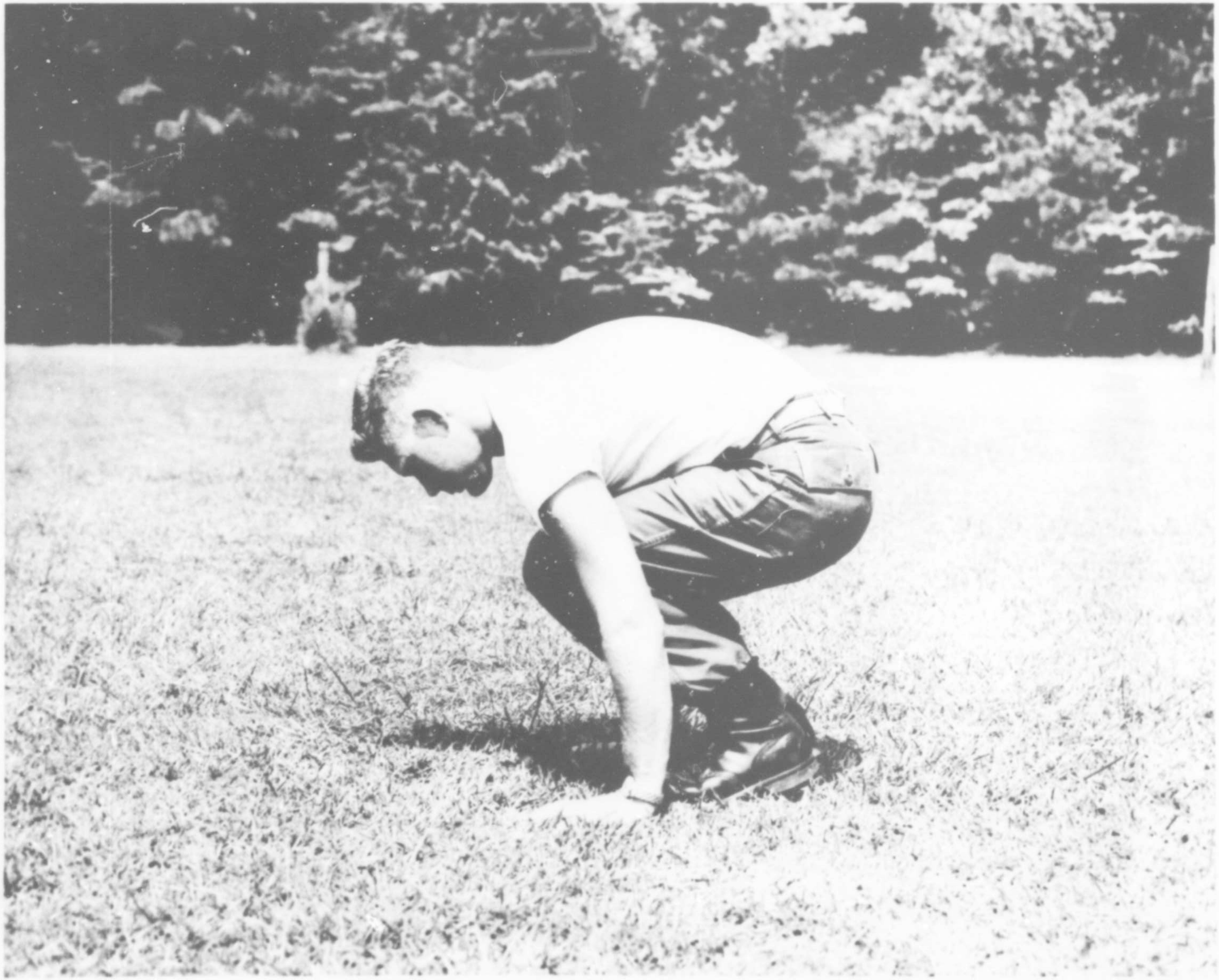

Fig. B-13

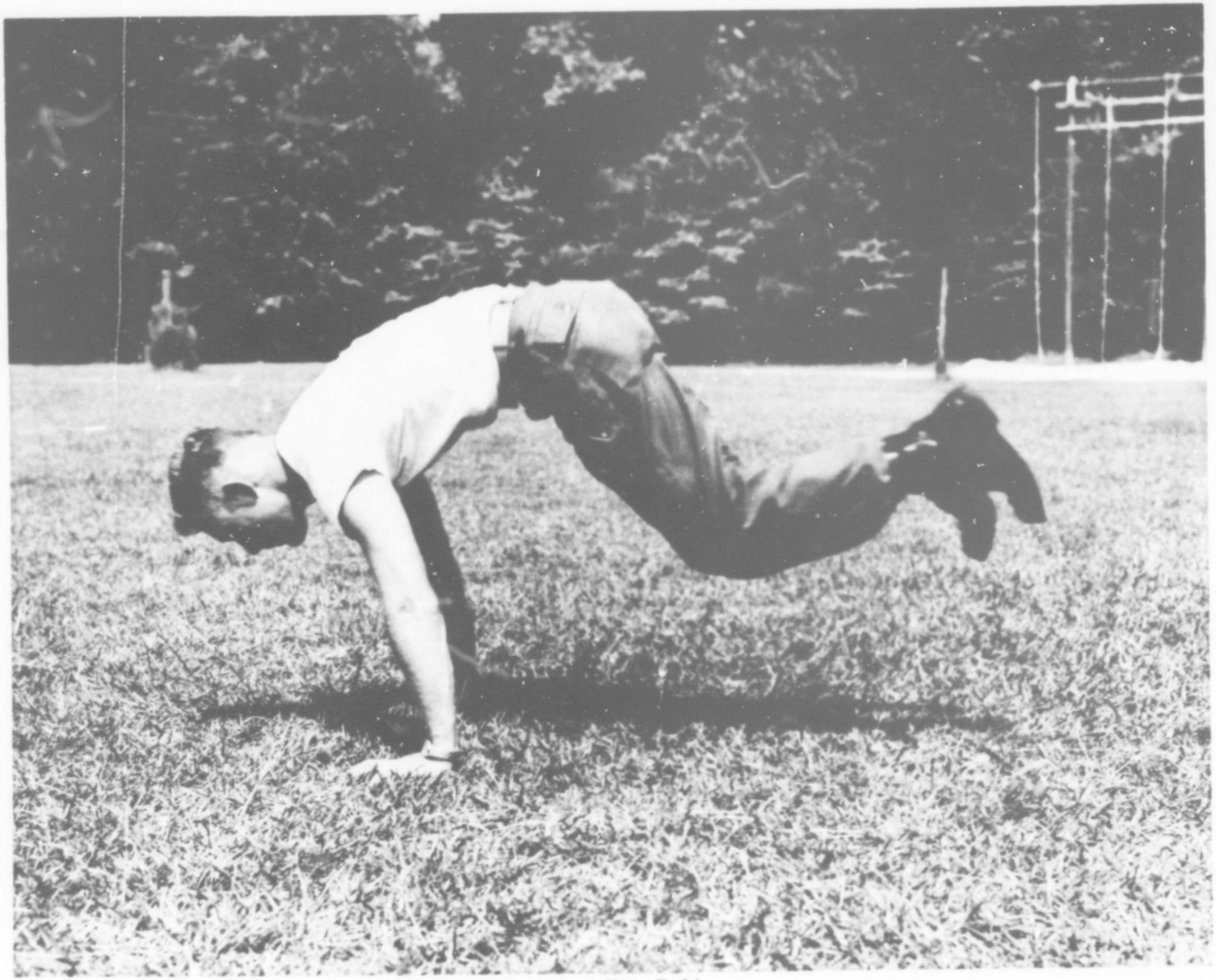

Fig. B-14

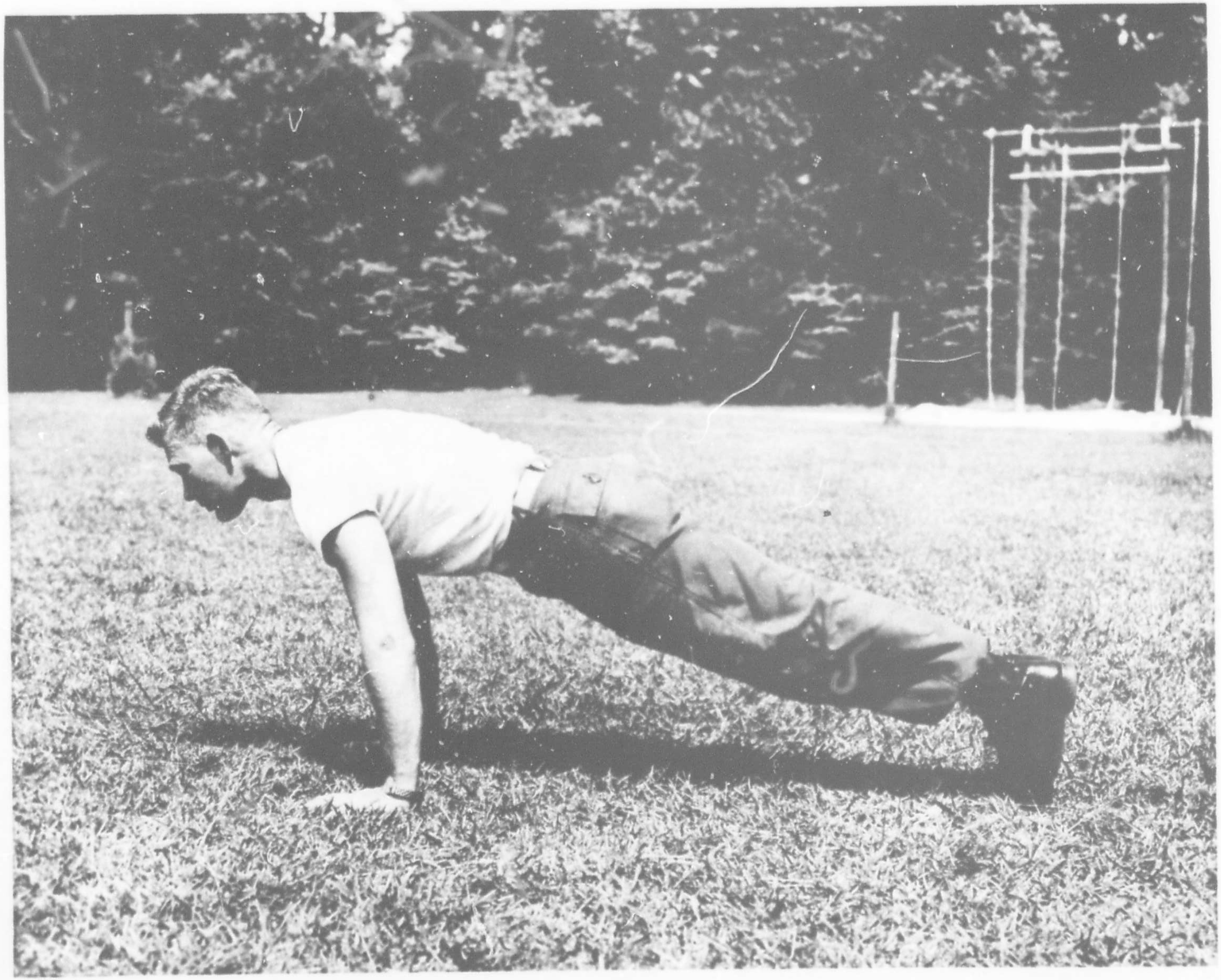

Fig. B-15

Fig. B-16

Fig. B-17

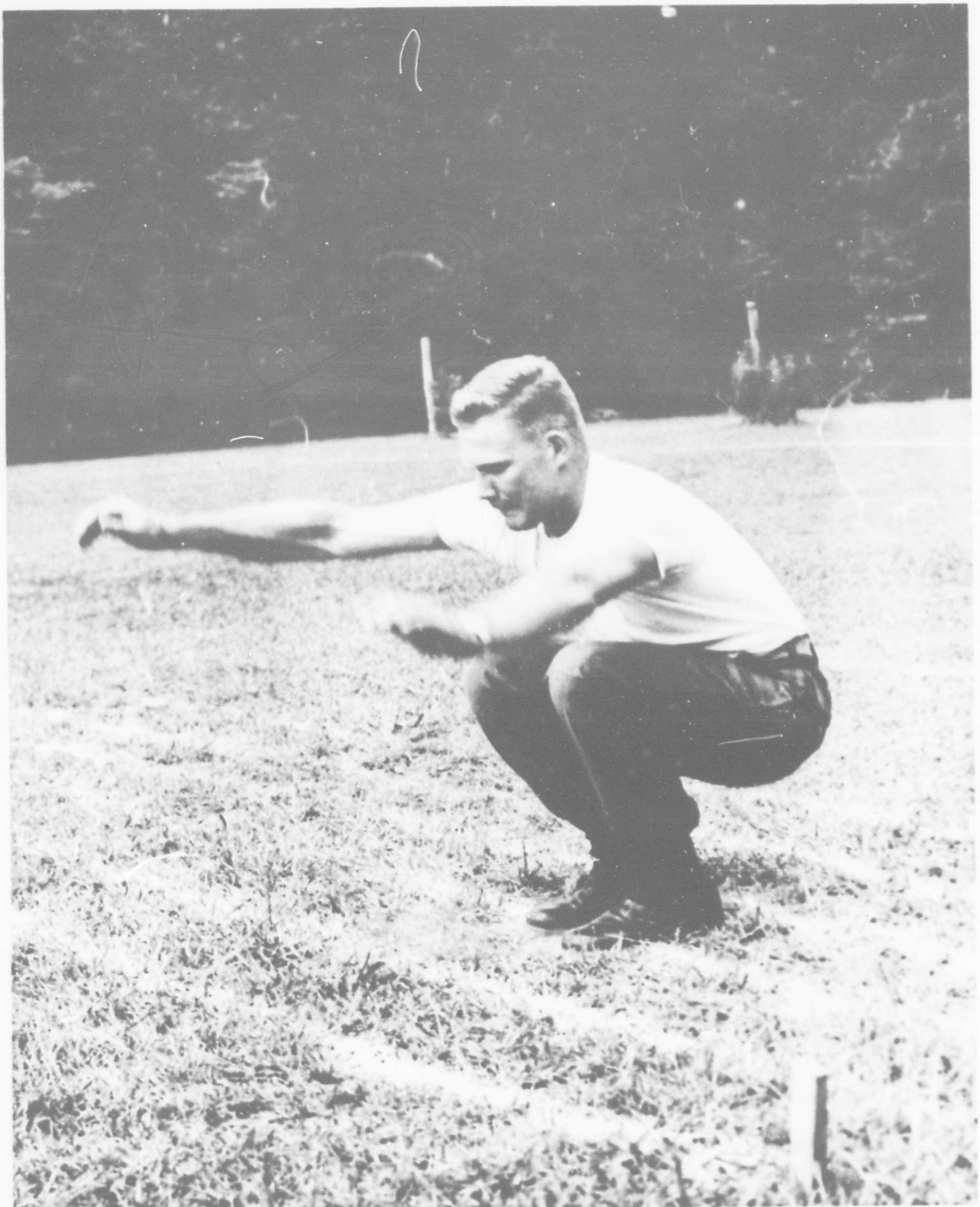

Fig. B-18

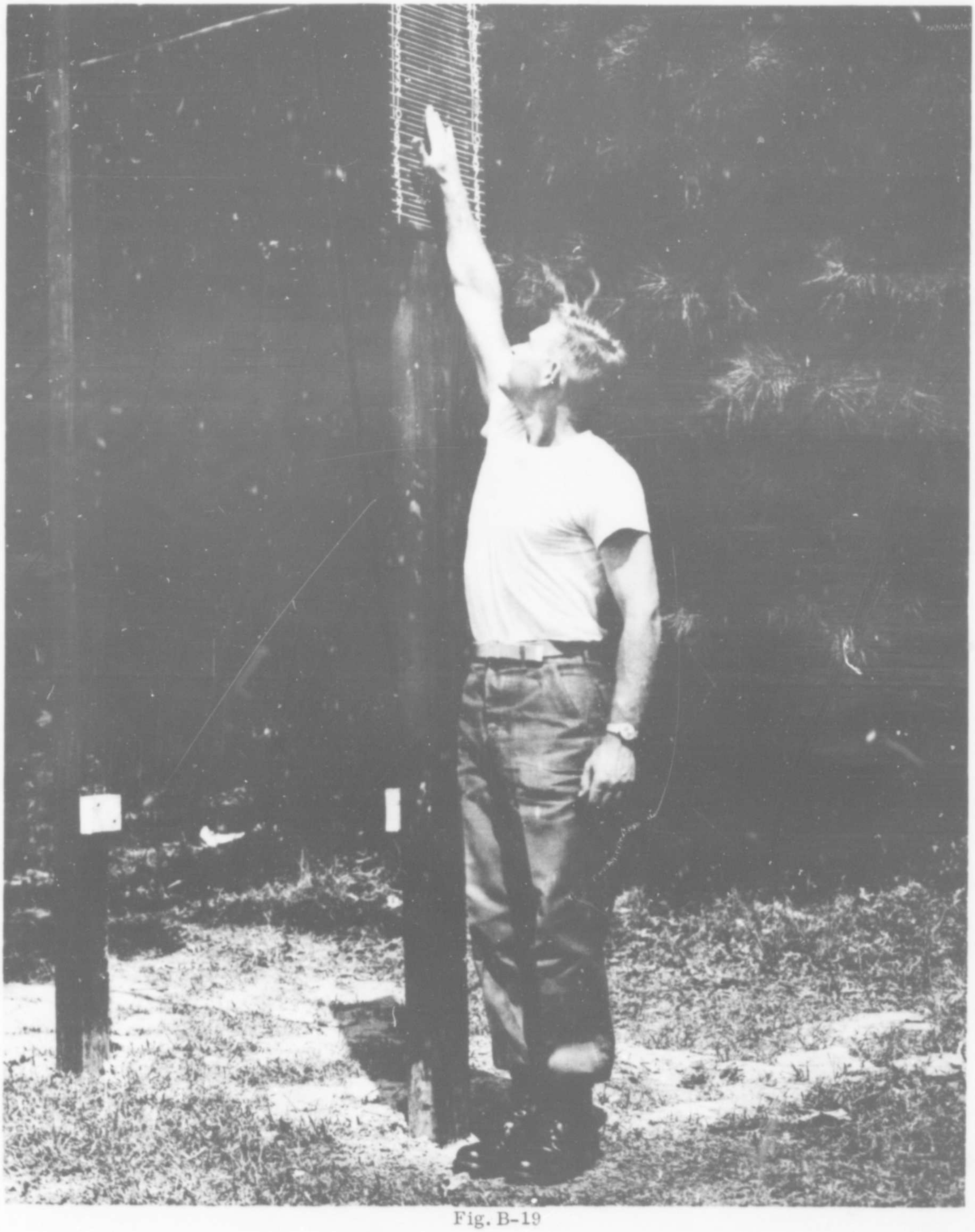

Fig. B-19

Fig. B-20

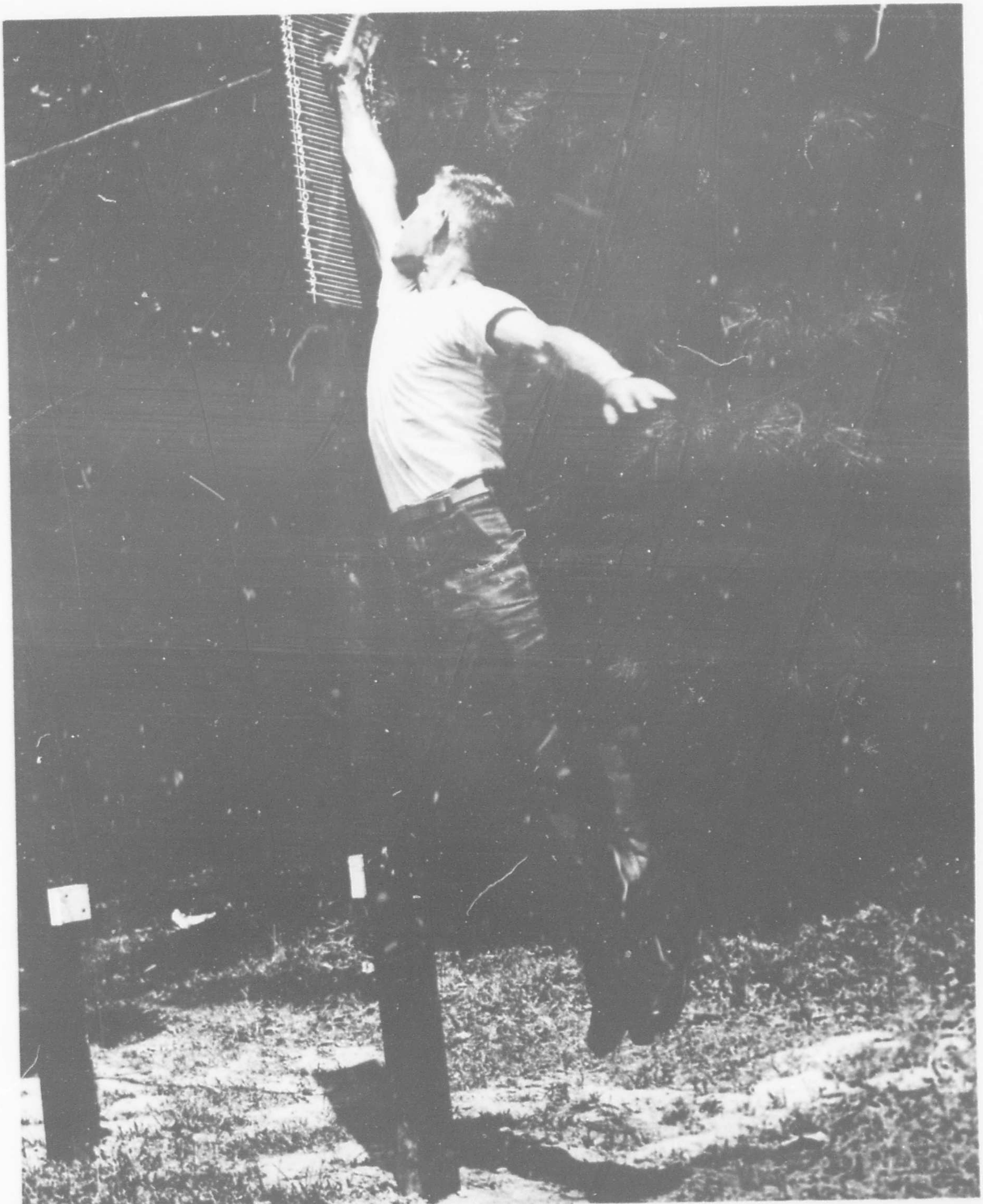

Fig. B-21

Fig. B-22

APPENDIX C

PHYSICAL STANDARDS FOR AVIATION PERSONNEL RECEIVING HAZARDOUS DUTY PAY

Chapter 15, Section V of the Manual of the Medical Department, U. S. Navy, describes the standards for aviation personnel. In particular, article 15-59, paragraph 7-b states: "Electrocardiograms shall be obtained on all flight physical examinations conducted on naval aviators on their 25th, 30th, and 35th birthdays and yearly thereafter except when facilities are unavailable." We were informed that those persons who had questionable tracings were sent to the Naval Hospital to be evaluated by a cardiologist with regard to any limitations of duty.

Flying personnel take the same quarterly Physical Readiness Test as do ground troops. However, the actual mandatory time for physical training veries from squadron to squadron. The maintenance of satisfactory physical condition is largely the responsibility of the individual.

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13. ABSTRACT

Approximately 250 Marines, aged 18-45 years, were administered a proposed new Physical Readiness Test, consisting of pull-ups; push-ups; rope climb; bent knee sit-ups in 2 minutes, feet held; leg raises in 2 minutes, elbows held; squat thrusts in 2 minutes; standing broad jump (best of three attempts); jump and reach (best of three attempts); and 3-mile forced march. Means, standard deviations, and intercorrelations of test scores are reported, together with observations and recommendations. Particular attention is drawn to the possibility of cardiac damage to older men subjected to such tests. ~~(U)~~

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